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A FUNCTIONAL ANALYSIS OF PARAMEDICAL OCCUPATIONS AS A  
FOUNDATION FOR CURRICULUM DEVELOPMENT.

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A MAJOR PURPOSE OF THIS PROJECT WAS THE DERIVATION OF A  
PROCEDURE FOR ANALYZING THE FUNCTIONS OF A MEDICAL LABORATORY  
ASSISTANT IN SUCH A WAY THAT CHARACTERISTICS USUALLY  
DESCRIBED ABSTRACTLY AS SKILL OR BACKGROUND KNOWLEDGE, WHICH  
CAN BE EVALUATED ONLY INTUITIVELY AND SUBJECTIVELY, CAN BE  
DEFINED INSTEAD IN CONCRETE TERMS THAT CAN BE DEALT WITH  
RATIONALLY AND OBJECTIVELY. THE PROCEDURE USED WAS AN  
ADAPTION OF "EVENTAL ANALYSIS," AN ANALYTICAL TECHNIQUE  
DEVELOPED MUCH EARLIER BY THE PRINCIPAL INVESTIGATOR FOR  
COMPLEX PROBLEMS OF ECOLOGICAL SUCCESSION. "EVENTAL ANALYSIS"  
CONSISTS ESSENTIALLY OF MAKING ALL KEY STATEMENTS REDUCIBLE  
TO PHILOSOPHICAL FUNDAMENTALS, THAT IS, TO STATEMENTS OF  
CHILDLIKE SIMPLICITY ABOUT REAL OBJECTS AND REAL EVENTS.  
BECAUSE EXPERIENCE IS THE DISTINGUISHING CHARACTERISTIC OF  
THE TRAINED ASSISTANT, AS COMPARED TO THE NOVICE, EVENTAL  
SPECIFICATION OF THE PRIMARY COMPONENT OF THE QUALITY  
"EXPERIENCE" WAS NARROWED TO A LIST OF ERRORS AND HOW TO  
AVOID THEM. FOR EACH LABORATORY PROCEDURE SELECTED FOR STUDY,  
THREE TEXTBOOKS WERE SEARCHED FOR ERRORS ASSOCIATED WITH THE  
PROCEDURES, AND THE DATA WERE ASSEMBLED AS A LIST OF PROBLEMS  
(OBSERVATIONS OF ERRONEOUS RESULTS) WITH EXPLANATIONS AND  
CORRECTIVE ACTIONS. THE FINAL DATA WERE ASSEMBLED AS APPENDIX  
A OF THIS REPORT. EXAMINATION QUESTIONS WERE DERIVED FROM THE  
DEFINITIVE PROBLEMS OF APPENDIX A AND WERE ASSEMBLED AS  
APPENDIX B. (PS)

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A FUNCTIONAL ANALYSIS OF PARAMEDICAL OCCUPATIONS  
AS A FOUNDATION FOR CURRICULUM DEVELOPMENT

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**ABSTRACT**

**Grant Number:** OEG-4-6-062193-2229

**Project Title:** A FUNCTIONAL ANALYSIS OF PARAMEDICAL OCCUPATIONS  
AS A FOUNDATION FOR CURRICULUM DEVELOPMENT

**Principal Investigator:** John P. Decker, Ph.D., Professor of Human Engineering  
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**Contracting Agency:** Arizona Health Services Education Association

**Duration:** July 1, 1966 - July 30, 1967

**General Nature of the Project:** There is nationwide need for increased effectiveness of instructional programs for the paramedical occupations. A major limit has been imposed in the past by the firmly established liberal-arts tradition of defining goals and standards in terms of intangibles. A practical procedure for breaking this crippling semantic barrier was developed in the present project.

**Specific Objectives of the Project:**

- a. To develop a practical procedure for deriving accurate behavioral specifications, in rigorously concrete terms, of the technical skills, the background knowledge, and the intangible personal traits desired in the paramedical occupations.
- b. To use that procedure to derive sets of such specifications in a pilot study of one paramedical occupation, that of medical laboratory assistant.

**Procedure:** The procedure used was an adaptation of "evental analysis" (an analytical technique developed much earlier by the principal investigator for complex problems of ecological succession). Evental analysis results in evental definition, a general class containing operational definition and behavioral specification as subclasses.

**Results:**

- a. The procedure specified above (under Objectives) was developed.
- b. Practical testing procedures for technical skills and background knowledge were specified.
- c. Sets of definitive problems were derived for evental specification of the intangible quality "experience".
- d. Data were accumulated for evental definition of several intangible personal traits (honesty, adaptability, loyalty, etc.).

## BACKGROUND FOR THE STUDY

Increasing concern about nationwide shortages of medical services has focused attention upon the task of increasing the effectiveness of paramedical educational programs (1)<sup>1</sup>. Overall effectiveness could be increased by expansion of current programs, by increased efficiency of programs, or by combinations of these two. The present study was concerned directly with only increased efficiency of educational programs for medical laboratory assistants (2). More specifically, it was concerned with removing a major limit to refinement imposed by the liberal-arts tradition of stating educational goals in terms of intangibles.

The tradition of intangible goals has obviously not prevented development of an effective system of higher education. The millions of students who have passed through and emerged satisfactorily trained and educated are direct evidence of its effectiveness. However, further refinement of this already effective system has apparently become quite another matter that now requires a much higher order of sensitivity of measurement, which in turn requires a higher order of accuracy and specificity of goals.

### How intangible goals limit educational refinement

The basic difficulty is low sensitivity in measuring effects of changes. There is now no way of deciding within a usefully short time

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<sup>1</sup>Numbers in parenthesis refer to References and Notes.

whether a change of curriculum or didactic procedure has actually helped or hindered progress toward that goal. The situation is analogous to trying to improve marksmanship by tampering with ammunition or gunsights when the target is too remote and hazy for impact points to be observed.

Long-term effects apparently can be evaluated usefully. For example, each of us probably has had valuable aid from his own "Mr. Chips" in accordance with the anchorman principle (3), but such effects can be realized only grossly and in long-term retrospect. The delay in feedback is too great to permit detailed alteration of the process while it is in progress.

#### The liberal-arts tradition of goals and standards

Catalogs of leading liberal-arts colleges (e.g., Claremont, Dartmouth, Duke, Yale, etc.) reveal a consistent practice of stating educational goals in terms of intangibles such as liberation of men from the meagerness of mere existence, development of mental maturity, development of wisdom and judgment, acquisition of knowledge, learning to understand and appreciate our democratic cultural heritage, development of intellectual curiosity, etc. Because direct standards cannot be derived for measuring progress of a student toward such hazy goals, evaluation of student performance is limited to the indirect standards of grades, credits, etc. Standards for Bachelor of Arts degree or Bachelor of Science degree range from quite simple (e.g., completion of 37 slightly specified courses at Dartmouth) to almost incomprehensibly complex patterns of arbitrary devices of academic bookkeeping including requisite courses, prerequisite courses, credit hours for time spent in classrooms, grades, honor points, majors, minors, cumulative indexes, etc., all of which point only vaguely and hopefully in the general direction of the hazy goals.

Liberal-arts education has apparently reached an upper limit, a kind of plateau, and now it oscillates through minor repetitive cycles of fashionable trends based on current convictions of individuals or committees. For example, cyclic trends can be traced from more emphasis on scientific training to more on broadly cultural general education and back again, from many electives to few electives and back again, from the case study method to the background lecture method and back again, etc. Without some means for making more sensitive measurements against explicitly rational standards, there seems little probability of making further refinement of higher education by such methods.

Professional and vocational schools follow the liberal-arts pattern

Catalogs of leading colleges of medicine, law and engineering (e.g., CalTech, Duke, M.I.T., Yale, etc.) reveal close adherence to liberal-arts tradition in that goals are stated as intangibles and standards are specified as an intricate maze of academic bookkeeping devices. A guidebook for schools of medical technology approved by the American Society of Clinical Pathologists, the American Society of Medical Technologists, and the Council of Medical Education and Hospitals of the American Medical Association specified both the prerequisites for admission and the curriculum in intricate detail of course titles and hours spent in classroom and laboratory (4). A similar pattern is specified for the certified laboratory assistant (5). All concentrate, in the liberal-arts tradition, on what the student is exposed to in the way of processing rather than on what he can demonstrate directly in the way of mechanical and intellectual skills.

A recent study demonstrated on a large scale the futility of trying to refine intangible goals expressed in abstract terms. This was a study of goals of engineering education conducted by the American Society for Engineering Education and funded by a \$300,000 NSF grant (6). It was probably the most comprehensive study of its kind ever made, and it represents the most advanced state of the traditional art of analysis of goals and curricula for education in a technical profession. This maximum-effort study offers little hope, however, of fostering substantial educational refinement. Goals were restated again only in terms of intangibles and not in terms of concrete measurables, thus short-term trends toward success or failure of proposed curricular changes can be judged only subjectively and intuitively as in the past. The recommended changes represent the expected cyclic return to past practices. Even if long-term refinements do occur, assigning them to any particular intended treatment effect will be practically impossible because of the high probability of confounding with unidentified extraneous factors.

#### Lack of a known approach to defining tangible educational goals

A survey of relevant literature reveals no suggestion of a procedure for deriving tangible educational goals stated in terms of rational measurables. Derivation of such a procedure was the major task of this project and is its major contribution.



## PROCEDURES AND RESULTS

A major task accomplished in the present project was derivation of a procedure for analyzing the functions of a medical laboratory assistant in such a way that characteristics usually described abstractly as skill, experience, background knowledge, understanding of basic scientific principles, judgment, etc., which can be evaluated only intuitively and subjectively, can be defined instead in concrete terms that can be dealt with rationally and objectively. The procedure derived was an adaptation of evental analysis, a technique developed much earlier by the author for the orderly simplification and solution of complex problems of ecology (7).

### Principles of evental analysis

Evental analysis consists essentially of making all key statements reducible to philosophical fundamentals or irreducibles, that is, to statements of childlike simplicity about real objects and real events. It is based on the following principles:

a. all happenings in ones surroundings may be resolved entirely into simple events, that is, into tangible changes of tangible objects (an object is a fundamental in that it cannot be described in simpler terms, we can only point to it and agree that we call it an object; likewise, a change is a fundamental);

b. every object is a system of component objects and is itself a component of a larger system (e.g., a man is an object; he is also a system of arms, legs, torso, head, etc.; and he is a component of a larger object called his group);

c. there is natural size-ordering of systems in that each object is composed entirely of first-order components, and each of these is composed of its own first-order components, and so on down into the wheels within wheels within the wheels (e.g., forest, tree, branch, leaf, tissue, cell, etc.)

d. there is natural size-ordering of events corresponding to size of object involved;

e. events have a meaningful time dimension whereas objects do not;

f. events may be displayed symbolically on a two-dimensional graph where size of object involved in the event is represented ordinally and time of the event is represented abscissally; the resulting figure is called a plane of events (7).

Much of our thinking about the happenings in our surroundings consists of recognition and solution of practical problems. A problem is conveniently definable as an undesired object or event. A solution to a problem then becomes a series of events by which an undesired object or event is transformed to or replaced by a desired one.

Evental analysis results in evental definition, of which behavioral specification is a subclass. Operational definition is a subclass of behavioral specification in that it specifies the actions one must perform to measure an abstract concept (e.g., mass, time, electricity, energy, etc.).

Evental analysis contains behavioral analysis as a subclass

Although it is customary to speak of considering the student's feelings in dealing with behavioral problems in education, his feelings do not actually enter into such problems at all, according to the simplifying definition of problem given in the second paragraph above. A problem is entirely relative to the observer in that a problem is an object or an event that is undesirable

to a specific observer ("According to whom?" is a key question in one systematic approach to problem recognition and definition). According to the instructor (observer), then, a problem involving a student consists of the undesired actions (behavioral events) of the student. Only the behavior of the student can be observed, his feelings cannot. They are entirely private. No observer can be sure that any observee even has feelings, he only assumes this by extrapolating his own. The observer's assumptions about the observee's feelings may be helpful or harmful in arriving at the solution according to whether they foster accurate or inaccurate predictions of behavior.

Thus, the evental approach is suitable for analysis of behavioral problems, including those customarily assumed to involve emotions of others. It is interesting to note further, in completing the philosophical treatment given here, that all human concerns and statements about the universe or any part of it (including other human beings and their behavior) can be reduced to simple statements about objects and events (either real or imaginary) and about ones own feelings. These three elements of cognition (objects, events and feelings) are thus the irreducible, fundamental repeating units of a simple philosophical system.

#### Application of evental analysis to educational research

A key step in productive research is formulating a good question, one that is relevant, rational and answerable. Evental analysis in educational research directs questioning toward what the student can do rather than what he has been exposed to, toward what he does rather than what he is said to be. The key question that must be asked and answered repeatedly is of the form, "Specifically what must I see a \_\_\_\_\_ do in order that I

would say he is \_\_\_\_\_?" For example: How does a laboratory assistant differ from a layman, that is, what must I see a person do in order that I would say he is a laboratory assistant and not a layman? What must I see a laboratory assistant do in order that I would call him a competent novice? What must I see a laboratory assistant do in order that I would call him an experienced old pro?

#### Evental specification of a competent novice

A laboratory assistant solves problems (recognizes undesired objects and events and transforms or replaces them) that a layman does not. A particular list of problems would define his skill. The definitive problems could be determined by functional analysis of the job, that is, by observing and tallying the actual functions he performs (the events he manipulates).

The procedure originally proposed for the present project involved determining by interview the mechanical steps (events) actually done by skilled assistants in performance of a job. It soon became obvious that a much simpler approach was needed and was possible.

Simplification came with the realization that a description of mechanical steps was not necessary in defining a skill. Instead, a skill can be defined in terms of performance of a practical test where the examinee is required to perform a complete procedure within specified limits of time and accuracy. These two measurables, time and accuracy, provide an overall test for competence on all steps of the procedure, and thus the steps need not be considered individually. The competent novice level of assistant could be defined in terms of certain groups of procedures he must perform satisfactorily under test conditions. Such testing is well within the state of the art and requires only routine development.

Clarification of this point showed that functional analysis of routine tasks performed by an assistant was unnecessary. Elimination of routine functional analysis resulted in a major reduction in the cost of the project and allowed earlier concentration on the task of deriving exact eventual specifications of those personal characteristics that have been described in the past only vaguely and abstractly as experience, judgment, responsibility, motivation, etc.

#### Evental specification of experience

How does a competent novice assistant differ from an experienced old pro, that is, what must one see an assistant do in order to call him an experienced old pro rather than merely a competent novice? One conspicuous difference is that an old pro is able to perform more kinds of laboratory procedures accurately and with greater speed. Although this difference is important in administrative decisions about costs, pay, promotions, etc., it is not the most important difference from the primary point of view, that of a physician ordering laboratory work.

A physician is concerned mainly with reliability of results. From his viewpoint the main element of experience can thus be specified in terms of probability of serious error. This statistic could be estimated directly from past errors, but gathering the necessary data appears impractically difficult. A simplifying assumption permits a reasonable and useful indirect approximation.

A competent novice is trained to recognize and avoid common procedural errors. With time on a job (experience) comes opportunity to make unusual errors and to see them made by co-workers. As he becomes familiar with a longer and longer list of errors and remembers how to avoid them, the

probability of his making a serious error can reasonably be expected to decrease, and this simplifying assumption is made here.

Eventual specification of the primary component of the abstract quality, experience, can thus be narrowed to a list of errors and how to avoid them. To be definitive of an old pro the errors should be those more familiar to old pros than to competent novices.

#### Derivation of errors definitive of experience

Laboratory procedures selected for study were those listed in a standard guidebook (5), with the exception of blood banking procedures which were eliminated because of a time limitation of the project. The routine for each procedure was as follows. Three standard textbooks (8) were searched for errors associated with the procedure, and the data were assembled as a list of problems (observations of erroneous results) along with explanations and corrective actions. The list was shown to a chief technologist in charge of a clinical laboratory, and he was asked to make additions and corrections from his own experience. The list was revised accordingly. The process was repeated with at least two other chief technologists. In the early stages of the study the process was repeated with a fourth and fifth chief technologist, but it soon became apparent that little was being gained from the additional replication and it was discontinued. The final data were assembled as Appendix A of this report.

Collecting similar data on missteps (mistakes that prevented completion of the procedure) was found to require little additional effort, and so this became part of the routine. Familiarity with missteps and how to avoid them is presumably related to a secondary aspect of experience, speed of performance of procedures.

### Use of the definitive problems in Appendix A

Examination questions (both true-false and multiple choice) were derived from the definitive problems of Appendix A and were assembled as Appendix B. These questions were designed to distinguish between a competent novice assistant and an experienced old pro, but actual calibration of the questions for discrimination and consistency was beyond the scope of the present project.

The problems of Appendix A define those primary skills of the experienced old pro distinguishing him from the competent novice. These define exactly then the content material that in-service training should aim at for rapid upgrading of primary skills.

### Evental specification of scientific background

Revising the requirements for scientific background offers opportunity for a major increase in efficiency of educational programs for laboratory assistants. Science requirements, which determine a large part of these programs, are specified in terms of credit hours of coursework rather than in terms of actual skills (4, 5), that is, specified in the liberal-arts tradition. The rationale for selection of information for inclusion in such courses, as stated in the prefaces of standard textbooks, is vague, intuitive and ambiguous with the underlying tacit assumptions apparently never identified or examined. Evental analysis avoids this traditional confusion and leads directly to rational specification.

What must I see or hear a laboratory assistant do in order that I would say he has a good scientific background? Directly observable evidence would be his handling routine laboratory equipment familiarly and

well, his predicting correctly the behavior of unfamiliar equipment, and his giving explanations for many technical events in the laboratory that agree with mine or go beyond them.

The first two categories of evidence involve what is usually called practical scientific information or technical information. Learning of this probably comes mostly from repeated firsthand experience, which seems to offer little chance for drastic improvement and was considered no further in the present study.

The third category of evidence (ability to explain events) involves the main body of information contained in textbooks of chemistry, biology, physiology, etc., and it offers opportunity for drastic improvement. All of the many modern textbooks reviewed in the present study are patterned for the traditional teaching approach of background-first-application-later wherein depth and scope of background are determined intuitively by the individual professor according to his taste or customs of his group. The plane of events (7) fixes a pattern for analytical explanations in which depth, scope and teaching approach are rigorously rational rather than intuitive and whimsical.

The pattern of inquiry fixed by the plane of events consists of simple and repeating steps. The event to be explained is identified exactly as a tangible change of a tangible object. The object is then resolved into its first order of components, and the appropriate subevents are identified separately. A key component event is identified and the process is repeated with it. The whole process is repeated to the limit of reliable human knowledge or to some convenient stopping point. Two specific examples are presented and discussed below:



1. To explain the bending of arm, the object (arm) is resolved into its first order of components: bones, muscles, tendons and assorted soft tissues. The biceps brachii muscle contracts (shortens and thickens) and pulls the tendon attached to the radius bone of the forearm. The bone rotates as a lever about its fulcrum (elbow), and the other bones and tissues of the forearm and hand follow it. The key component event is the contraction of the biceps brachii. How does this event happen? Resolving this object into its first order of components reveals it to be composed principally of a mass of longitudinally oriented fibers, each about the size of a human hair. The fibers are stuck together in a cohesive mass, and most of them contract during muscle contraction. Simultaneous shortening and thickening of a great number of fibers explains the contraction of the muscle. Now, how does an individual fiber contract? Resolving a fiber into its first order of components reveals it to be composed of a mass of longitudinally oriented subfibers (myofibrils) that are visible only with a compound optical microscope. Each myofibril shortens and thickens during fiber contraction and thus explains it. Now, how does a myofibril contract? Electronmicrographs reveal a myofibril to consist of cylindrical bundles of longitudinally oriented subsubfibers (mycellae). Individual mycellae do not shorten and thicken. Longitudinally adjacent bundles slide together, with individual mycellae of each bundle sliding into the spaces between mycellae of the other bundle, presumably in much the same way that the extended fingers slide together as two hands are forced into an interlocked position. Now, by what mechanism do the mycellae slide together? No instrument of sufficient resolving power is yet available to extend the human sense of sight far enough to permit the necessary next step of

examining the first order of components of mycellae. Thus, the frontier of direct knowledge has been reached, and scientists are restricted to making conjectural models (educated guesses) about the nature and behavior of the smaller orders of components and subcomponents.

For a reason not clear to the present author consideration of conjectural models has become extremely popular with scientists and popularizers of science. Educated guesses about imaginary particles called molecules, atoms, electrons, etc. are somehow more awesome and tantalizing than are accurate observations of the behavior of tangible objects and systems. The smaller the particles, the more basic and fundamental "information" about them seems. The rational denotation of "basic and fundamental" is very obscure, but the connotation is strongly emotional with a compelling air of mystery approaching that of blessed, sacred or occult. The mystery is probably associated with that of the popular image of Science wherein the research laboratory resembles a mysterious temple presided over by a Scientist, a kind of high priest in a white coat, whose highness or status is partly related inversely to the size of particles he investigates.

Treating conjectural models as though they were realities has become customary. For example, statements to the effect that energy for muscular contraction comes from the breakdown of ATP molecules into ADP molecules are common in introductory textbooks of biology and physiology. At present such statements are but jargonized doubletalk. The linkage between mycellar events and submycellar events is not known. Thus to believe that reliable knowledge exists about linkages to even lesser events is to be self-deceiving. Irrational preoccupation with the most up-to-date legends about imaginary particles is perhaps a compulsive questing for a

magic panchreston or explain-all and is a modern version of the ancient quest for a philosopher's stone that was supposed to be the key to all knowledge. In modern usage as illustrated above, the energy concept has become a magic panchreston (9). This concept, which started as a completely abstract symbol for the mass of a particle multiplied algebraically by the square of its velocity relative to another specified particle, has suffered the classical semantic blunder of reification. In modern usage it has become an almost tangible entity, the prime mover of the universe, the 20th century spirit of light, heat and motion resembling its 18th and 19th century ancestors, phlogiston and caloric. To require a student to recite that a part of the chemical energy of ATP is released as mechanical energy and a part in the form of heat energy is to require him to prattle about the physical properties of a disembodied nothing--the philosophical equivalent of discussing how many angels can stand on the head of a pin.

2. A beaker of aqueous solution of a salt can be heated to dryness more easily on a dry day than on a humid day. Explain. It is absolutely impossible for a mortal man to know what really happens to water as it disappears in the process called drying. Resolving water to the limit of our microscopically extended sense of sight reveals no substructure; for example, the thin film of water left on a bartop by the bartender's damp rag simply shrinks and disappears, and a microscope reveals no more. So the drying of water cannot be explained in terms of direct evidence. We must resort immediately to conjectural models. It is convenient to think of water breaking up spontaneously into droplets too tiny to be seen individually--like those from a lawn sprinkler but much smaller. As individual tiny masses separate from the large group and scatter into the air they disappear like the

scattered members of a flock of sheep on a distant hillside. Translate "tiny mass" into its Latin equivalent "molecule", assign the name vapor to the air-borne dispersed particles, and assign the name evaporation to the change from the closely grouped to the dispersed state, and we are back on legendary ground so familiar that we easily forget it is only fancy and not established fact.

The task now is to construct a conjectural model showing how humidity might retard drying rate. Imagine that some of the invisible droplets return from the air and rejoin the group, and call this return process condensation. Now drying or net evaporation becomes the difference between gross evaporation and condensation. Imagine that the number of tiny droplets returning to the group per unit time (condensation rate) is a simple function of the number per unit of volume of air (absolute humidity). This model then shows how humidity might reasonably be imagined to retard drying rate. It is much simpler than the model implied by the traditional statement that humidity retards evaporation, which requires imagining some device whereby vapor molecules collide selectively with those just escaping from the group and knock them back--that is, vapor molecules must be imagined as acting differently towards each other than towards other gas molecules, a complication in violation of Occam's Razor or the principle of parsimony.

All physical and chemical phenomena encountered in the laboratory present similar examples for analytically explanatory sequences. Exploration of these would establish the worthwhile so-called basic principles of physical science, that is, analytical explanations common to many observable phenomena. Restricting exploration to events

actually encountered in the real world would avoid burdening students with recitation based on models constructed by researchers to explain events encountered only under the highly improbable conditions of a research laboratory. These highly specialized and temporary models (e.g., subatomic particles) do have a compelling aura of mystical fundamentality about them as though they were very close to the tacit Golden Key, that ultimate panchreston that will unlock and explain all mysteries of the universe. This is perhaps why they are so often peddled enthusiastically in academia as the glittering latest in up-to-date Science. The tacit assumption that analysis into the vanishingly small is the only possible pathway to that implicit mythical state of ultimate understanding is interestingly one-sided from a philosophical point of view. Synthesis (consideration of larger and larger systems) offers an equally plausible pathway, but it is apparently more subtle and less likely to be reached by the blindly intuitive groping of a dedicated scientist. Behavior of some small systems can be hypothesized more easily by observing larger ones, for example the model of electrons in planetary orbits came directly from astronomical observations and models. Further, there is a large body of historical records of highly competent religious thought contending that the ultimate wisdom lies upward in the infinitely large. At any rate, explicit identification of the tacit assumptions implicit in the naive intuitive approach should at least begin to clear the way for a rational approach to specifying desirable scientific background.

A clear, concrete and rational specification of the amount of scientific background required for good performance at the different levels of laboratory assistant (aide, certified assistant, technician,

technologist, etc.) could be made in terms of the number and kinds of events to be explained and in terms of the number of size-orders of analytical resolutions to be completed in each explanation. Empirical data required as the basis for those specifications is, of course, lacking at present, but gathering it would be only a routine research task. Experimental investigation could be made also to establish which explanatory information was directly useful to assistants and which was indirectly useful because students gained confidence and esthetic satisfaction from being able to explain events one or more steps beyond absolute necessity. Gathering these two kinds of data was far beyond the scope of this first exploratory study and was not attempted.

Step 12 of the procedures listed in the amended proposal ("Interview supervisor and pathologist in charge to ascertain those chemical and physical principles involved in the test that they consider essential 'basic background information'.") was found impractical for two reasons and was discontinued early in the study. The first reason was that it proved to be extremely expensive in terms of time required of pathologists. The second reason was that when pathologists talked about goals and techniques for science teaching they sounded like college professors talking about the teaching and learning processes, that is, they made little distinction between fact, folklore, pet hunch and tacit assumption. The following are rough summaries of three interviews that weighed heavily in the decision to abandon the step:

1. A pathologist was asked for an example of a background principle of physics that an assistant should be familiar with in connection with the microhematocrit procedure. He mentioned centrifugal

force. What about centrifugal force? It causes red cells to separate from plasma and pack into a tight mass at one end of the tube. Should they understand <sup>it</sup> that causes centrifugal force? Not necessarily but it would probably be worthwhile. Should they know that centrifugal force increases as the square of velocity and inversely as the radius of the centrifuge? No, only that velocity and radius have effects on centrifugal force that must be taken into account. Comment: The most interesting fact about this basic background information is that it is false. Any good modern textbook for high school physics (e.g., 10) describes a simple experiment for proving unequivocally that centrifugal force does not exist and therefore cannot explain anything.

2. An assistant in a chemistry lab might be working with distillation and refluxing; do you think he ought to be familiar with the physics of condensation? For example, should he be able to explain why moisture condenses heavily on the inside of the windows in winter if there is much water boiling in the laboratory? I'd be disappointed if an assistant hadn't learned to explain that in high school or maybe grade school. How much of an explanation should he be able to give? He certainly ought to know that the warm moist air is cooled as it touches the window and its moisture holding capacity goes down until the air is supersaturated, at which point the moisture condenses on the window. Comment: This classical explanation tacitly assumes semi-magical properties (properties that cannot be modeled) for water vapor and air--- with plain old  $N_2$  and  $O_2$  having a strange spongelike affinity for another simple gas,  $HOH$ , that they do not have for each other, and with that strange affinity being temperature sensitive. The assumption requires

another set of gas laws peculiar to HOH, and it thus violates the principle of parsimony as well as common sense. It is far simpler to imagine that the cold glass has no effect whatsoever on condensation but instead cools the attached water film and reduces its evaporation rate enough that net condensation (where normal condensation rate exceeds reduced evaporation rate) causes the ever-present film on the glass to become noticeably thick.

3. One justly pleased pathologist remarked nearly as follows: One of my brightest gals was put on the 12 channel autoanalyzer. One day she caught it giving some funny little squiggles--slanted lines that should have been vertical. She spotted this as a malfunction, got out the book, diagnosed the trouble and corrected it. I am confident she was able to do this so easily because of her excellent scientific background. Comment: Her rote knowledge of electronic planetary orbits and changes in energy levels (an explain-all for modern chemistry) and of the classificatory categories and names of animals (a major part of standard zoology) had no demonstrable bearing on this good diagnosis. A more likely explanation is that she had worked with recording galvanometers and similar instruments long enough to realize that unusual output usually results from unusual input which can be traced systematically to a malfunction somewhere in the detector system--a practical kind of familiarity that seemingly comes more from firsthand experience with instruments and their malfunctions than from theoretical lectures by the most diligent and competent of science teachers.



### Evental definition of personal traits

This was a bonus phase of the project based on a secondary objective that was pursued for a short time after the main objectives had been accomplished. A rationale was developed for applying evental analysis to those personal traits that weigh heavily in supervisory decisions about hiring, firing and promotion; and promising preliminary results were obtained.

Pathologists, chief technologists and senior technologists were interviewed. At the beginning of each first interview the subject was encouraged to talk freely in his own language until he had mentioned several abstract labels for behavior <sup>t</sup>pat<sub>^</sub>terns. Then he was asked to give a specific example illustrating what he meant by, for example, "responsible". This was continued for the rest of the interview period with other abstractions he had mentioned. He was asked to jot down notes as other illustrations occurred to him during the next several days. The tape recording was transcribed later, and lists of his labels and illustrations were compiled. A consolidated list was compiled after the first round of interviews.

Usually at the beginning of the second interview (sometimes during the first) the aims and rationale of this phase of the project were described to the subject about as follows: "We're trying to come to grips usefully with those slippery, nebulous, intangible personality characteristics that are so important but so hard to define. You can say, for example, that you want your assistants to be responsible and ethical, and I will nod in agreement. But what have we actually agreed upon? Your conception of responsible

and ethical are probably different from mine, and we could easily get into a long and fruitless argument about what the words really mean. But that's the trap. Our real concern is not with the words and what they mean, not with what we say the person is. Our real concern is with what he did in the past and does in the future, our concern is with his actual behavior. To help train our assistants in school and to upgrade them on the job we ought to have a detailed listing of the exact actions we'd like to see and of those we'd not like to see. This is the list I want finally to derive in this study. Can you now give me more examples of actions, of behavior that you particularly like to see or don't like to see on the part of your lab assistants? We'll use a list of abstract labels as memory catalyzers, but the emphasis now is not on your trying to illustrate to me what you mean by, for example, "unethical", the emphasis is instead on your describing actions you have actually observed and that you want increased or stopped-- and we won't worry about whether those actions are best labeled as ethical, dishonest, irresponsible or what."

The following list of labels was compiled from the interviews:

1. ability to get along with other people,
  2. attitude,
  3. compassion,
  4. confidence,
  5. conscientiousness,
  6. creativity,
  7. curiosity,
  8. dependability,
  9. desire to learn,
  10. professional ethics,
  11. honesty,
  12. humility,
  13. initiative,
  14. integrity,
  15. intelligence,
  16. interest,
  17. leadership,
  18. loyalty,
  19. maturity,
  20. neatness,
  21. personality,
  22. reliability,
  23. responsibility,
  24. selflessness,
  25. stability,
  26. tractability.
- At least one illustrative case history was obtained for each term. Some case histories were in great detail, others were fragmentary

and vague. These preliminary data are too meager to be worth summarizing yet, but the pattern of needed inquiry and the specifications for the needed data are now clear: don't be concerned with defining any intangible characteristic or personal trait, per se, but instead collect accurate descriptions (in strictly evental terms) of conspicuously undesirable actions of laboratory assistants that have actually been observed by a reliable witness (the rules for admissibility of testimony into court apply--don't tell us what you think, what you feel, or what somebody told you had happened, tell us only what you saw and heard firsthand). Later refinements might include establishing more and smaller intervals along the desirability scale to increase sensitivity, and studying frequency distributions. A reasonable first hypothesis to be tested statistically is that behavioral events in a laboratory are distributed normally with respect to the desirability scale, with extremely desirable and extremely undesirable events vanishingly rare and with neutral events (central zero on the scale) having the highest frequency of occurrence. Careful study of frequency distributions would also permit precise searching for factor effects having management significance, for example, does the distribution curve tend to skew to the right (negative desirability) in a laboratory where the chief technologist is a grouchy old man and to the left if the chief is a beautiful and well-proportioned girl? Collecting, compiling and interpreting the needed data would be a project worthy of perhaps a doctoral dissertation in human engineering. Its potential usefulness in both academic and in-service training of laboratory assistants is obvious.

A similar brief exploratory study was done on motivational factors. Assistants were asked about the intangible rewards of the occupation, what is the most attractive aspect of the work, what part of it do you get the biggest kick from, and gradually the questioning was directed into eventual terms--are there any particular things you do (actions you take, games you contrive) to make it more pleasant (make it more fun, increase the kick), etc. The patterns of inquiry and of handling data were essentially similar to those described for personal traits. Again, the patterns of what data are needed and how to go about gathering them are now clear. Collecting and compiling the data will be another project worthy of a master's thesis in human engineering.

### CONCLUSIONS

Evental analysis proved to be a practical procedure for deriving accurate behavioral specifications, in rigorously concrete terms, of the technical skills, the background scientific knowledge, and the intangible personal traits desired in medical laboratory personnel. Such specifications can be used as a basis for drastic improvement of curricula in technical schools and of in-service training for upgrading personnel to higher professional competence and responsibility.

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APPENDIX A

**Definitive problems with their explanations and solutions.**



MISSTEPS (mistakes that prevented completion of the procedure)

V E N I P U N C T U R E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. No blood enters syringe. Hematoma forms.</p>	<p>(Syringe)</p> <p>1a. Piercing outer coat of vein without entering lumen.</p> <p>1b. Transfixation of vein.</p> <p>1c. Needle gone completely through vein.</p> <p>1d. Piercing vein, then drawing needle out.</p>	<p>1a. Withdraw syringe slightly and reenter vein.</p> <p>1b. Withdraw syringe slightly aspirate gently. If puncture must be repeated place sponge on puncture, apply pressure to stop bleeding. Repeat puncture in other arm.</p> <p>1c. Withdraw syringe slightly.</p> <p>1d. Place needle back into vein.</p>
<p>2. No blood enters syringe. Hematoma does not form.</p>	<p>2a. Excessive pulling on plunger of syringe caused vein to collapse.</p> <p>2b. Area has poor circulation.</p> <p>2c. Bevel of needle covered by wall of vein.</p> <p>2d. Vein was missed.</p>	<p>2a. Aspirate gently. Do not pull back quickly on syringe.</p> <p>2b. Repeat puncture in area of good circulation.</p> <p>2c. Place needle into vein a little farther to enter lumen.</p> <p>2d. Hold vein in place with thumb and index finger--repeat procedure. This will help prevent hematoma.</p>

V E N I P U N C T U R E

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>3. Air enters syringe instead of blood.</p>	<p>3a. Glass syringe tip was cracked.</p> <p>3b. Luer-Lok dirty so needle did not fit properly.</p>	<p>3a. Repeat procedure with syringe that is not broken, or vacutainer, or disposable syringe.</p> <p>3b. Repeat procedure with clean syringe, or use vacutainer, or disposable syringe.</p>
<p>4. Syringe comes off needle while needle still in patients arm.</p>	<p>4a. Luer-Lok dirty so needle did not fit properly.</p> <p>4b. Needle not secured to syringe.</p>	<p>4a. Remove needle from patients arm. Repeat procedure with clean glass syringe, vacutainer, or disposable syringe.</p> <p>4b. Remove needle from vein, secure syringe to it, repeat procedure.</p>
<p><u>(Vacutainer)</u></p>		
<p>1. No blood in vacutainer tube. Hematoma forms.</p>	<p>1a. Piercing coat of vein without entering lumen.</p> <p>1b. Transfixation of vein.</p> <p>1c. Needle gone completely through vein.</p> <p>1d. Piercing vein, then drawing needle out.</p>	<p>1a. Withdraw needle slightly and reenter vein.</p> <p>1b. Place sponge on puncture, apply pressure to stop bleeding. Repeat puncture in other arm.</p> <p>1c. Withdraw syringe slightly.</p> <p>1d. Place needle back into vein.</p>

V E N I P U N C T U R E

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>2. No blood in vacutainer. Hematoma does not form.</p>	<p>2a. Vacutainer is old and there is no longer a vacuum in it.</p> <p>2b. Vacuum in vacutainer caused vein to collapse.</p> <p>2c. Area has poor circulation.</p> <p>2d. Bevel of needle covered by wall of vein.</p> <p>2e. Vein missed completely.</p>	<p>2a. Repeat procedure using another or new vacutainer.</p> <p>2b. Repeat procedure with syringe.</p> <p>2c. Repeat puncture in area of good circulation.</p> <p>2d. Place needle farther into vein to enter lumen.</p> <p>2e. Hold vein in place with thumb and index finger. This will help prevent hematoma. Repeat procedure.</p>

ERRORS (mistakes that led to erroneous results)

V E N I P U N C T U R E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Bubbles in test tube.</p>	<p style="text-align: center;">(Syringe)</p> <p>1a. Blood expelled through needle into tube quickly causing hemolysis.</p> <p>1b. Plunger of syringe was withdrawn too quickly causing ruptured platelets.</p>	<p>1a. Take fresh blood sample, remove needle, expel it slowly from syringe into test tube. Allow blood to flow down side of tube.</p> <p>1b. Repeat procedure withdrawing plunger slowly.</p>
<p>1. Growth of various organisms in bacteriologic blood culture.</p>	<p style="text-align: center;">(Syringe and Vacutainer)</p> <p>1a. Unsterile equipment used for collection of blood.</p> <p>1b. Skin not properly cleaned with aqueous iodine and alcohol. Culture contaminated with skin organisms.</p> <p>1c. Bottle top not flamed and/or bottle not placed in slanted position while injecting blood. Culture contaminated with air organisms.</p>	<p>1a. Collect fresh blood sample with sterile equipment. Use disposable sterile equipment whenever possible.</p> <p>1b. Cleanse skin thoroughly with aqueous iodine and alcohol saturated gauze sponges.</p> <p>1c. Repeat procedure. Flame bottle top, place bottle in slanted position while injecting blood.</p>
<p>2. High results for an alcohol in blood determination.</p>	<p>2. Skin was disinfected with alcohol.</p>	<p>2. Disinfect site with aqueous iodine, repeat puncture.</p>

V E N I P U N C T U R E

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. Results too high or low for chemistry tests.	3a. Skin cleaned with aqueous iodine. 3b. Tourniquet left on while blood was being drawn.	3a. Repeat procedure cleansing skin with alcohol. 3b. Repeat procedure removing tourniquet as soon as blood begins to flow.
4. Patient has been infected.	4. Finger touched puncture area and site was not disinfected again.	4. Puncture area must be disinfected just before it is punctured.
5. Hemolysis of blood.	5. Needle too small for amount of blood required.	5. Repeat procedure using larger needle.
6. Small, purplish, hemorrhagic spots appeared on skin.	6. Tourniquet on too long (over 2 min.), blood entered into surrounding tissue.	6. Remove tourniquet.
7. Discoloration of skin.	7. Tourniquet so tight it cut off arterial flow of blood.	7. Remove or loosen tourniquet. Use wide band tourniquets to prevent trauma.
8. Blood flowing out of arm after removal of needle.	8. Removal of needle from arm before removal of tourniquet.	8. Remove tourniquet immediately.

MISSTEPS (mistakes that prevented completion of procedure)

CAPILLARY PUNCTURE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. No blood is flowing from puncture.</p>	<p>1a. Puncture not made deep enough.</p> <p>1b. Poor circulation at site of puncture.</p>	<p>1a. Puncture same spot crosswise immediately, if you put blade down use new one, or use sterile Bard Parker blade.</p> <p>1b. Increase circulation by rubbing or immersing site in warm water. Repeat puncture.</p>
<p>2. Blood has spread out and not formed a round drop.</p>	<p>2. After puncture site was disinfected, it was not allowed to dry before puncture was made.</p>	<p>2. Wipe puncture site with sterile gauze, squeeze finger to start blood flowing again. Wipe first two drops away to insure no tissue juice or alcohol on slides.</p>

ERRORS (mistakes that led to erroneous results)

CAPILLARY PUNCTURE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Cell count high due to stasis.</p> <p>2. Few cells on slide.</p>	<p>1. Site where puncture was made was cold (especially true of heel puncture).</p> <p>2a. Interstitial fluid diluted blood.</p> <p>2b. First drop of blood used to make slide.</p>	<p>1. Warm puncture site by immersing it in warm water. Repeat puncture.</p> <p>2a. Repeat puncture being careful not to squeeze finger.</p> <p>2b. Repeat puncture, wipe first two drops away.</p>

MISSTEPS (mistakes that led to erroneous results)

HEMATOCRIT PROCEDURE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Tube broken, blood sprayed inside centrifuge.	1. Tube not seated firmly because of debris on ring, tube slammed outward with high G.	1. Rerun sample after cleaning centrifuge.
2. Tube empty, blood sprayed inside centrifuge.	2. Inadequate plug, or tube not seated firmly against ring.	2. Repeat procedure correctly.
3. Meniscus above lighted zone on reader preventing 100% alignment.	2. Tube overfilled.	3. Measure $L_1$ and $L_2$ with millimeter scale and compute routinely.



ERRORS (mistakes that led to erroneous results)

HEMATOCRIT PROCEDURE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Rubber ring is bloody, but duplicate samples agree within 2% and agree with hemoglobin value.	1. Blood was not wiped off outside of tube.	1. Clean rubber ring and repeat entire test.
2. Tube conspicuously less full than others after centrifuging.	2a. Slight leak of plug, traces of blood found on rubber ring. 2b. Failure to fill tube completely.	2a. Read tube and if it does not differ from its duplicate by more than 2% treat it routinely. 2b. Read tube and if it does not differ from its duplicate by more than 2% treat it routinely.
3. All tubes less full after centrifuging.	3. Rubber ring has not been changed recently and is worn out so tubes do not sit firmly in contact with it.	3. Replace rubber ring.
4. Duplicate hematocrits read 30 and 31 but hemoglobin reads 15 gms.	4. Small clots formed in blood sample because sample was not thoroughly mixed with anticoagulant immediately after withdrawal.	4. Discard sample and obtain new one; inspect sample by transmitted light and when no clots are found rerun duplicate tubes.
5. Control tubes read 50 and 52 respectively instead of 45.	5. Centrifuge was run too slowly or for too short a period.	5. Recheck time and test rpm with tachometer, adjust accordingly.

HEMATOCRIT PROCEDURE

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
6. Duplicate readings are 40 and 30 respectively, but both contain approximately same amount of fluid.	6. Slight but disproportional leakage of red cells which was concealed because tube had been overfilled and had leaked down to normal level.	6. Repeat test with careful, accurate measuring.
7. Assistant consistently read 1% higher than technologist.	7a. Reading top of buffy (platelet) layer. 7b. Tube filled beyond 0 on left side of tube. 7c. Spinning too slowly or for too short a period. 7d. Reading top of meniscus instead of bottom.	7a. Take reading from top of red column. 7b. Make sure meniscus at exactly 0 point 7c. Recheck time, test rpm with tachometer and adjust accordingly. 7d. Be sure to read at bottom of meniscus.
8. Low results, plasma layer is cherry-red instead of straw-colored yellow.	8. Hemolysis has taken place due to rough handling, wet syringes, needles and hematocrit tubes.	8. Obtain fresh blood sample with care.

## MISSTEPS (mistakes that prevented completion of procedure)

H E M O G L O B I N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Instrument will not adjust to 100.	la. Blank cuvet was improperly inserted. lb. Light source has deteriorated. lc. Lens and/or photocell clouded. ld. Mirror clouded or misaligned.	la. Insert blank cuvet properly and adjust instrument. lb. Replace light source. lc. Clean or replace lens and/or photocell. ld. Clean or realine mirror.

ERRORS (mistakes that led to erroneous results)

H E M O G L O B I N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Control is beyond standard given.	<p>1a. Instrument not calibrated properly.</p> <p>1b. Sample and reagents not measured out accurately.</p> <p>1c. Pipets were contaminated or wet.</p> <p>1d. Hemoglobin pipet used was not calibrated and was inaccurate.</p>	<p>1a. Calibrate instrument and repeat test.</p> <p>Repeat test measuring and adding samples and reagents with care.</p> <p>1c. Repeat test using acid cleaned, dry pipet.</p> <p>1d. Use only accurate certified pipets that you calibrated.</p>
2. Most blood samples, including standard, showing unusually high hemoglobin readings.	2. Automatic pipet drawing blood sample larger than 0.02 ml., or delivering more than 5.0 ml of Drabkin's solution.	2. Readjust pipet and repeat test. Adjust pipet before each test.
3. Hemoglobin value on samples very high.	3. Outside of pipet not wiped clean of blood.	3. After blood is drawn into pipet wipe outside clean.
4. Hemoglobin value on one sample unusually high.	<p>4a. Sample not allowed to stand in cyanide solution long enough for complete hemolysis.</p> <p>4b. Scratched cuvet used.</p>	<p>4a. Repeat test allowing sample to stand in cyanide 10 minutes.</p> <p>4b. Replace cuvet with one free from scratches.</p>
5. Hemoglobin expressed in per cent.	5. Values arbitrarily selected as equivalent of 100% and various instruments have different standards for per cent.	5. Express hemoglobin in gm/100 cc.

HEMOGLOBIN

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
	<u>(Acid Hematin Method)</u>	
1. Control value is beyond standard range.	<p>1a. Hemoglobin pipet used was not calibrated and was inaccurate.</p> <p>1b. Pipets were contaminated or wet.</p> <p>1c. Samples and reagents not measured out accurately.</p> <p>1d. Results not read each time after same interval for which instrument was standardized.</p>	<p>1a. Use only accurate certified pipets that you have calibrated.</p> <p>1b. Repeat test using acid cleaned dry pipets.</p> <p>1c. Repeat test measuring and adding samples and reagents with care.</p> <p>1d. Repeat test reading result after each time interval.</p>
2. Air bubbles in tube.	2. Blood was not properly mixed with acid.	2. Repeat test. Mix blood and acid properly to prevent air bubbles.
3. Acid hematin has changed colors.	3. Time interval for blood to be converted to acid hematin was not strictly observed.	3. Repeat test allowing for exact time interval for blood to be converted to acid hematin.
4. Hemoglobin value on samples very high.	4. Outside of pipet not wiped clean of blood.	4. After blood is drawn into pipet wipe outside clean.
5. Color of blood diluted with acid is strange.	4. Nonhemoglobin substances in plasma and cell stroma influence color of blood diluted with acid.	5. Learn to recognize color of blood due to non-hemoglobin substances.
6. Hemoglobin expressed in per cent.	6. Values arbitrarily selected as equivalent to 100% and various instruments have different standards for per cent.	6. Express hemoglobin in gm/100 cc.

MISSTEPS (mistakes that prevented completion of procedure)

WHITE BLOOD COUNT

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Hand Count Method)</u>		
1. Raised cover-glass.	1. Too much fluid in counting chamber.	1. Clean counting chamber, coverglass, and reload chamber.
2. Sample solution ran over into most of counting chamber.	2. Too much fluid in counting chamber.	2. Clean counting chamber, coverglass, and reload chamber.
3. Uneven distribution of cells in counting chamber.	3a. Failure to discard enough diluting solution from pipet stem.	3a. Clean counting chamber and coverglass. Mix sample thoroughly, discard several drops from pipet stem, reload chamber.
	3b. Insufficient mixing of pipet or waiting too long after mixing to load chamber.	3b. Use pipet rotor for mixing, load counting chamber immediately.
<u>(Coulter Counter)</u>		
1. Orifice screen indicates clogging.	1a. Solution contaminated with large particles.	1a. Clean orifice with small brush. Mix blood with fresh solution, run again. Filter solution frequently and keep refrigerated until shortly before use.
	1b. Blood has clotted.	1b. Obtain fresh blood sample from patient. Before putting solution in counter, check to see if blood has clotted.

WHITE BLOOD COUNT

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. No count and mercury drops in vacuum tube.	2a. Air bubbles in mercury column. 2b. Malfunction of vacuum pump.	2a. Drain and replace mercury. 2b. Repair pump and connections.

ERRORS (mistakes that led to erroneous results)

W H I T E   B L O O D   C O U N T

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Count very low.	<p style="text-align: center;"><u>(Hand Count Method)</u></p> <p>1a. Tissue juice in blood sample (fingerstick method).</p> <p>1b. Blood taken from cold, pale or cyanotic skin.</p> <p>1c. Did not discard first five drops from sampling pipet.</p> <p>1d. Let solution stand too long after use of lysin.</p>	<p>1a. Obtain new sample by good puncture in finger so there will be no need to squeeze finger. Wipe first three drops of blood off finger.</p> <p>1b. Draw new blood sample from healthy, warm skin--if none, warm hand with hot packs or hold and massage fingers.</p> <p>1c. Clear solution from pipet stem and get sample from mixing bulb.</p> <p>1d. Mix fresh blood with lysin agent and count cells after one or two minutes. If count still low, cut concentration of lysin in diluent.</p>
2. Count too high.	<p>2a. Counted nucleated red cells.</p> <p>2b. Blood on outside of sampling pipet was not wiped off and contaminated whole bottle of diluent.</p>	<p>2a. Check differential, calculate correction for proportion of nucleated red cells.</p> <p>2b. Obtain new bottle diluent. Be sure outside of pipet is free from blood before drawing diluent into pipet.</p>
3. Count too high or too low.	<p>3a. Too little or too much blood drawn into pipet.</p>	<p>3a. Be accurate in drawing blood into pipet. If over 0.5 or 1.0 mark, use clean pipet and draw again.</p>



WHITE BLOOD COUNT

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. (continued)	<p>3b. Too much or too little diluent drawn into pipet.</p> <p>3c. Sampling pipet was contaminated.</p> <p>3d. Did not use accurate counting pipet.</p> <p>3e. Cells and diluent not thoroughly mixed in sampling pipet.</p> <p>3f. Did not use accurate counting chamber.</p> <p>3g. Over-counting or not counting cells on border.</p> <p>3h. Calculations were inaccurate.</p>	<p>3b. Be accurate in amount of diluent drawn into pipet. Draw up to 11 mark exactly</p> <p>3c. After use, clean pipet by immediately placing it under tap water. Acid Clean once a week.</p> <p>3d. Repeat test using accurate counting pipet such as a Clay Adams.</p> <p>3e. Repeat test making sure to mix cells and diluent well</p> <p>3f. Repeat test using a Spencer Bright Line counting chamber.</p> <p>3g. Count cells on line at top and left side of each square. Disregard cells on lower line and right side.</p> <p>3h. Check your math.</p>
4. Total count from two chambers varies more than 5% of average.	<p>4a. Improper loading of counting chamber.</p> <p>4b. Counting too many or too few squares.</p>	<p>4a. Clean chamber and cover-glass, reload by carefully touching pipet to tip of counting chamber so solution will immediately run in one smooth flow completely filling counting chamber.</p> <p>4b. Count 16 squares in each chamber and compare results. If still differs more than 5% of average, clean chamber and cover-glass, mix sample, reload and recount.</p>

WHITE BLOOD COUNT

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Very low count.	<p style="text-align: center;"><u>(Coulter Counter)</u></p> <p>1a. Tissue juice in blood sample (fingerstick method).</p> <p>1b. Blood taken from cold, pale, or cyanotic skin.</p> <p>1c. Let blood sample stand too long in lysin solution.</p>	<p>1a. Obtain new sample by good puncture in finger so it will not be necessary to squeeze finger. Be sure to wipe first three drops off finger.</p> <p>1b. Draw fresh blood sample from healthy, warm skin. If there is no healthy warm skin, warm hand with hot packs or hold and massage fingers.</p> <p>1c. Mix blood with fresh solution and run count after lysing only a very short time.</p>
2. Count very high.	<p>2a. Solution was contaminated.</p> <p>2b. Dirt or moisture in mercury.</p> <p>2c. Counted nucleated red cells.</p>	<p>2a. Check background count of solution. If count over 200, destroy vial of diluent and mix blood in fresh vial.</p> <p>2b. Clean manometer and replace mercury periodically.</p> <p>2c. Check differential and calculate correction for proportion of nucleated red cells.</p>
3. Count very high or very low	3. Too little or too much solution with amount of blood.	3. Mix blood with new solution and run duplicate samples. Check against differential slide.

**MISSTEPS (mistakes that prevented completion of procedure)**
**D I F F E R E N T I A L**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Cells seen on top of each other.	1. Smear is too thick. Angle of spreader was too large.	1. Make a new slide having a thick and thin area to work from.
2. Do not have a feather edge on the slide.	2. Angle of spreader was too large.	2. Make a new slide with smaller angle on spreader. Find slide with very smooth edge, without crack or chip, and use this slide for spreader.
3. Cells too faint to see.	3. Slide not in stain long enough.	3. Make new slide, stain again being careful to leave slide in stain for appropriate time.
4. Holes in smear.	4. Contamination on slide catches stain. Grease on slide leaves holes in smear.	4. Make new smear on clean slide. Wash bought slides, handle clean slides only by edges.
5. Unidentifiable object in blood smear.	5a. Dirt on slide.	5a. Make new smear on clean slide.
	5b. Abnormal cell.	5b. Let technologist determine results.
6. Cells are so dark one cannot distinguish between nuclei.	6a. Slide was left in stain too long.	6a. Make new slide being careful not to leave it in stain for too long. Rinse slide properly.
	6b. Precipitate at end of stain is all over slide.	6b. Make new slide and stain with new jar of stain.
7. Cannot distinguish between cromatin and cytoplasm.	7a. Rinse water pH too alkaline.	7a. Restain slide, rinse with water at pH 6.8.

D I F F E R E N T I A L

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
7. (continued)	<p>7b. Rinse water pH too acid.</p> <p>7c. Length of time slides were in stain not proportional to length of time they were in buffer.</p> <p>7d. Stain lost some fluid so pH changed and it no longer stains as before.</p>	<p>7b. Restain slide. Rinse with water at pH 6.8.</p> <p>7c. Make new slide using 1 minute for stain and 4 minutes for buffer, or 5 minutes for stain and 8 minutes for buffer.</p> <p>7d. Correct pH of stain or obtain new bottle of stain. Check pH of stain once a week.</p>

**ERRORS (mistakes that led to erroneous results)**

**D I F F E R E N T I A L**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Count too high of certain leukocytes.</p>	<p>1a. Counting same field more than once.</p> <p>1b. Mistake in classification of cell types.</p>	<p>1a. Make new count using technique of scanning so as not to go over same field more than once.</p> <p>1b. Make new count, ask for help in identifying cells, or have experienced technician check your work.</p>
<p>2. Blood cells are distorted which prevents proper classification.</p>	<p>2. Anticoagulant used when making venipuncture blows cells up and may cause vacuoles.</p>	<p>2. Use different anticoagulant such as heparin, or take finger stick and do differential from this.</p>

MISSTEPS (mistakes that prevented completion of procedure)

RED BLOOD COUNT

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Hand Count)</u>		
1. Coverglass raised on counting chamber.	1. Too much fluid in counting chamber.	1. Clean counting chamber and coverglass, reload chamber.
2. Sample solution runs into moat of counting chamber.	2. Too much fluid in counting chamber.	2. Clean counting chamber, and coverglass, reload chamber.
3. Uneven distribution of cells.	3a. Failure to discard enough diluting solution from pipet stem.	3a. Clean counting chamber and coverglass, mix sample thoroughly, discard several drops from pipet stem, reload chamber.
	3b. Insufficient mixing of pipet or waiting too long after mixing to load chambers.	3b. Use pipet rotor for mixing, discard 5 drops, load counting chamber immediately.
<u>(Coulter Counter)</u>		
1. Orifice screen indicates clogging.	1a. Solution contaminated with large particles.	1a. Clean orifice with small brush. Mix blood with fresh solution and run again. Filter solution frequently and keep refrigerated until shortly before use.
	1b. Blood has clotted.	1b. Obtain fresh blood sample from patient. Before putting it in counter, check to see if blood is clotted.
2. No count mercury drops in vacuum tube.	2. Malfunction of vacuum pump.	2. Repair pump and connections.

ERRORS (mistakes that led to erroneous results)

RED BLOOD COUNT

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Count very low.</p>	<p style="text-align: center;"><u>(Hand Count Method)</u></p> <p>1a. Tissue juice in blood sample (fingerstick method).</p> <p>1b. Blood taken from cold, pale or cyanotic skin.</p> <p>1c. Did not discard first five drops from sampling pipet.</p> <p>1d. Failure to count nucleated red cells.</p>	<p>1a. Obtain new sample by good puncture in finger so there will be no need to squeeze finger. Wipe first three drops of blood away.</p> <p>1b. Draw new sample from healthy, warm skin--if none, warm hand with hot packs or hold and massage fingers.</p> <p>1c. Clear solution from pipet stem, get sample from mixing bulb.</p> <p>1d. Recount hand sample looking especially for nucleated red cells.</p>
<p>2. Count too high.</p>	<p>2. Blood on outside of sampling pipet was not wiped off and contaminated whole bottle of diluent.</p>	<p>2. Obtain new bottle of diluent, be sure outside of pipet is free from blood before drawing up diluent.</p>
<p>3. Count too high or too low.</p>	<p>3a. Too little or too much blood drawn into pipet.</p> <p>3b. Too much or too little diluent drawn into pipet.</p> <p>3c. Sampling pipet was contaminated.</p>	<p>3a. Be accurate in drawing blood into pipet. If over 0.5 mark use clean pipet and draw again.</p> <p>3b. Be accurate in amount of diluent drawn into pipet. Draw up to 1 mark exactly.</p> <p>3c. After use, clean pipet by immediately placing it under tap water--acid clean once a week.</p>

RED BLOOD COUNT

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. (continued)	3d. Did not use accurate counting pipet. 3e. Cells and diluent not thoroughly mixed in sampling pipet. 3f. Did not use accurate counting chamber. 3g. Over-counting or not counting cells on border.	3d. Repeat test using accurate counting pipet. 3e. Repeat test making sure to mix cells and diluent well. 3f. Repeat test using a reliable counting chamber. 3g. Count cells on line at top and left side of each square. Disregard cells on lower line and right side.
4. Total count from two chambers varies more than 5% of average.	4a. Improper loading of counting chamber.  4b. Counting too many or too few squares.  (Coulter Counter)	4a. Clean chamber and cover-glass, reload by carefully touching pipet to tip of counting chamber so solution will immediately run in one smooth flow completely filling counting chamber.  4b. Count 16 squares in each chamber and compare results. If still differs more than 5% of average, clean chamber and cover-glass, mix sample, reload and recount.
1. Very low count.	1a. Tissue juice in blood sample (fingerstick method).	1a. Obtain new sample by good puncture in finger so it will not be necessary to squeeze finger. Be sure to wipe first three drops of blood away.



**RED BLOOD COUNT****ERRORS**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. (continued)	1b. Blood taken from cold, pale or cyanotic skin.  1c. Failure to count nucleated red blood cells.	1b. Draw fresh sample from healthy warm skin. If there is no healthy warm skin, warm hand with hot packs or hold and massage fingers.  1c. Check the differential and correct according to formula of correction.
2. Count very high.	2. Dirt or moisture in mercury.	2. Clean manometer and replace mercury periodically.

ERRORS (mistakes that led to erroneous results)

DUKE BLEEDING TIME

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Bleeding time shorter than one minute.</p>	<p>1a. Puncture not deep enough.</p> <p>1b. Stopwatch not started as soon as blood began to flow.</p> <p>1c. Got too much tissue juice as finger was squeezed to get free flow of blood.</p>	<p>1a. Repeat puncture with depth of 2 mm.</p> <p>1b. Repeat procedure starting stopwatch as soon as blood begins to flow.</p> <p>1c. Repeat deep puncture in new spot.</p>
<p>2. Bleeding time much longer than 3 minutes.</p>	<p>2. Finger touched by filter paper disturbing coagulation process.</p>	<p>2. Repeat procedure touching filter paper only to blood.</p>
<p>3. Bleeding time prolonged or shortened. Blood running down patient's hand.</p>	<p>3. After puncture site was sterilized, it was not allowed to dry before puncture was made, so antiseptic mixed with blood.</p>	<p>3. Select new puncture site, sterilize, let dry thoroughly, puncture.</p>

MISSTEPS (mistakes that prevented completion of procedure)

DUKE BLEEDING TIME

<p>1. No free flow of blood from puncture.</p> <p>2. Unable to determine bleeding time.</p>	<p>1a. Puncture not 3 mm deep.</p> <p>1b. Patient's circulation was poor.</p> <p>2. Failed to start stopwatch.</p>	<p>1a. Immediately puncture again crosswise.</p> <p>1b. Rub or immerse hand in warm water. Repeat puncture.</p> <p>2. Repeat procedure making certain to start stopwatch as soon as blood begins to flow.</p>

MISSTEPS (mistakes that prevented completion of procedure)

LEE - WHITE COAGULATION TIME

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Unable to get 5 ml. of blood.</p>	<p>1a. Plunger pulled out too fast causing a collapsed vein.</p> <p>1b. Needle ran through vein into tissue.</p> <p>1c. Wall of vein covers bevel of needle.</p>	<p>1a. Repeat procedure in larger vein in other arm.</p> <p>1b. Repeat puncture in new location with care to make a clean puncture without trauma.</p> <p>1c. Place needle into vein a little farther to enter lumen.</p>
<p>2. Unable to determine clotting time.</p>	<p>2. Stopwatch was not started.</p>	<p>2. Repeat procedure with accurate timing.</p>

ERRORS (mistakes that led to erroneous results)

LEE - WHITE COAGULATION TIME

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Clotting complete in less than laboratory limits.</p>	<p>1a. Clean puncture not made, tissue juice in specimen.</p> <p>1b. Blood drawn rapidly, rupturing platelets.</p> <p>1c. Air bubbles drawn through needle seat into blood sample.</p> <p>1d. Blood forced into tube from syringe causing platelets to rupture.</p> <p>1e. Used too large of test tube.</p> <p>1f. Did not use silicone coated syringe.</p> <p>1g. Blood was agitated by too much tipping.</p> <p>1h. Tubes put in water bath but cover was not replaced so tubes were in draft.</p>	<p>1a. Redraw blood making clean puncture without trauma.</p> <p>1b. Repeat puncture with care.</p> <p>1c. Repeat procedure pulling plunger back slowly.</p> <p>1d. Repeat procedure drawing blood slowly.</p> <p>1e. Repeat test using special Lee-White tubes.</p> <p>1f. Repeat procedure using silicone coated syringe to draw blood for test.</p> <p>1g. Repeat procedure, tipping gently during coagulation period.</p> <p>1h. Repeat test being sure to cover water bath.</p>
<p>2. Clotting time well over laboratory limits.</p>	<p>2a. Used tube coated with silicone.</p> <p>2b. Tubes too small.</p> <p>2c. Used plastic instead of glass tubes.</p> <p>2d. Specimen tubes not put in water bath.</p>	<p>2a. Repeat procedure using clean, dry Lee-White test tubes.</p> <p>2b. Repeat procedure using special Lee-White tubes.</p> <p>2c. Repeat procedure with special Lee-White tubes.</p> <p>2d. Repeat procedure placing tubes in water bath as soon as blood is put in them.</p>

## LEE-WHITE COAGULATION TIME

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. (continued)	2e. Temperature of water bath too low.  2f. Failure to stop timer when second tube reached clotting stage.	2e. Repeat procedure keeping temperature at exactly 37°C.  2f. Repeat procedure with strict attention to timing.

## MISSTEPS (mistakes that prevented completion of procedure)

CAPILLARY COAGULATION TIME

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. No free flow of blood.	1a. Puncture not 3 mm deep.  1b. Puncture made in cold, clammy hands.	1a. Immediately puncture again at least 3 mm deep.  1b. Rub hand or immerse it in warm water to increase circulation. Repeat puncture.
2. Fibrin thread has not formed after breaking off all capillary tube.	2a. Breaking fibrin thread while breaking piece from capillary tube.  2b. Used heparinized capillary tube.	2a. Break off piece of second tube very carefully. If thread shows, repeat test breaking tubes gently.  2b. Repeat test with noncoated capillary tubes.
3. Amount of time between appearance of blood and coagulation time is not known.	3a. Stopwatch not stopped when fibrin thread was found.  3b. Stopwatch not started when blood began to flow.	3a. Repeat procedure with accurately measured timing.  3b. Repeat test making sure timing is accurate.
4. Blood will not flow into capillary tube from finger stick.	4. Too much time passed between puncture and attempt to fill capillary tube.	4. Get all necessary equipment ready for use. Make another puncture.

ERRORS (mistakes that led to erroneous results)

CAPILLARY COAGULATION TIME

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Low coagulation time.</p>	<p>1a. Failed to wipe off first two drops of blood.</p> <p>1b. Stopwatch was started late.</p> <p>1c. Stopwatch not set at zero.</p>	<p>1a. Repeat test making sure to remove first two drops of blood.</p> <p>1b. Repeat test with accurate timing.</p> <p>1c. Be sure stopwatch is set at zero before beginning test.</p>
<p>2. High coagulation time.</p>	<p>2a. Stopwatch started early.</p> <p>2b. Inaccurate reading of stopwatch.</p>	<p>2a. Repeat test with accurate timing.</p> <p>2b. Repeat procedure with strict attention to timing.</p>



## MISSTEPS (mistakes that prevented completion of procedure)

SEDIMENTATION RATE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Blood has clotted.	1a. Anticoagulant not added immediately.  1b. After anticoagulant was added tube was not inverted.	1a. Add anticoagulant to tube first, then take fresh blood sample and mix immediately.  1b. Repeat test being sure to mix blood and anticoagulant immediately by inverting tube ten times.

ERRORS (mistakes that led to erroneous results)

S E D I M E N T A T I O N   R A T E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Sedimentation rate is slow and high.</p>	<p>1a. Sedimentation tube used was not chemically clean and dry.</p> <p>1b. Diameter of tube less than 2 mm.</p> <p>1c. Blood sample stood longer than one hour before test was started and erythrocytes became spherical on standing.</p>	<p>1a. Repeat test with chemically clean and thoroughly dry sedimentation tube.</p> <p>1b. Repeat test with tube whose diameter is 3 mm or more.</p> <p>1c. Immediately after fresh blood sample is collected repeat test.</p>
<p>2. Sedimentation rate is rapid</p>	<p>2a. Red Cells hemolyzed due to rough handling.</p> <p>2b. Tube placed in slanted position.</p>	<p>2a. Collect fresh blood sample and handle with care.</p> <p>2b. Repeat test making sure tube is in absolutely perpendicular position throughout test.</p>
<p>3. Sedimentation rate is either rapid or slow, high or low.</p>	<p>3a. Anticoagulant used caused erythrocytes to swell or shrink.</p> <p>3c. Blood standing at temperature cooler or warmer than (27°C) room temperature.</p>	<p>3a. Collect fresh blood sample using mixture of ammonium and potassium oxalate as anticoagulant.</p> <p>3c. Make correction for temperature.</p>

MISSTEPS (mistakes that prevented completion of the procedure)

P R O T H R O M B I N T I M E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Less than 4.5ml blood in vacutainer.</p> <p>2. Blood has clotted.</p>	<p><u>(Fibrometer and Manual Methods)</u></p> <p>1a. Suction on vacutainer caused vein to collapse.</p> <p>1b. As vacutainer got fuller, suction was less and vacutainer was not given time to completely fill.</p> <p>2. Blood and anticoagulant were not mixed.</p>	<p>1a. Collect another blood sample with syringe.</p> <p>1b. Repeat test allowing time for vacutainer to fill or collect sample with a syringe.</p> <p>2. Repeat test mixing blood and anticoagulant immediately after blood is drawn.</p>

## ERRORS (mistakes that led to erroneous results)

PROTHROMBIN TIME

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Control prothrombin time longer than 14 minutes and unknown is greatly prolonged.</p>	<p>(Fibrometer Method and Manual)</p> <p>1a. Withdrew plunger of syringe quickly getting bubbles which ruptured platelets.</p> <p>1b. Tourniquet left on while blood was being drawn, bursting many red blood cells.</p> <p>1c. Venipuncture not clean.</p> <p>1d. Blood was forced into tube through needle which hemolyzed cells.</p> <p>1e. Traces of detergent left in tube.</p> <p>1f. Centrifuged too long or too fast and platelets ruptured.</p> <p>1g. Plasma not removed from cells immediately after centrifugation.</p> <p>1h. Plasma, reagents not kept in refrigerator.</p> <p>1i. Thromboplastin and/or synplastin, plasma, pipets were not pre-heated.</p>	<p>1a. Take fresh blood sample, slowly withdrawing syringe plunger.</p> <p>1b. Draw fresh sample, as needle enters vein remove tourniquet, draw blood out.</p> <p>1c. Draw fresh blood sample carefully. Repeat test.</p> <p>1d. Collect new blood sample removing needle before transferring blood.</p> <p>1e. Repeat test with acid clean and well rinsed glassware.</p> <p>1f. Collect fresh blood sample, centrifuge at specified rate and amount of time.</p> <p>1g. Obtain fresh blood sample, centrifuge, remove cells from plasma immediately.</p> <p>1h. Repeat test with new reagents and fresh blood sample. Store reagents, plasma in refrigerator.</p> <p>1i. Place thromboplastin and/or synplastin, plasma, pipets, in 37° water bath to warm them and repeat test.</p>

PROTHROMBIN TIME

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. (continued)	<p>1j. Regular distilled water used to reconstitute synplastin contaminated it.</p> <p>1k. Synplastin and/or thromboplastin has deteriorated. Should be discarded after a week.</p> <p>1l. Plasma stood at 37°C for an hour and lost 50% of its activity.</p> <p>1m. Test not run within two hours</p>	<p>1j. Obtain new bottle synplastin, reconstitute with injectable distilled water.</p> <p>1k. Repeat procedure with newly reconstituted thromboplastin, synplastin. Return to refrigerator as soon as used or place them in accurate aliquots in test tubes and freeze to slow down deterioration. Thus you can take out only necessary amount needed for test.</p> <p>1l. Repeat procedure allowing plasma to stand at 37°C for only necessary amount of time.</p> <p>1m. Obtain new blood sample, perform test within two hours.</p>
2. Much slower or longer prothrombin time for unknown.	<p>2a. Control not run along with test therefore slight deterioration of thromboplastin or synplastin, and a lower or higher normal due to them is not accounted for.</p> <p>2b. Did not use correct anticoagulant and it was not used in proper proportion to blood.</p>	<p>2a. Repeat test with control. Always run a control along with test.</p> <p>2b. Use exactly 0.5 ml. of 0.1 M sodium oxalate to exactly 4.5 ml. blood and repeat test.</p>

PROTHROMBIN TIME

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Much slower or longer prothrombin time for unknown and control.</p>	<p style="text-align: center;"><u>(Manual Method)</u></p> <p>1a. Pipets used were not accurate.</p> <p>1b. Water bath temperature was too high or too low.</p>	<p>1a. Calibrate pipets in your laboratory or use Standard Certified Pipets for the test.</p> <p>1b. Repeat test making sure water bath remains at 37°C while prothrombin tubes are in it.</p>

ERRORS (mistakes that led to erroneous results)

C R E A T I N I N E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. High results.</p>	<p>1a. Whole blood used in which only half of color is due to creatinine because red blood cells contain other substances that give same reaction.</p> <p>1b. Reaction in blood of creatinine with picric acid and sodium hydroxide.</p> <p>1c. Alkaline picrate solution used before it stood 20 minutes.</p> <p>1d. Absorption was too great.</p>	<p>1a. Repeat test using serum or plasma in which 80% color is creatinine.</p> <p>1b. Repeat test on serum or plasma.</p> <p>1c. Repeat test using alkaline picrate after it stood 20 minutes.</p> <p>1d. Repeat test with smaller amount of filtrate or dilution made up to 4 ml. with water and multiply accordingly.</p>
<p>2. Cloudy filtrate.</p>	<p>2. No balance between protein precipitating agents because it was not properly prepared.</p>	<p>2. Prepare filtrates carefully. Be sure filtrate is clear before doing test; if necessary prepare fresh solutions. Repeat test.</p>
<p>3. Low results.</p>	<p>3a. Used wrong strength picric acid.</p> <p>3b. Alkaline picrate solution used after it had been standing one hour.</p> <p>3c. Not read within 15 minutes so color faded.</p> <p>3d. Dilution made but results not multiplied by dilution factor.</p>	<p>3a. Repeat test using saturated solution picric acid.</p> <p>3b. Repeat test using fresh alkaline picrate. Do not prepare alkaline picrate before it is needed.</p> <p>3c. Read test immediately.</p> <p>3d. Repeat test using saturated solution picric acid.</p>

CREATININE

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
4. Results high or low.	4a. Period between adding alkaline picrate and reading tubes was incorrect.  4b. Pipeted incorrectly.	4a. Repeat test allowing exactly 20 min. for development of final color, NOT MORE OR LESS.  4b. Repeat test pipeting with care.



MISSTEPS (mistakes that prevented completion of the procedure)

B L O O D U R E A N I T R O G E N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Manual Method)</u>		
1. Solution is turbid and/or there is slow completion of reaction.	1. 2.5 NaOH not standardized against a standard acid.	1. Standardize 2.5N NaOH by titration, repeat test.
2. Solution in test tube is turbid.	2a. Did not wait 5 minutes before discarding tubes because of their turbidity.	2a. Repeat test waiting full 5 minutes before turbidity has returned.
	2b. Waited longer than 5 minutes to read tubes.	2b. Repeat test reading tubes after exactly 5 minutes, before turbidity has returned.
	2c. NaOH is old and collects CO <sub>2</sub> from fresh air, thus losing its standardization.	2c. Obtain fresh NaOH, standardize it.
3. Blank is slightly bluish instead of straw colored.	3. Urease has deteriorated.	3. Repeat test using new bottle of urease.
<u>(Warner-Chilcott Column Chromatography Method)</u>		
1. Small green line is fuzzy.	1. Test tube was left open and ammonia floating around in room got in.	1. Seal test tube as soon as chromatographic strip is dropped in.
<u>(Unimeter Method)</u>		
1. Needle on unimeter is fluctuating.	1. Vial pushed down into colorimeter with enough force to break vial, so solution is escaping.	1. Clean colorimeter, repeat test placing vial in colorimeter gently.

B L O O D U R E A N I T R O G E N

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Autoanalyzer Method)</u>		
1. Needle of graph is moving all around.	1a. Antifoam reagents not added to diacetylmonoxime and/or to saline.  1b. One of reagents has run out.	1a. Add antifoam reagents to diacetylmonoxime and saline.  1b. Refill the bottle.
2. Only a base line is recorded on graph.	2. Bulb of autoanalyzer colorimeter has gone out.	2. Replace colorimeter bulb.
3. Autoanalyzer has stopped working.	3a. Dialyzer membrane has hole in it.  3b. Water bath is dirty.  3c. Tubes of autoanalyzer have become unhooked.	3a. Replace membrane, routinely change it once a month.  3b. Change water in water bath. Clean water bath once a month.  3c. Refasten tubes.

B L O O D   U R E A   N I T R O G E N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<b>Mistakes that led to erroneous results.</b>		
1. Low results.	<u>(Manual Method)</u> 1. While decanting supernatant of solution A Nessler's Reagent much of mercury was discarded.	1. Remake solution A, decant so as not to lose any sediment.
1. Low results.	<u>(Kit Method)</u> 1. Used reagent from BUN kit that has degenerated. Kit reagent stable about 30 days.	1. Repeat test using newly reconstituted reagent from fresh BUN kit.
1. High reading.	<u>(PHENATE-HYPOCHLORITE)</u> 1. Oxalate as anticoagulant.	1. Repeat test on serum.
11. High or low results.	<u>(All Colorimeter Methods)</u> 1a. Reagents stored in wrong type of bottle 1b. Amount of reagent pipeted in more or less than needed. 1c. Dirty pipets or test tubes used. 1d. Colorimeter not adjusted to blank before reading was taken.	1a. Prepare reagents again, store in proper bottles. 1b. Repeat test adding reagents with care. 1c. Repeat test with clean glassware. 1d. Adjust colorimeter against water blank, reread tube.
2. High results.	2a. Laboratory assistant or someone walking by work place was smoking, adding ammonia fumes to test. 2b. Bottle of ammonia was opened nearby.	2a. Do not smoke, put up No Smoking signs in room where test is being run. 2b. Repeat test in area where bottles that would contaminate solution will not be opened.

B L O O D U R E A N I T R O G E N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<b>Mistakes that led to erroneous results.</b>		
<p>3. Low results.</p>	<p>3a. Test not run soon after blood was taken from patient.</p> <p>3b. Sample was diluted but results not multiplied by dilution factor.</p> <p style="text-align: center;">(All Methods)</p>	<p>3a. Take new blood sample, run test immediately.</p> <p>3b. Multiply results by dilution factor.</p>
<p>1. High or low re- results.</p>	<p>1a. Test tubes incubated too long or not long enough.</p> <p>1b. Water bath was at wrong temperature.</p>	<p>1a. Repeat test using accurate timing for incubation.</p> <p>1b. Repeat test, check temperature before and during incubation of tubes to be sure it is correct.</p>

**ERRORS (mistakes that led to erroneous results)**

U R I C A C I D

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Modified Koch's Method)</u>		
1. High results.	1. Using dilute standard solution that stood more than a month.	1. Use fresh solution of dilute standard.
2. Low results	2a. Urea cyanide not kept in refrigerator, not cold when added to filtrate and standard.	2a. Repeat test using urea cyanide that was kept cold in refrigerator to keep it from denaturing.
	2b. Dilution made but results not multiplied by dilution factor.	2b. Check your math.
3. Results high or low.	3. Calculations were incorrect.	3. Check your math.
4. Quality control is incorrect	4. Sodium cyanide is not very stable and its concentration is critical to standardization.	4. Obtain fresh sodium cyanide and repeat test.
<u>(Filtrate Method)</u>		
1. Cloudy filtrate.	1a. Wrong dilution of reagents for filtrate used.	1a. Repeat test with strict attention to dilution.
	1b. Did not let filtrate sit long enough (10 min.) for precipitate to settle.	1b. Centrifuge or filter solution again.
2. Low results.	2a. Results not read within an hour so color faded.	2a. Repeat test, read immediately.
	2b. Dilution was made but results not multiplied by dilution factor.	2b. Check your math.

URIC ACID

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. High results.  4. Results high or low.	3. Solution placed in colorimeter is cloudy.  4a. Did not pipet correctly.  4b. Reagent used is contaminated due to dirty pipets that were put in it.	3. Repeat test being sure solution placed in colorimeter is clear.  4a. Repeat test taking care to pipet exactly.  4b. Repeat test with fresh reagent. Keep reagent in stock bottle, place reagent to be pipeted from in smaller bottles to prevent contamination of complete reagent.

## ERRORS

TOTAL PROTEINS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
Mistakes that led to erroneous results.		
<u>(Colorimetric Method)</u>		
1. Low results.	1. Tubes not heated slowly and liquid boiled above 35cc mark.	1. Repeat test heating tubes slowly.
2. High results.	2a. Hemolysis has taken place. 2b. Distilled water used not free of nitrogen compounds.	2a. Repeat test handling blood carefully to prevent hemolysis. 2b. Repeat test using distilled water free of nitrogen compounds. Use triple distilled water.
<u>(Biuret Method)</u>		
1. Low results.	1. Tubes not allowed to sit 30 minutes before they were read.	1. Allow tubes to sit at least 30 minutes before reading them.
2. High results.	2. Cloudy test put in colorimeter.	2. Repeat test making sure it is clear before reading it.
<u>(All Methods)</u>		
1. High or low results.	1. More or less than 1cc serum pipeted into test tube.	1. Repeat test pipeting exactly 1cc serum into test tube.

MISSTEPS (mistakes that prevented completion of the procedure)

A L B U M I N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Crystallization of <math>\text{NaSO}_4</math> occurred.</p>	<p>(<u>Modified Kingsley Method</u>)</p> <p>1. Temperature of solution and glassware below <math>25^\circ\text{C}</math>.</p>	<p>1. Repeat test keeping solution and glassware above <math>25^\circ\text{C}</math>.</p>
<p>1. Cannot read result.</p>	<p>(<u>Electrophoresis Method</u>)</p> <p>1a. Electrophoretic sheet was placed at an angle.</p> <p>1b. Timing was too short so there was no or very little separation between zones.</p> <p>1c. Timing was too long so zones ran into each other.</p>	<p>1a. Repeat test placing sheets straight across.</p> <p>1b. Make sure the timing is accurate.</p> <p>1c. Repeat with accurate timing.</p>



ERRORS (mistakes that led to erroneous results)

A L B U M I N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Low results.</p> <p>2. High or low results.</p>	<p><u>(Colorimetric Method)</u></p> <p>1. Tubes not heated slowly and liquid boiled above 35cc mark.</p> <p>2. More or less than 1cc serum pipeted into test tube.</p>	<p>1. Repeat test heating tubes slowly.</p> <p>2. Repeat test pipeting exactly 1cc serum into test tube.</p>
<p>1. Low results.</p> <p>2. High results.</p> <p>3. Low or high results.</p>	<p><u>(Paper Electrophoresis Method)</u></p> <p>1a. Done on mixture of proteins.</p> <p>1b. Whatman No. 1 filter paper used. Due to albumin "tailing" heavier paper results in lower albumin.</p> <p>1c. Rinsing done by alcohol.</p> <p>1d. Buffer is old.</p> <p>2a. Temperature or time increased so dye uptake increases.</p> <p>2b. Slight variance in thickness and color. Electrophoretic paper was not standardized.</p> <p>3. Variation in pH and/or buffer.</p>	<p>1a. Correct for low result or repeat test by another method.</p> <p>1b. Repeat test using Whatman No. 3MM paper or use cellulose acetate sheets.</p> <p>1c. Repeat test using aqueous acetic acid for rinsing.</p> <p>1d. Use fresh buffer solution. Repeat test. Keep buffer in refrigerator to get better results.</p> <p>2a. Repeat test having proper temperature and time interval.</p> <p>2b. Standardize electrophoretic paper. Repeat test. Standardize every morning.</p> <p>3. Use veronal buffers.</p>

ALBUMIN

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Modified Kingsley Method)</u>		
1. Low results.	1. Test tube with serum-salt and ether violently shaken causing albumin to denature.	1. Repeat test mixing serum-salt and ether by inverting twice gently.
2. High results.	2a. After taking albumin solution from below globulin layer, globulin adhering to pipet was not wiped off.  2b. Sodium sulfate (23%) used in the test.	2a. Repeat test being sure to wipe pipet clean after taking albumin solution from below globulin layer.  2b. Repeat test using method that does not call for 23% sodium sulfate.
<u>(Biuret Method)</u>		
1. High results.	1a. Sodium sulfate solution not made up to 23%.  1b. Cloudy test put in colorimeter.	1a. Repeat test making sure to have 23% solution of sodium sulfate.  1b. Repeat making sure test is clear before reading it.

## MISSTEPS (mistakes that prevented completion of procedure)

GLOBULIN

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
	<u>(Modified Kingsley Method)</u>	
1. Crystallization of sodium sulfate occurred.	1. Temperature of solution and glassware below 25°C.	1. Repeat test keeping solutions and glassware above 25°C.
	<u>(Paper Electrophoresis Method)</u>	
1. Low results.	1a. Done on mixture of proteins. 1b. Whatman No. 1 filter paper used. Due to albumin "tailing" heavier paper results in lower albumin. 1c. Rinsing done by alcohol. 1d. Buffer is old.	1a. Correct for low result or repeat test by another method. 1b. Repeat test using Whatman No. 3MM paper or use cellulose acetate sheets. 1c. Repeat test using aqueous acetic acid for rinsing. 1d. Use fresh buffer solution. Repeat test. Keep buffer in refrigerator to get better results.
2. High results.	2a. Temperature or time increased so dye uptake increases. 2b. Slight variance in thickness and color. Electrophoretic paper was not standardized.	2a. Repeat test having proper temperature and time interval. 2b. Standardize electrophoretic paper. Repeat test. Standardize every morning.
3. Low or high results.	3. Variation in pH and/or buffer.	3. Use veronal buffers.

ERRORS (mistakes that led to erroneous results)

GLOBULIN

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
	<u>(Modified Kingsley Method)</u>	
1. Low result.	1. In test, 23% sodium sulfate was used.	1. Repeat test using method that does not call for 23% NaSO <sub>4</sub> .
	<u>(Biuret Method)</u>	
1. Low result.	1. Sodium sulfate solution not made up to 23%.	1. Repeat test being sure to make 23% solution of NaSO <sub>4</sub> .
2. High result.	2. Cloudy test put in colorimeter.	2. Repeat test making sure it is clear before reading it.
	<u>(Electrophoresis Method)</u>	
1. High results.	1. Done on mixture of proteins, as in serum.	1. Correct for high results or repeat test by another method.
2. Low or high results.	2a. Variations in pH and/or buffer.	2a. Use veronal buffers.
	2b. Slight variance in thickness and color. Electrophoretic paper was not standardized.	2b. Standardize electrophoretic and repeat test. Standardize every morning.
3. Low results.	3a. Rinsing done by alcohol.	3a. Repeat test using aqueous acetic acid for rinsing.
	3b. Buffer is old.	3b. Use fresh buffer solution and repeat test. Keep buffer in refrigerator to get better results.

ERRORS (mistakes that led to erroneous results)

F I B R I N O G E N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Fibrinogen results are high.</p>	<p style="text-align: center;"><u>(Colorimetric Method)</u></p> <p>1a. Hemolysis has taken place.</p> <p>1b. Distilled water used not free of nitrogen compound.</p> <p>1c. More than 1cc serum pipeted into test tube.</p> <p>1d. Laboratory assistant or someone walking by work place was smoking, adding ammonia fumes to test.</p> <p>1e. Bottle of ammonia was opened nearby.</p>	<p>1a. Repeat procedure handling blood with care to prevent hemolysis.</p> <p>1b. Repeat test using distilled water free of nitrogen compounds--triple distilled water.</p> <p>1c. Repeat test pipeting exactly 1cc serum into test tube.</p> <p>1d. Do not smoke, put up NO SMOKING signs in room where test is being run.</p> <p>1e. Repeat test in area where bottles that would contaminate solution will not be opened.</p>
<p>2. Fibrinogen results are low.</p>	<p>2a. Tubes not heated slowly and liquid boiled above 35cc mark.</p> <p>2b. Less than 1cc serum pipeted into test tube.</p> <p>2c. While boiling, solution spurted out of tube.</p> <p>2d. Incomplete digestion. Not boiled down to sufficiently charred condition.</p>	<p>2a. Repeat test heating tubes slowly.</p> <p>2b. Repeat test pipeting exactly 1cc serum into test tube.</p> <p>2c. Repeat test boiling at 100°C.</p> <p>2d. Repeat test boiling solution down to charred condition.</p>

ERRORS (mistakes that led to erroneous results)

B I L I R U B I N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Cloudy serum.	1a. Serum allowed to stand more than 24 hours in contact with cells.  1b. Blood has hemolyzed.  1c. Diazo B not added to test.  1d. Test not done immediately and bilirubin disappeared.	1a. Take new blood sample and centrifuge it as soon as it clots. Do test with only clear serum.  1b. Draw new blood sample, handle with care to prevent hemolysis or run a blank made from same serum with unknown and this will cancel out hemolysis.  1c. Be sure to add all reagents.  1d. Obtain fresh blood sample and run test immediately.
2. Precipitation in tube.	2. Reagents not added in exact proportions and/or order listed so proteins precipitated.	2. Repeat test adding reagents in exact proportions and order listed.
3. Bubbles appeared	3. Glassware not scrupulously clean.	3. Tap tube gently to dislodge bubbles.
4. Standards becoming paler.	4. Standards were exposed to light.	4. Prepare new standard solution and keep it in the dark.
5. Low results.	5. Blanks contaminated with diazo reagents from test.	5. Make new blank using clean pipets and cuvet.
6. Low level in test tube.	6. Left all or some of reagents out of test tube.	6. Be sure to add all reagents.

ERRORS (mistakes that led to erroneous results)

C E P H A L I N - C H O L E S T E R O L F L O C C U L A T I O N

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. False positive result.</p>	<p>(Hanger's and Hopper's Ceph-Flocks Methods)</p>	
		<p>1a. Repeat test with scrupulously clean glassware.</p>
		<p>1b. Draw fresh blood sample and do test immediately.</p>
<p>2. Cloudy solution or false negative result.</p>	<p>1c. Bacterial contamination.</p>	<p>1c. Repeat test with scrupulously clean glassware.</p>
	<p>2a. During 24 hour developing period, tubes were exposed to light.</p>	<p>2a. Repeat test keeping tubes in total darkness for 24 hour developing period.</p>
	<p>2b. Test not run within 4 hours after blood was drawn.</p>	<p>2b. Obtain fresh blood sample. run test immediately.</p>
<p>3. False positive or negative result.</p>	<p>2c. Hopper's antigen (reagent) left out of refrigerator and deteriorated.</p>	<p>2c. Repeat test with new reagent. Take reagent out of refrigerator when ready to use, use immediately and return to refrigerator.</p>
	<p>3. Pipeted incorrectly.</p>	<p>3. Repeat test pipeting exactly.</p>

## MISSTEPS (Mistakes that prevented completion of the procedure)

AMYLA SE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Disturbing greenish tinge transmitted to blue color.	<p style="text-align: center;"><u>(Amylolytic Method)</u></p> 1. Iodine was used in excess.	1. Repeat test using specified amount of iodine.



ERRORS (Mistakes that led to erroneous results)

A M Y L A S E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
	<u>(Amylolytic Method)</u>	
1. Color has faded.	1. Large amounts of unsaturated material in test tube.	1. Repeat test adding iodine dropwise until maximum color appears.
2. Low results.	2. Dilution made but result not multiplied by dilution factor.	2. Check your math.
	<u>(Saccharogenic Method)</u>	
1. High or low results.	1. End point of titration passed due to dark color occurring when iodine and starch are titrated making it hard to observe point where white cuprous iodine has gone completely into solution.	1. Repeat often and long enough before titration with thiosulfate to enhance oxidation and dissolution of iodine.
2. Cloudy filtrate.	2. Copper and tungstate used to precipitate protein.	2. Repeat test precipitating protein with barium and zinc.
	<u>(Amylolytic and Saccharogenic Methods)</u>	
1. Low results.	1a. Test done on whole blood. 1b. Test not run soon after blood was drawn and amylase deteriorated. 1c. Old starch paste was used.	1a. Repeat test on serum. 1b. Repeat test immediately after blood is drawn. 1c. Repeat test with new starch paste.

## ERRORS (Mistakes that led to erroneous results)

A M Y L A S E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. Low or high results.	2a. Incorrect water bath temperature.  2b. Incubation time too long or too short.  2c. Did not pipet accurately.	2a. Make sure water bath remains at correct temperature.  2b. Incubate samples correct amount of time.  2c. Repeat test pipeting with care.



B L O O D   G L U C O S E

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>3. (continued)</p> <p>1. Unknown sample is yellow instead of blue.</p> <p>2. Titration check of reagents is outside required range.</p> <p>3. Solution is wrong color.</p> <p>4. Did not have correct volume in one test tube.</p> <p>1. Much fluctuation of needle. Cannot get reading on colorimeter.</p>	<p>3b. Foam not removed after phosphomolybdic acid was added.</p> <p>(<u>Nelson Somogyi Method</u>)</p> <p>1. Sodium fluoride not added immediately so glycolysis has taken place.</p> <p>2. Solution not accurately weighed or measured out.</p> <p>3a. Wrong reagent added, or reagent not added at all.</p> <p>3b. Insufficient water in water bath, water not boiling.</p> <p>4. Reagent not added or too little or too much was added.</p> <p>(<u>All Methods</u>)</p> <p>1a. Cuvet pushed down into colorimeter with enough force to break it and solution is escaping.</p> <p>1b. Exciter tube in Coleman colorimeter is blown out.</p>	<p>3b. Tap test tube to remove foam. Be sure foaming has stopped before the tubes.</p> <p>1. Obtain new blood sample, immediately add sodium fluoride, separate serum.</p> <p>2. Add appropriate amount of water to weaken stronger solution.</p> <p>3a. Repeat test, add all proper reagents.</p> <p>3b. Add more water to water bath, allow time to heat up to boiling.</p> <p>4. Repeat Test Pipeting with care.</p> <p>1a. Clean colorimeter and repeat test.</p> <p>1b. Replace exciter tube, repeat reading.</p>

ERRORS (mistakes that led to erroneous results)

B L O O D   G L U C O S E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Test result is low.	<p align="center"><u>(Folin-Wu Method)</u></p> <p>1. Filtrate and alkaline tartrate not mixed well enough.</p>	1. Repeat test mixing solutions well.
1. Low results.	<p align="center"><u>(Nelson Somogyi Method)</u></p> <p>1. Precipitate not completely dissolved before tube was diluted with distilled water.</p>	1. Repeat test shaking tubes well to dissolve all precipitate.
2. Standard unknown, control results high; and blank more color than usually.	2. Arsenomolybdic acid not added after contents of tube were discarded from water bath.	2. Repeat test with clean Folin-Wu tubes.
3. Results too high or too low.	<p>3a. Barium hydroxide and zinc sulfate were not balanced.</p> <p>3b. Mathematics not figured correctly.</p>	<p>3a. Repeat test, balance barium hydroxide and zinc sulfate as soon as they are made.</p> <p>3b. Check your math.</p>
1. Very low results.	<p align="center"><u>(Folin-Wu and Nelson Somogyi Methods)</u></p> <p>1a. Glycolysis has taken place.</p> <p>1b. Improper specimen.</p> <p>1c. Not pipeting correctly.</p>	<p>1a. Collect fresh blood sample and either add an agent to prevent glycolysis or prepare filtrate immediately.</p> <p>1b. Obtain fresh specimen.</p> <p>1c. Repeat test adding exact amounts.</p>

B L O O D   G L U C O S E

## ERRORS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. Results too high or too low.	2a. Water bath temperature too high or low.  2b. Samples boiled too long or not long enough.  <u>(All Colorimeter Methods)</u>	2a. Repeat test making sure to have correct temperature for bath.  2b. Repeat test being careful to have accurate timing for incubation.
1. Control results either high or low.	1a. Test not done immediately.  1b. Colorimeter not calibrated.  1c. Results were read on wrong wave length.  1d. Colorimeter not adjusted to blank before reading was taken.  1e. Special dilution made, after reading graph correction not made for it.	1a. Take new blood sample, run test immediately or separate serum from cells. Serum is stable for a longer amount of time.  1b. Calibrate colorimeter and read tubes again. Colorimeter should be routinely calibrated each morning.  1c. Correct wave length and read tubes again.  1d. Adjust colorimeter to zero against water blank and read again.  1e. Check calculations.
2. High result.	2a. Cuvet has finger prints on outside.  2b. Cuvet has scratch in it.  2c. Cuvet pushed into colorimeter too far.	2a. Wipe cuvet off, make another reading. After wiping vial, handle by cap.  2b. Repeat test with new cuvet.  2c. Remove cuvet and replace gently.

ERRORS (mistakes that led to erroneous results)

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Urine is cloudy.	<p style="text-align: center;"><u>C H A R A C T E R</u></p> <p>1. It was left on laboratory bench and bacteria multiplied in it.</p>	1. Obtain fresh urine sample, put preservative in it or refrigerate it.
2. High alkalinity.	<p style="text-align: center;"><u>P H R E A C T I O N</u></p> <p>2. Sample not fresh enough.</p>	2. Obtain fresh sample, if it cannot be tested immediately, refrigerate it or use preservative such as toluene or thymol crystal.

**MISSTEPS (mistakes that prevented completion of the procedure)**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Color on dip-stick does not match any color on comparison chart.	<p style="text-align: center;"><u>P H R E A C T I O N</u></p> 1. Previous wetting of dip-stick neutralized reagent.	1. Use fresh dip-stick. Keep sticks in tightly closed jar--never lay it on work table where it can absorb moisture.
2. Clouded gradation on urinometer making accurate reading difficult.	<p style="text-align: center;"><u>S P E C I F I C G R A V I T Y</u></p> 2. Improper cleaning and storing of urinometer and container.	2. Clean urinometer and container, read again. Clean with concentrated sulfuric acid regularly.





ERRORSS P E C I F I C   G R A V I T Y

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. Very low reading on diluted urine specimen.	3. Failure to calculate correction for dilution.	3. Multiply last two digits by proportion of dilution.

**MISSTEPS (mistakes that prevented completion of the procedure)**

**P R O T E I N T E S T**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<ol style="list-style-type: none"> <li>1. Reagent on dip-stick turns orange, blue, or green when dipped into specimen.</li> <li>2. Dip-stick color does not change after dipping in urine.</li> </ol>	<p style="text-align: center;"><b><u>(Dip-Stick Method)</u></b></p> <ol style="list-style-type: none"> <li>1. Medication containing dye taken by patient prevents reaction to presence or absence of protein.</li> <li>2. Previous wetting of dip-stick has neutralized reagent.</li> </ol>	<ol style="list-style-type: none"> <li>1. Perform one of chemical tests.</li> <li>2. Use fresh dip-stick. Never lay stick on work table where it can absorb moisture. Keep dip-stick in tightly sealed jar.</li> </ol>
<ol style="list-style-type: none"> <li>1. Point of contact between urine and reagent not visible in ring test.</li> </ol>	<p style="text-align: center;"><b><u>(Chemical Tests)</u></b></p> <ol style="list-style-type: none"> <li>1. Faulty technique prevents reagent layering on or under urine.</li> </ol>	<ol style="list-style-type: none"> <li>1. Take new sample, layer reagent on urine taking care not to mix reagent and specimen.</li> </ol>

ERRORS (mistakes that led to erroneous results)

P R O T E I N T E S T

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. All dip-stick tests show trace of protein.</p> <p>2. Strongly positive protein reaction in urine with high pH.</p>	<p>1. Failure to allow for difference between absorption color of specimen and reflective color on chart.</p> <p>2. Highly alkaline urine gives false positive protein reaction due to over extension of buffers of dip-stick.</p>	<p>1. Shake excess moisture from dip-stick so colors will be more nearly true. If still positive, perform one of chemical tests for confirmation.</p> <p>2. Acidify urine with acetic acid until slightly acid and use fresh dip-stick.</p>
<p>(<u>Chemical Tests</u>)</p>		
<p>1. Strongly positive protein reaction in urine with high pH.</p> <p>2. Positive protein reaction to chemical test, microscopic shows mucus.</p> <p>3. Positive protein reaction to chemical test, microscopic shows excess of bacteria.</p>	<p>1. Failure to acidify urine before performing test.</p> <p>2. Mucus causes false positive protein reaction.</p> <p>3. False positive protein reaction caused by numerous bacteria.</p>	<p>1. Add acetic acid until slightly acid pH and run test again.</p> <p>2. Perform chemical test on supernatant fluid after centrifuging.</p> <p>3. Centrifuge urine, acidify with acetic acid until slightly acid pH, run test again.</p>

## ERRORS (mistakes that led to erroneous results)

P R O T E I N   T E S T

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
4. Positive protein reaction on ring test, specific gravity normal or low.	4a. Mistaking ring above zone of contact, indicating urates of mucus, for protein ring.  4b. Waiting too long to check reaction on ring test.	4a. Have technologist check your work. Become thoroughly familiar with possible rings in Robert's and Heller's ring test.  4b. Perform test again, time formation of ring test.

## ERRORS (mistakes that led to erroneous results)

ACETONE

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. High acetone results.	1. Diacetic acid decomposed to acetone on standing.	1. Collect fresh specimen, do test immediately or refrigerate sample.

## MISSTEPS (mistakes that prevented completion of procedure)

B I L E

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. No ring has been formed.	1. Lugol iodine solution not on top of urine, but mixed with it.	1. Repeat test making sure Lugol solution is laked on top of urine. In presence of bile green ring will form at point of contact.

ERRORS (mistakes that led to erroneous results.)

SUGAR TEST

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Dip-stick indicates very high sugar, Clinitest indicates only 2+.	1. Failure to watch color changes as reaction takes place.	1. Run Clinitest again and watch during reaction. If reaches orange or rust-red color before 15 seconds, report as 4+.
2. Dip-stick indicates small amount of sugar, Clinitest indicates 3+ or 4+.	2. Handling of test tube disrupted layer of carbon dioxide formed by tablet.	2. Start again with fresh ice urine. Do not shake or move tube during boiling. Put tube in stable holder before adding tablet.
3. Low or high result.	3. Incorrect proportion of urine to chemical or water depending on test.	3. Repeat test measuring with accuracy.



## MISSTEPS (mistakes that prevented completion of procedure)

M I C R O S C O P I C

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Limited findings in urine specimen.	<p>1a. Leaving too much liquid in test tube after centrifuging.</p> <p>1b. Too large urine drop on slide causing sediment to flow toward edges when cover is placed on slide.</p> <p>1c. Failure to mix entire urine specimen thoroughly before centrifuging.</p> <p>1d. Urine not fresh and some cellular elements have disintegrated.</p> <p>1e. Failure to examine more than one field.</p>	<p>1a. Pour all liquid from sediment, leaving only that which clings to sides of tube to mix with sediment to make not more than 0.5 cc, so concentration of solids is greater.</p> <p>1b. Search edges of slide for sediment or repeat using very small drop of sediment. Can process without cover slip by spreading drop and working quickly to prevent crystallization through drying.</p> <p>1c. Get fresh sample and start over.</p> <p>1d. Get fresh sample and start over.</p> <p>1e. Check several fields, particularly edges of slide. If findings still limited, get another drop.</p>
2. Excessive amount of amorphous crystals obscures organized crystals.	2. Drying of urine specimen.	2. Test again with fresh specimen or reconstitute urine, centrifuge, draw sample again.
3. Blurred field of vision on slide.	3. Barrier formed over microscope lens by immersing it in sediment drop on uncovered slide.	3. Place cover over slide to keep from drying while thoroughly cleaning contaminated lens, examine specimen under cover. If too much sediment is lost, get fresh drop from centrifuge another 10 cc. and start over.

M I C R O S C O P I C

## MISSTEPS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
4. Unable to confirm doubtful findings due to lack of specimen.	4. Throwing out urine before completely finishing all tests and confirmation of findings.	4. Get new specimen and run again. Do not throw out specimen until all tests are finished and findings have been confirmed.
5. Apparent high concentration of red blood cells, but negative reaction on occult blood dip-stick.	5. Inability to differentiate between red blood cells and yeast.	5. Tap cover slide gently. RBC will tumble, yeast will not. If RBC present add drop of 2% acetic acid to lyse RBC. Study yeast for better recognition, get new sediment drop, count RBC.
6. No cellular elements appear in sample.	6a. Too much light on sediment sample.	6a. Use subdued light. If still cannot see them move coverglass slightly to make them roll.
	6b. Use of high power objective only.	6b. Turn microscope to low power. Once casts are seen, identification of types may be made through high power.
7. Normal sediment obscured by bacteria.	7. Bacteria have multiplied in urine which stood too long.	7. Discard specimen and get fresh urine.
8. Cellular elements piled on top each other making identification impossible.	8. Failure to spread sediment drop evenly on uncovered slide.	8. Use cover on slide to spread drop thinly and evenly.

ERRORS (Mistakes that led to erroneous results)

M I C R O S C O P I C

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Very high red blood count indicated in cateterized specimen.	1. Oil used in catheterization mistaken for red blood cells.	1. Adjust light to bring out refraction qualities of oil drops, Can lyse red cells with 2% acetic acid for better recognition of oil drops.
2. Counts of WBC, RBC, and other sediment vary from one field to another.	2. Inadequate mixing of centrifuged sediment.	2. Count ten fields, report averages.
3. Unidentified crystals in sediment which fall in unusual pattern.	3. Scratch on slide or cover slip.	3. Put fresh drop of sediment on undamaged slide.
4. Many pus cells in urine.	4. Centrifuge tube not cleaned thoroughly, therefore pus cells from previous patient contaminated urine specimen.	4. Repeat procedure being sure to use thoroughly cleaned centrifuge tubes.

## MISSTEPS (Mistakes that prevented completion of procedure)

TEST FOR INCREASED GLOBULIN CONCENTRATION  
IN BODY FLUIDS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Cannot see ring.	<u>(Chemical Tests)</u>  1. Did not centrifuge cloudy spinal fluid.	1. Repeat test with clear supernatant fluid.

TEST FOR INCREASED GLOBULIN CONCENTRATION  
IN BODY FLUIDS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. High results.	1. Blood in sample of body fluid.  (Electrophoresis Method)	1. Obtain new sample not contaminated with blood, repeat test.
1. High results.	1. Done on mixture of proteins, as in serum.	1. Correct for high results or repeat test by another method.
2. Low or high results	2a. Variations in pH and/or buffer.	2a. Use veronal buffers.
2. (Continued)	2b. Slight variance in thickness and color. Electrophoretic paper was not standardized.	2b. Standardize electrophoretic paper. Repeat test. Standardize machine every morning.
3. Low results.	3a. Rinsing done by alcohol.  3b. Buffer is old.	3a. Repeat test using aqueous acetic acid for rinsing.  3b. Use fresh buffer solution and repeat test. Keep buffer in refrigerator for better results.
	(Chemical Tests)	
1. High result.	1. Did not centrifuge cloudy spinal fluid.	1. Repeat test with clear supernatant fluid.
2. Low result.	2a. Solution not proper strength.  2b. Did not prepare solution correctly.	2a. Prepare new solution with strict adherence to strength.  2b. Prepare new solution.

MISSTEPS (mistakes that prevented completion of procedure)

CELL COUNT IN CEREBROSPINAL FLUID (TOTAL, DIFFERENTIAL)

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Degenerated cells seen in microscope.	1. Cerebrospinal fluid not fresh.	1. Spinal fluid tests must be done immediately and correctly as cerebrospinal taps usually are done only once.
2. Coagulated fluid.	2. Coagulum formed in cerebrospinal fluid.	2. Spinal fluid tests must be done immediately and correctly as cerebrospinal taps are sometimes very painful and usually are done only once.

**ERRORS (Mistakes that led to erroneous results)**

**CELL COUNT IN CEREBROSPINAL FLUID (TOTAL, DIFFERENTIAL)**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. In presence of cells a high or low count.</p>	<p>1a. Too much or too little spinal fluid, in comparison to solution, was drawn into leukocyte pipet.</p> <p>1b. Too much or too little solution in comparison to spinal fluid was drawn into leukocyte pipet.</p> <p>1c. Sample of spinal fluid not mixed adequately.</p>	<p>1a. Repeat procedure drawing spinal fluid up to exact mark in pipet.</p> <p>1b. Repeat procedure drawing solution up to exact mark in pipet.</p> <p>1c. Mix sample of spinal fluid and repeat procedure.</p>
<p>2. In presence of cells low results.</p>	<p>2a. Cells not allowed to settle five minutes on counting chamber before they were counted.</p> <p>2b. Smear made for differential and many cells lost.</p>	<p>2a. Allow cells five minutes to settle before counting them.</p> <p>2b. Carefully prepare a new smear or do differential on counting chamber.</p>

OCCULT BLOOD IN FECES

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Results negative.</p>	<p>1a. Glassware contaminated with ascorbic acid.</p> <p>1b. Benzidene dihydrochloride used for test.</p> <p>1c. Too much benzidene and/or too much hydrogen peroxide used.</p> <p>1d. Old hydrogen peroxide used.</p> <p>1e. Did not wait 5 minutes for appearance of blue or dark green color.</p>	<p>1a. Clean and rinse glassware thoroughly and repeat test.</p> <p>1b. Repeat test with benzidene base labeled for blood test.</p> <p>1c. Repeat test using 2 drops of benzidene and 1 drop hydrogen peroxide.</p> <p>1d. Repeat test using new bottle hydrogen peroxide. Test activity of hydrogen peroxide by placing few drops 10% potassium dichromate with few drops <math>H_2SO_4</math> to 2 cc peroxide. Blue color will show activity.</p> <p>1e. Be sure to wait full 5 min. for color before reporting test as negative.</p>
<p>2. Results positive</p>	<p>2a. Specimen not previously boiled and pus produced positive reaction.</p> <p>2b. Test tube contaminated with cuprous oxide left from positive sugar test.</p> <p>2c. Glassware contaminated with bromides, iodides, nitric acid or formaline.</p> <p>2d. Fats were not removed.</p> <p>2e. Glassware not free of blood.</p> <p>2f. Waited too long to read test.</p>	<p>2a. Boil specimen and repeat test.</p> <p>2b. Rinse tube with final solution of Folin-Wu blood sugar test, repeat occult blood test.</p> <p>2c. Repeat test with thoroughly clean glassware.</p> <p>2d. Remove fats by ether, repeat test.</p> <p>2e. Repeat test with thoroughly clean glassware.</p> <p>2f. Repeat test being sure to read it in specified time.</p>



ERRORS (mistakes that led to erroneous results)

NEUTRAL FATS IN FECES

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. High results.	1a. Osmic acid used to stain feces.  1b. Fatty substances in reagents sediments.	1a. Use stain other than osmic acid as it may stain substance other than fat black.  1b. Make blank determination to rule out fatty substances in reagents, repeat test.
2. Low results.	2. Feces standing for some time before analysis was performed.	2. Obtain fresh specimen, perform test immediately as fat decreases on standing, even in frozen state.
3. High or low results.	3. Amount fat not expressed in terms of dry matter.	3. Report fat determined in "wet" feces as percent "dry" feces because amount of wet matter is extremely variable in normal stool.

ERRORS (mistakes that led to erroneous results)

TITRATION OF ASPIRATED GASTRIC FLUID FOR  
FREE AND TOTAL ACID

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<u>(Topfer's Method for Total Acidity)</u>		
1. Low results.	1a. Stopped titrating at permanent pink color.  1b. Lowered alkalinity due to age.	1a. Carry titration out to rose-red color due to interaction of phosphates. End reaction is sharper if fluid is saturated with sodium chloride.  1b. Prepare new solution of 0.1 N NaOH. Check against 0.1 N HCL to make sure its strength is proper. Never keep less than 0.1 N solution in stock. If in NaOH has precipitate, discard.
<u>(Topfer's Method for Concentration of Combined HCL)</u>		
1. Low results.	1a. Titration of NaOH with decinormal solution was stopped at appearance of violet color.  1b. Lowered alkalinity due to age.	1a. Continue titration until color does not become deeper on addition of another drop NaOH.  1b. Prepare new solution NaOH.
2. High or low.	2. NaOH solution not properly prepared.	2. Prepare solution NaOH. Check against 0.1 N HCL to make sure its strength is proper.
<u>(All Methods)</u>		
1. Low or high.	1. Colored bench was only thing under beaker during titration.	1. Repeat test with sheet of white paper beneath beaker to facilitate recognition of color change.

MISSTEPS (mistakes that prevented completion of procedure)

TITRATION OF ASPIRATED GASTRIC FLUID FORFREE AND TOTAL ACID

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Orange-red color produced.	<p>(Dimethylamino-Azobenzene Method)</p> 1. Large amount of organic acid. Color produced by free hydrochloric acid is cherry red.	1. Repeat test by another method.

**MISSTEPS (mistakes that prevented completion of procedure)**

**PREPARATION OF BACTERIOLOGIC AND SEROLOGIC SPECIMEN FOR MAILING**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Sample leaked out.	1. Sample not sealed properly for handling through mail. Very dangerous.	1. Obtain new sample, seal securely for mailing. Use plastic container for sample itself, seal with parafilm cover, put into two metal containers before mailing it.
2. Broken sample received.	2. Sample not prepared properly to be handled through mail. Very dangerous.	2. Obtain new sample preparing it securely for mailing. Use plastic container for sample itself, seal with parafilm cover, put into two metal containers before mailing it.
3. Specimen sent to wrong place.	3. Specimen not labeled carefully.	3. Obtain new sample, label carefully.
4. Indicator is yellow so specimen received unsuitable for isolation work.	4a. Sample not sealed properly.	4a. Obtain new sample sealing it carefully and securely before mailing.
	4b. Contaminated sample.	4b. Obtain new sample prepared with sterile equipment, seal properly for mailing.
5. Serum sample not clear.	5a. Red blood cells have diffused or hemolyzed.	5a. Obtain new sample, separate serum from cells immediately.
	5b. Excessive heat coagulated serum.	5b. Do not use excessive heat on new serum obtained.

ERRORS (mistakes that led to erroneous results)

PREPARATION OF BACTERIOLOGIC AND SEROLOGIC SPECIMEN FOR MAILING

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Serologic specimen is contaminated and therefore not clear.	1. Equipment used was not sterile.	1. Obtain new specimen repeat procedure.
2. Specimen is contaminated.	2a. Poor technique in transferring sterile sample into container for mailing. 2b. Mailing container was contaminated.	2a. Obtain new sample using utmost care in transferring it into container. 2b. Be sure mailing container is sterile before transferring sample into it.
3. Absurd results.	3. Sample not labeled clearly and/or correctly, therefore had wrong test run on it.	3. Obtain new sample label it clearly and correctly.
4. High results.	4a. Cells lysed due to improper handling. 4b. Serum not rendered free of native complement by inactivation.	4a. Obtain new sample, separate cells from serum before mailing. 4b. Obtain new sample. Prepare serum by placing tubes in 56°C for 30 minutes.
5. High or low results on specimen received.	5a. Specimen not frozen immediately. 5b. Specimen not sent on dry ice.	5a. Obtain new sample that was frozen immediately to keep it from being contaminated or changing in other ways. 5b. Obtain new sample frozen immediately and send on dry ice.

## ERRORS (mistakes that led to erroneous results)

PREPARATION OF BACTERIOLOGIC AND SEROLOGIC SPECIMEN FOR MAILING

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
5. (continued)	5c. Serum came in contact with metals (silver, mercury).  5d. Specimen not prepared and handled with sterile procedure and/or instruments.	5c. Obtain new sample. Keep all samples from coming in contact with it.  5d. Collect, prepare and process new specimen under sterile conditions.

**MISSTEPS (mistakes that prevented completion of procedure)**

**STAINING OF SLIDES FOR BACTERIOLOGIC STUDY**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Can not see separate bacteria.	1. Aqueous suspension of organism preparation too thick.	1. If smear shows no areas where bacteria are separated, add normal saline to dilute it, being careful in preparing slides.
2. Unidentifiable object on slide.	2a. Solids from broth culture used to make smear has interfered with stain. 2b. Slide used more than once and is contaminated. 2c. Reagent not taken care of or used properly (acid fast staining). 2d. Coverglasses and/or slides were greasy. 2e. Cultures are old. 2f. Smears dried too slowly because they were too thick and bacteria shriveled.	2a. Repeat procedure or use more satisfactory method. 2b. Repeat test using clean slide. 2c. Prepare reagents carefully with freshly distilled water, keep properly covered. Do not use if too old. Check water sources often to determine if acid-fast bacilla are present. 2d. Repeat staining (flagella stain) with meticulously clean coverglasses and slides. 2e. Repeat staining with fresh culture (flagella stain). 2f. Dilute bacterial suspension.

MISSTEPS (mistakes that prevented completion of procedure)

STAINING OF SLIDES FOR BACTERIOLOGIC STUDY

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. (continued)	2g. Organisms suspended in water.	2g. Make new suspension in normal saline, mix well.
3. Strange bacteria and spores seen.	3a. Solution and water used for slide not free of bacteria and spores. 3b. Stain used has bacterial or fungal growth. 3c. Smears dried too slowly and contamination occurred.	3a. Repeat procedure with bacteria and spore free solutions and water. 3b. Obtain new bottle of stain. Add few drops antifungal growth, check stain often. 3c. Repeat test using scrupulously clean slides heated before use and cooled to body temperature. Have slides warm enough to allow rapid drying, but fixation of films by heat may destroy flagella.
4. Stain sediment found on slide.	4a. Dye not accurately weighed. 4b. Stain dried before slide was rinsed. Dye crystals stuck to slide. 4c. Dye impure and precipitated out.	4a. Repeat procedure weighing dye accurately on analytical balance. 4b. Decolorize slide. 4c. Use only certified dyes.



## ERRORS (mistakes that led to erroneous results)

STAINING OF SLIDES FOR BACTERIOLOGIC STUDY

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Flagella stain failed to show flagella.	1. Bacteria left in water too long and have shed their flagella.	1. Repeat procedure. Excellent results have been obtained when bacteria were left in water only 7 hours, or leave in normal saline.
2. All bacteria are red or pink.	2. Too much decolorization, decolorized everything (Gram stain).	2. Stain again. Be sure not to decolorize to point of dissolving all the stain.



ERRORS (mistakes that led to erroneous results)

FLOCCULATION TEST FOR SYPHILIS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. (continued)	2c. Speed of shaker or rotating machine is too slow so solution not mixed well enough.	2c. Adjust speed or machine or get a serologic rotator and repeat test.
3. False reactive or nonreactive	3a. Water bath or refrigerator temperatures were incorrect.	3a. Adjust temperature, obtain new reagents. Check temperatures every day.
	3b. Speed of shaking and rotating machines is incorrect.	3b. Adjust speed of machines, repeat test. Check speeds before testing.
	3c. Glassware not thoroughly cleaned or rinsed.	3c. Clean glassware with dichromate cleaning solution, rinse thoroughly, repeat test.
	3d. Antigens not stored at room temperature in dark.	3d. Retitrate and restandardize reagents, repeat test.
	3e. pH of 0.9% saline solution not between 5.5 and 7.0.	3e. Repeat test, check pH; if necessary correct pH of saline before continuing test.
	3f. Solutions not prepared in sequence given.	3f. Repeat test being sure to prepare solutions in given sequence.
<u>(VDRL Test)</u>		
1. Weakly reactive.	1. Serial dilutions not made on zonal reaction.	1. Make serial dilutions as serum may be highly reactive.
2. Reactive result.	2. Cork left off antigen bottle and alcohol evaporated.	2. Obtain new antigen bottle, keep corked when not in use. Repeat test.

ERRORS (mistakes that led to erroneous results)

FLOCCULATION TEST FOR SYPHILIS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. Nonreactive result.	3. Old antigen suspension.	3. Repeat test with new antigen. Add a preservative to preserve 3 or 4 days.
4. Reactive or non-reactive result.	4a. Serum not inactivated.	4a. Repeat test with serum has been inactivated for 30 minutes at 56°C.
	4b. Concentration of serum antigen is incorrect.	4b. Repeat test making sure concentration of antigen to serum is correct.

ERRORS (mistakes that led to erroneous results)

FLOCCULATION TEST FOR SYPHILIS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Nonreactive results.</p>	<p>(Kahn Determination)</p> <p>1a. Use of antigen suspension that has aged more than 24 hours from time of preparation.</p> <p>1b. Cork left off antigen bottle and alcohol in antigen evaporated.</p>	<p>1a. Prepare new antigen suspension, use within 24 hours from time of preparation.</p> <p>1b. Obtain new antigen bottle, Keep corked when not in use. Repeat test.</p>

**MISSTEPS (mistakes that prevented completion of procedure)**

**FLOCCULATION TEST FOR SYPHILIS**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<ol style="list-style-type: none"> <li>1. Cannot tell if no reaction or a weak one.</li> <li>2. Cannot tell if reaction is weak or positive.</li> </ol>	<p style="text-align: center;"><u>(Kahn Determination)</u></p> <ol style="list-style-type: none"> <li>1. Antigen emulsion not mixed sufficiently.</li> <li>2. Incorrect preparation of antigen emulsion.</li> </ol>	<ol style="list-style-type: none"> <li>1. Prepare antigen by swirling bottle on table and dropping antigen in diluent.</li> <li>2. Prepare new antigen emulsion with care. It is viable for one day if kept out of light and not allowed to dry.</li> </ol>

**ERRORS (mistakes that led to erroneous results)**

**APPLICATION OF SENSITIVITY DISCS TO CULTURE PLATES AND READING RESULTS**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Results read as resistant.</p>	<p>1a. Disc dispenser used did not permanently press each sensitivity disc into media so antibiotic was not able to diffuse freely.</p> <p>1b. Did not have fresh culture and fresh media. Antibiotic will not diffuse on dry media and organism did not grow.</p> <p>1c. Did not have right type of media.</p> <p>1d. Antibiotics diffused too rapidly. There is no concentration of antibiotic and organism overgrew it.</p>	<p>1a. Repeat on fresh culture plates. Press each disc down with sterile pointer so they will stick.</p> <p>1b. Repeat procedure on fresh media and culture.</p> <p>1c. Repeat on blood agar base without blood in it, or media made by case.</p> <p>1d. Place antibiotics farther apart, more concentration of antibiotic.</p>
<p>2. Results read as resistant on sulfa disc.</p>	<p>2a. Placed sulfa and antibiotic discs on same plate.</p> <p>2b. Sulfa did not diffuse.</p>	<p>2a. Place sulfa discs and antibiotic discs on separate plates as sulfa must first be put in refrigerator and antibiotics put immediately into incubator.</p> <p>2b. Place sulfa plates in refrigerator for one hour, then in incubator.</p>

MISSTEPS(mistakes that prevented completion of procedure)

APPLICATION OF SENSITIVITY DISCS TO CULTURE PLATES AND READING RESULTS

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Inhibition zones have coalesced.	1. Impregnated sensitivity discs were placed too close to one another.	1. Apply sensitivity discs to fresh culture at regular intervals and space far enough apart to give perimeter for largest possible zoning.



ERRORS (mistakes that led to erroneous results)

FECAL CONCENTRATION FOR PARASITOLOGIC STUDY

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. No organisms are seen.</p>	<p>1a. Glassware not clean. Chemicals on glassware have destroyed organisms.</p> <p>1b. Temperature above 37° C has destroyed organisms (ameba).</p> <p>1c. Centrifuged with too much force which ruptured organisms (ameba).</p> <p>1d. Washed material with clear water. Osmotic pressure caused disintegration.</p>	<p>1a. Obtain new sample. Use thoroughly cleaned and well rinsed glassware.</p> <p>1b. Obtain new sample keeping temperature down to 37°C.</p> <p>1c. Obtain new sample, do not centrifuge too hard.</p> <p>1d. Obtain new sample, wash with normal saline.</p>
<p>2. Unidentifiable object in feces.</p>	<p>2a. Did not wash centrifuged material.</p> <p>2b. Feces on slide dried; organisms lost their morphology.</p>	<p>2a. Wash centrifuged material several time before looking for organisms.</p> <p>2b. Obtain fresh sample. Once procedure is started continue to end. Seal cover-slip with parafin to prevent evaporation.</p>
<p>3. Few or no organisms seen.</p>	<p>3. Did not study both top and bottom of centrifuged material.</p>	<p>3. Be sure to study all parts of centrifuged material.</p>
<p>4. No larvae found, only ova.</p>	<p>4. Test not performed soon after collection, larvae died or went into cyst stage.</p>	<p>4. Collect new sample. Identify organism from ova. Examine feces immediatly.</p>
<p>5. When looking for ameba none found.</p>	<p>5a. Only looked at one feces specimen.</p> <p>5b. Examination not done with in one hour. Ameba died.</p>	<p>5a. For ameba examine minimum of three specimens.</p> <p>5b. Obtain fresh specimen, examine immediately.</p>

ERRORS (mistakes that led to erroneous results)

FECAL CONCENTRATION FOR PARASITOLOGIC STUDY

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
6. Can not identify ameba (pathogenic, nonpathogenic)	6. Feces washed in cold saline which stopped motion of ameba.	6. Wash Feces in warm saline.
7. Cannot identify objects.	7. Dirty glassware. Grease spots cause moisture to flow.	7. Use alcohol clean slides to look at feces. Objects are stationary on clean glassware.
8. Hookworm larvae when looking for strongyloides stercoralis.	8. Hookworm larvae present, movement is alike and vigorous.	8. Get help in distinguishing larvae. Have work checked.
9. Firm irregular segmented strands of mucus.	9. Shreds of mucus in mucus colitis appear as firm irregular segmented strands--may be mistaken for pieces of tapeworm.	9. Identify between strands of mucus and tapeworm. Have work checked.
10. Round worms.	10. Poorly masticated celery or greens identified as round worms.	10. Study and learn to distinguish between them. Have work checked.
11. Pinworms.	11. Cells from oranges identified as pinworms.	11. Study and learn to distinguish between them. Have work checked.
12. Tapeworms and ova.	12. Fibers from banana are identified as tapeworms and ova.	12. Study and learn to distinguish between them. Have work checked.
13. Many larvae, few ova.	13. Ova develop into larvae quickly.	13. Obtain fresh specimen. Identify organisms from larvae. Examine feces immediately.

ERRORS (mistakes that led to erroneous results)

FECAL CONCENTRATION FOR PARASITOLOGIC STUDY

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
14. Unidentifiable objects in feces specimen containing trophozoites.	14. Specimen not examined soon after collection. Trophozoites degenerated.	14. Obtain fresh specimen. Examine immediately.

MISSTEPS (mistakes that prevented completion of procedure)

BASAL METABOLISM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Solution is cloudy.	1. Soda lime has not been changed for 40 tests.	1. Change soda lime, repeat test. Test soda lime by an indicator, old soda lime will turn pink from blue.
2. Flutter valve lips will not close properly.	2. Flutter valves lost elasticity.	2. Change flutter valves, repeat test.
3. Indicator on zero.	3. Oxygen tank is empty.	3. Obtain filled oxygen tank.
4. Hissing sound.	4. Machine has oxygen leak.	4. Obtain filled oxygen tank. Have leak repaired. Test for leak by filling machine to certain position, closing and running again. Descending line indicates a leak.
5. Patient can not breathe.	1a. Soda lime is moist.	1a. Obtain fresh supply soda lime for machine, repeat test.
	1b. Flutter valve is stuck together.	1b. Obtain new flutter valve, repeat test.
	1c. Water in base of machine or in breathing tube.	1c. Remove water and dry machine completely, repeat test.

ERRORS (mistakes that led to erroneous results)

BASAL METABOLISM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>1. Very high results.</p>	<p>1a. Machine has oxygen leak.</p> <p>1b. Patient has perforated ear drum so oxygen leaks through.</p> <p>1c. Patient has false teeth and cannot grasp mouth piece.</p> <p>1d. Patient has eaten, cooked breakfast, or smoked.</p> <p>1e. Patient has tight clothing on.</p>	<p>1a. Have leak repaired. Test for leak by filling machine to certain position, closing and running again. Descending line indicates a leak.</p> <p>1b. Use ear stoppers.</p> <p>1c. Use a mask or ask patient to remove teeth for test.</p> <p>1d. Have patient return on another day as soon as he gets out of bed.</p> <p>1e. Have patient loosen or take off tight clothing.</p>
<p>2. Low results.</p>	<p>2a. Oxygen leaked into spirometer through oxygen set cock.</p> <p>2b. Inefficient soda lime, CO<sub>2</sub> not removed.</p> <p>2c. Singer or athlete has large lung capacity in comparison to his heart beat.</p>	<p>2a. Close valve on gas tank and pet cock on machine, repeat test.</p> <p>2b. Obtain fresh supply soda lime for machine, repeat test.</p> <p>2c. Report as found plus notation of patient's profession</p>
<p>3. High results.</p>	<p>3a. Leak around nose clip or mouthpiece.</p> <p>3b. Leak around attachment of rubber tubing.</p>	<p>3a. Readjust nose clip and mouthpiece, continue test.</p> <p>3b. Readjust attachment of rubber tubing or if necessary obtain new rubber tubing, repeat test.</p>

## BASAL METABOLISM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
3. (continued)	<p>3c. Leak of oxygen from spirometer.</p> <p>3d. Patient not instructed to lie down 30 minutes immediately preceding test.</p> <p>3e. Patient not completely relaxed physically, mentally, and emotionally.</p> <p>3f. Patient making voluntary movements during determination.</p> <p>3g. Patient had apprehensions about test.</p> <p>3h. Patient had a fever.</p> <p>3i. Patient did not have complete rest, at least eight hours sleep night before.</p>	<p>3c. Close valve on gas tank and pet cock, repeat test.</p> <p>3d. Have patient lie down 30 minutes, repeat test.</p> <p>3e. Put patient completely at ease. Take pulse rate, an increase of few points denotes some cause of disturbance.</p> <p>3f. Ask patient to make no voluntary movements during determination, repeat test.</p> <p>3g. Consider first basal metabolism rate as only a practice test, discard results. Take second test.</p> <p>3h. Subtract 7% with each degree fahrenheit fever. Take temperature of patient before test, if he has fever, postpone test until temperature is normal.</p> <p>3i. Repeat test on day when patient has had complete rest the night before.</p>
4. False low or high result.	4. Clock running too fast or too slow.	4. Have clock repaired, repeat test. Check clock with stopwatch once a week.

## MISSTEPS (mistakes that prevented completion of procedure)

ELECTROCARDIOGRAM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
	<u>(New Machine--EKG)</u>	
1. Film is burned.	1. Stylus over heated.	1. Repeat test not over heating stylus.
2. No tracing on film.	2. Stylus not heated enough.	2. Repeat test heating stylus just enough.
3. Blurred tracing.	3. Electronic eye not operating correctly.	3. Call repairman
4. Machine stops.	4. Transistor not functioning correctly.	4. Call repairman.
5. Wandering base line	5a. Machine not warmed up.	5a. Let machine warm up for 2 min. prior to use.
	5b. Lead selector switch was moved while the machine was running.	5b. Stop paper, turn selector, wait for needle to stabilize.
	5c. Needle was not centered properly.	5c. Put paper on run, not on any lead, and turn centering knob until stylus is tracing on center line.
	5d. Machine is too close to the wall.	5d. Center machine in room that EKG is being taken.
	5e. Machine is too close to the patient.	5e. Keep EKG machine at least one foot from patient.
	5f. Patient is making some sound, from groaning to conversation.	5f. Make patient comfortable, do not converse or ask questions of the patient and during the test.
	5g. Patient is tense and nervous.	5g. Put patient at ease through a clear explanation; respect patient's privacy by keeping as well covered as possible throughout test. Converse, comfort, and answer all questions while preparing patient and letting machine warm up.

## MISSTEPS (mistakes that prevented completion of procedure)

ELECTROCARDIOGRAM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
5. (continued)	5h. Good electrode connection has not been made.	5h. Check lead connections on machine and on patient to see if they are too loose or too tight and that enough paste was used.
6. Regular sawtooth base line or alternating current interference in tracing.	6a. Poor electrode techniques.	6a. Repeat line check, tighten thumb screws. Push ground button.
	6b. Poor patient location.	6b. Move patient to another part of room. Push ground button.
7. Indistinct base line.	7a. Temperature was not set properly.	7a. Stop, put paper on run and adjust temperature of stylus.
	7b. Stylus had accumulated a plastic coating.	7b. Clean stylus or replace if needed.
8. Somatic tremors, irregular baseline.	8a. Patient is tense or uncomfortable.	8a. Make patient comfortable; reassure patient. Make sure patient is warm enough.
	8b. Patient is moving.	8b. Ask patient to lie still during EKG leads.
	8c. Patient is speaking.	8c. Have patient remain silent during EKG leads.
	8d. Straps are loose.	8d. Check all straps and tighten straps securely but not to the point of discomfort to the patient.
	8e. Machine was not warmed up.	8e. Warm up machine for 2 min. prior to test.
	8f. Patient fuse has blown.	8f. Replace patient fuse.
	8g. Electrode tube is loose.	8g. Tighten electrode tube.



## MISSTEPS (mistakes that prevented completion of procedure)

## ELECTROCARDIOGRAM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
8. (continued)	8h. Electrode paste was used too sparingly causing poor contact with the skin. 8i. Cable has a break in it. 8j. Electronic tube and parts are dirty.	8h. Clean area and apply enough paste to area to make good contact with skin. 8i. Check and replace cable. 8j. Check and clean machine.
9. Machine operates at all lead positions: stylus goes off-scale then drifts back on scale 30 seconds later with no EKG pulse and is apparently normal on STD position.	9. Patient fuse blown.	9. Replace patient fuse. (Viso Cardiette Model 100).
10. Cables are corroded.	10. Electrode paste was not wiped off cables after contact with paste applied to skin.	10a. Replace electrodes and make sure they are mechanically cleaned after using. 10b. Replace cables and keep cables clean and free from paste.
11. Machine will not operate.	11. One or more power fuses have blown, preventing operation of machine.	11. Replace fuses.
12. Machine not working properly.	12. Machine was not kept covered.	12. Clean machine and keep covered when not in use.
13. One or more controls fail to work properly.	13. Apparatus not prepared properly.	13. Repeat entire procedure of preparing apparatus.

**MISSTEPS (mistakes that prevented completion of procedure)**
**ELECTROCARDIOGRAM**

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
<p>14. Patient is tense and nervous.</p>	<p>14a. Fear that test is uncomfortable.</p> <p>14b. Fear of the outcome of the test.</p> <p>14c. Economic worries.</p> <p>14d. Fear of hospitalization.</p>	<p>14a. Explain test. Answer questions. Make patient comfortable. Listen if he wants to talk. Be interested and friendly. Exhibit an air of quiet competence.</p> <p>14b. Answer questions. Listen if he wants to talk. Explain that test is an aid to the doctor in diagnosis and treatment.</p> <p>14c. Point out that many community facilities are available to help people who need medical care and financial assistance.</p> <p>14d. Explain that his doctor would suggest hospitalization only if that is the best place for him to be. Build up his confidence in his doctor.</p>
<p>15. Reading not clear.</p>	<p>15. Poor electrode contact.</p>	<p>15. Rub area where electrode is to be placed to cause hyperemia before placing electrode to area.</p>
<p>16. Patient complains that strap is too tight.</p>	<p>16. Strap too tight.</p>	<p>16. Loosen strap; draw tight enough for firm contact but not so tight as to cause discomfort.</p>
<p>17. Laboratory assistant does not know where to place electrode.</p>	<p>17. Patient missing arm or leg.</p>	<p>17. Place on stump.</p>

## ERRORS (mistakes that led to erroneous results)

ELECTROCARDIOGRAM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
1. Doctor asks for test to be repeated.	1. Electrodes placed on wrong limbs.	1. Make sure electrodes are on correct areas.
2. A.C. artifacts.	2a. Patient has metallic article. 2b. EKG is being taken near electrical appliances 2c. Distant electrical appliances. 2d. Concealed electrical wiring in wall. 2e. Loose straps. 2f. Electrode tip is loose. 2g. Electrode is dirty. 2h. Electrode is corroded. 2i. Right leg electrode was not connected. 2j. Patient or operator has touched electrode. 2k. Patient was left alone, moved, and electrode has slipped.	2a. Have patient remove all clothing and objects possessing metal. 2b. Pull plugs of electrical appliances near area. 2c. Use ground wire. 2d. Move patient away from wall. Push ground button. 2e. Check and adjust straps for good, flat contact with skin surface. 2f. Tighten electrode tip to cable. 2g. Clean electrode with warm water and soap. Polish to keep contact surface bright, shiny. 2h. Dispose of corroded electrode and replace with new electrode. 2i. Connect right leg electrode. 2j. Make a point of informing patient not to touch electrodes. Push ground button. 2k. Readjust electrodes and do not leave patient unattended.

## ERRORS (mistakes that led to erroneous results)

ELECTROCARDIOGRAM

OBSERVATION	EXPLANATION	CORRECTIVE ACTION
2. (continued)	<p>2l. Patient is touching wall, metal on bed or floor.</p> <p>2m. Machine was not polarized.</p> <p>2n. Powder of metal all over patient from his place of work.</p>	<p>2l. Move patient away from wall, have patient on bed or table, of adequate size for comfort, and inform patient not to touch metal on bed, floor, or wall. Push ground button.</p> <p>2m. Polarize machine.</p> <p>2n. Have patient scrub down thoroughly.</p>
3. Machine operates normally, but red plastic lens will not light.	3. Indicator lamp turned out.	3. Replace indicator lamp.

APPENDIX B

Examination questions, with answers, derived from Appendix A. Correct answers are marked with X. The questions as stated require essentially true-false decisions. For a multiple-choice decisions the student would be instructed to pick only the best answer.

All questions were submitted to the same three experienced supervisory technologists, some were submitted also to one or two other similar people. They were asked to select a best answer and to select the error most likely to be made by a novice. Majority choice of a best answer is marked XX. A numeral before an answer indicates the number of times it was selected as the most likely error to be made by a novice.

## VENIPUNCTURE

Missteps

1. You are trying to make a venipuncture, but when you draw on the plunger no blood enters the syringe. A hematoma forms at the site. Which of the following could have caused this?
  - X a. Needle pierced the outer coat of the vein without entering the lumen.
  - XX 2 b. Needle went through the lumen.
  - c. Needle missed the vein completely.
  - X 1 d. Needle pierced the vein but you let it slip out.
  - e. Pulled too hard on the plunger and caused the vein to collapse.
  
2. You are trying to make a venipuncture, but when you draw on the plunger no blood enters the syringe. No hematoma forms. Which of the reasons below would account for this?
  - a. Needle is stuck in the patient's humerus.
  - X b. Area has poor circulation.
  - X 1 c. Bevel of the needle is covered by the wall of the vein.
  - d. Needle pierced the outer coat of the vein without entering the lumen.
  - XX 2 e. Vein was missed completely.
  
3. While doing a venipuncture, air entered the syringe instead of blood. Which of the reasons below would cause this?
  - a. Area has poor circulation.
  - X 1 b. Glass syringe tip is cracked.
  - X 1 c. Luer-lok is dirty so the needle does not fit properly.
  - d. Needle went through the vein.
  - XX 2 e. Needle and syringe tip do not fit properly.

## VENIPUNCTURE

Missteps

4. During a venipuncture, the syringe came off the needle while the needle was still in the patient's arm. Which of the following explanations would account for this?
- a. There is much scar tissue on the wall of the vein.
  - b. Needle is too small for the amount of blood needed.
  - XX 3 c. Needle was not secured to the syringe.
  - X d. Luer-lok is dirty so the needle does not fit properly.
5. You are trying to make a venipuncture with a vacutainer, but no blood enters the vacutainer tube. A hematoma forms at the site. Which of the following would cause this?
- XX 3 a. Needle went completely through the vein.
  - b. Needle was not secured to the syringe.
  - c. Withdrew the needle too quickly
  - d. Vacuum in the vacutainer caused the vein to collapse.
  - X e. Needle transfixed the vein.
6. You are trying to make a venipuncture with a vacutainer, but no blood enters the vacutainer tube. No hematoma forms. Which of the reasons below would cause this?
- XX 3 a. Vacutainer is old and there is no longer a vacuum in it.
  - b. Needle transfixed the vein.
  - c. Tourniquet is on too tight.
  - X d. Vacuum in the vacutainer caused the vein to collapse.

## VENIPUNCTURE

Errors

7. After doing a venipuncture there are bubbles in the test tube. Which of the reasons below would cause this to happen?
- a. Needle is too small for the amount of blood required.
  - XX 2 b. Blood was expelled through the needle into the tube too quickly.
  - c. Area has poor circulation.
  - d. Vein was transfixed.
  - X 1 e. Plunger of the syringe was withdrawn too quickly.
8. There is a growth of various organisms in the bacteriologic culture that are not ordinarily found in a blood culture. Which of the following reasons would explain this?
- X 1 a. Equipment used for the collection of blood was unsterile.
  - b. Used disposable equipment.
  - XX 2 c. Skin was not properly cleaned with aqueous iodine and alcohol.
  - X d. Bottle was not placed in a slanted position while injecting the blood.
  - X e. Bottle top was not flamed before injecting the blood.
9. The results for an alcohol in blood determination are high.
- a. Tourniquet was on too long.
  - b. Area has poor circulation.
  - XX 3 c. Skin was cleaned with alcohol.
  - d. Skin was cleansed with aqueous iodine.



## VENIPUNCTURE

Errors

10. The results of some chemistry tests, for which the blood was taken by a venipuncture, are either too high or too low. Which of the reasons below would explain this?
- a. Skin was cleaned with alcohol.
  - X b. Skin was cleaned with aqueous iodine.
  - c. Needle was too far into the vein.
  - XX 3 d. Tourniquet was left on while the blood was being drawn.
  - e. Anticoagulant was shaken too hard before adding it to the blood.
11. The patient on which you did a venipuncture became infected. Which of the following reasons would cause this to happen?
- a. Needle was too small for the amount of blood required.
  - XX 3 b. Touched the puncture site and the area was not cleaned again.
  - c. Vein was transfixed.
  - d. Solution used to sterilize the puncture site was not allowed to dry before puncture was made.
12. The blood taken by venipuncture was hemolyzed. Which of the following could cause this?
- X a. Needle was too small for the amount of blood required.
  - b. Tourniquet was left on while the blood was being drawn.
  - c. Tourniquet was too tight.
  - d. Tourniquet was on too long.
  - XX 3 e. A wet syringe was used.

## VENIPUNCTURE

Errors

13. Small, purplish hemorrhagic spots appeared on the patient's skin during a venipuncture. Which of the following reasons would explain this?
- a. Vein was transfixed.
  - b. Needle was too large.
  - c. Needle was removed from the patient's arm before the tourniquet.
  - XX 3 d. Tourniquet was on too long.
  - e. Patient's arm was not placed in the proper position for taking a venipuncture.
14. The patient's skin has discolored during a venipuncture. Which of the following explanations would account for this?
- XX 3 a. Tourniquet was on too tight.
  - b. Patient's arm was not placed in the right position.
  - c. Used a wide band tourniquet.
  - d. Placed the tourniquet too high on the arm.
  - e. Needle missed the vein completely.
15. You have just drawn blood by venipuncture. Blood is flowing out of the patient's arm after the needle has been removed. Which of the explanations below would cause this?
- XX 3 a. Needle was removed from the patient's arm before the tourniquet.
  - b. Needle used was too large.
  - c. Tourniquet was on too tight.
  - d. Punctured the vein while removing the blood.
  - e. There is too much scar tissue on the wall of the vein.

**CAPILLARY PUNCTURE****Missteps**

1. There is no blood flowing out of the capillary puncture you just made. Which of the following reasons account for this?
  - a. Did not squeeze the patient's finger.
  - XX 3 b. Puncture was not made deep enough.
  - X c. There was poor circulation at the site of the puncture.
  - d. There was much scar tissue on the finger.
  
2. After a capillary puncture was made, the blood did not form a well rounded drop; it spread out. Which of the following reasons would cause this to happen?
  - a. Puncture was made too deep.
  - b. Puncture site was rubbed too much before it was pricked.
  - XX 3 c. After the puncture site was sterilized, it was not allowed to dry before the puncture was made.
  - d. Puncture site was immersed in warm water before it was pricked.
  - e. Too much alcohol was used to clean the puncture site.

**Errors**

3. The cell count for the capillary puncture is too high. What would cause this?
  - a. Puncture was made too deep.
  - b. Puncture site was immersed in warm water before it was pricked.
  - c. The finger was squeezed adding interstitial cells to the blood cells.
  - d. The finger was not cleaned before the puncture was made.
  - XX 3 e. The site where the puncture was made was cold.

**CAPILLARY PUNCTURE****Errors**

4. You have just done a capillary puncture, but there are few cells on the slide. Which of the explanations below would account for this?
- XX 2 a. Interstitial fluid diluted the blood.
- b. Puncture was not made deep enough.
- c. Site where the puncture was made was cold.
- X 1 d. First drop of blood was used to make the slide.
- e. After the puncture site was sterilized, it was not allowed to dry before the puncture was made.

**HEMATOCRIT****Missteps**

1. You are preparing blood for a hematocrit but while centrifuging the tube broke and blood sprayed inside the centrifuge. What could have caused this.
  - a. Centrifuge was run too quickly.
  - XX 3 b. Tube was not seated firmly because of debris on the ring, thus slammed outward.
  - c. Tube was overfilled.
  - d. Centrifuge was run for too long a time.
  - e. Outside of the tube was not wiped clean of blood.
  
2. You are preparing blood for a hematocrit but while centrifuging the tube emptied and blood sprayed inside the centrifuge. What could have caused this?
  - a. Tube was overfilled.
  - b. Centrifuge was run too quickly.
  - XX 3 c. Plug is inadequate.
  - X d. Tube was not seated firmly against the ring.
  - e. Rubber ring is worn out.
  
3. The meniscus above the lighted zone on the hematocrit reader prevented 100% alignment. Which of the following could explain this?
  - XX 3 a. Tube is overfilled.
  - b. You failed to fill the tube completely.
  - c. You are reading the top of the buffy layer.
  - d. Hemolysis has taken place due to rough handling.
  - e. Blood was not wiped off outside of tube.

## HEMATOCRIT

Errors

4. The rubber ring of the centrifuge is bloody, but duplicate samples agree within 2% and agree with the hemoglobin value. What could have caused this?
- a. Tube is cracked and some of the blood leaked out.
  - b. Plug was inadequate.
  - XX 3 c. Blood was not wiped off the outside of the tube.
  - d. Blood from another tube has leaked out.
  - e. Rubber ring was bloody before tubes were put in.
5. In preparing to do hematocrits, one tube is conspicuously less full than the others after centrifuging. Which of the following explanations would account for this?
- XX 3 a. There is a slight leak of the plug.
  - b. While putting tube in centrifuge you unnoticingly spilled some of the blood.
  - c. While centrifuging, part of the fluid evaporated due to high speed.
  - d. Rubber ring has not been changed recently and is worn out.
6. In preparing blood samples for hematocrits, all of the tubes are less full after centrifuging. Which of the following statements would explain this?
- a. Centrifuge was run too quickly.
  - b. All of the plugs fell out during centrifuging.
  - c. Centrifugal force has caused the blood to spill.
  - XX 3 d. Rubber ring is worn out and the tubes do not sit firmly.
  - e. Centrifuge was run too long a time.

## HEMATOCRIT

Errors

7. In an absence of disease, duplicate hematocrits read 30 and 31, but the hemoglobin reads 15 gms. Why?
- a. An anticoagulant was added so blood did not clot.
  - XX 3 b. The blood sample was not thoroughly mixed with the anticoagulant and small clots formed.
  - c. The sample was centrifuged too long.
  - d. The blood cells were lysed due to too much shaking.
8. The hematocrit control tubes read 50 and 52 respectively. Why?
- a. Rubber ring was worn out.
  - b. Centrifuge was run too fast.
  - X 1 c. Centrifuge was run too slowly.
  - d. Centrifuge was run for too long.
  - XX 3 e. Centrifuge was run for too short a period.
9. Duplicate hematocrit readings were 40 and 30 respectively, but both contained approximately same amount of fluid. What could have caused these results?
- a. Rubber ring has not been changed recently and is worn in places.
  - XX 3 b. An overfilled tube which had a leakage of red cells.
  - c. Blood for each reading was obtained in two venipunctures.
  - d. Plug was inadequate.

## HEMATOCRIT

Errors

10. The assistant is consistently reading 1% higher than the technologist when doing hematocrits. Which of the following might explain this? He:

- XX 1 a. reads the top of the buffy layer.
- X b. fills the tube beyond the 0 point on the left side of the tube.
- X c. runs the centrifuge too slowly.
- X d. runs the centrifuge for too short a period.

11. In reading a hematocrit, you note that the plasma layer is cherry-red instead of straw-colored yellow, thus the results are low. What could cause this result?

- XX 3 a. Blood was handled roughly.
- X b. Hematocrit tubes were wet.
- c. Blood was taken from an area of poor circulation.
- d. Blood was not centrifuged long enough.
- e. Too much anticoagulant was used.



## HEMOGLOBIN

Missteps

1. Your instrument will not adjust to 100. In preparing to do a hemoglobin test, which of the following statements suggest the possible explanations?
- X a. Photocell clouded.
  - X b. Cuvet improperly inserted.
  - XX 2 c. Light source has deteriorated.
  - X d. Lens clouded.
  - X 1 e. Mirror clouded or misaligned.

Errors

2. You are doing a hemoglobin test, and the control is beyond the standard given. Which of the following would explain this result?
- X 1 a. Instrument was not calibrated properly.
  - X b. Pipet was contaminated or wet.
  - X c. Pipet was not calibrated and was inaccurate.
  - d. Blood was contaminated with acid-fast bacteria.
  - XX 3 e. Reagents were not measured out accurately.
3. When doing hemoglobin tests you notice that most samples, including the standard, show unusually high hemoglobin readings. Which of the following statements, if any, might offer an explanation?
- a. Punctures made were too deep.
  - b. Interstitial fluid had diluted the blood.
  - XX 3 c. Pipet drawing the blood sample was larger than 0.02 ml.
  - d. Pipet drawing the blood was smaller than 0.02 ml.
  - X e. More than 5 ml. of the reagent was delivered by the pipet.

## HEMOGLOBIN

Errors

4. When doing a group of hemoglobin tests, you unexpectedly get a very high hemoglobin value? What might cause this?
- X a. A scratched cuvet.
  - X b. Sample was not allowed to stand in solution long enough for complete hemolysis.
  - c. Control was beyond the standard given.
  - XX 2 d. Outside of the pipet was not wiped clean of blood.
  - e. High sedimentation rate.
  - X 1 f. Sample placed in used cuvet.
5. In the acid hematin method of hemoglobin determination, you find air bubbles in the tube coupled with an unusually high hemoglobin. Which of the following statements would explain these reactions?
- a. A high sedimentation rate.
  - XX 2 b. Blood was not properly mixed with acid.
  - X 1 c. Outside of the pipet was not wiped clean of blood.
  - d. Non-hemoglobin substances in the blood affected the test.
  - e. Pipet used for the blood was smaller than 0.02 ml.
6. In the acid hematin method of hemoglobin determination, you find that most samples, including the standard, show unusually low hemoglobin readings. Which of the following statements might offer an explanation?
- a. Time interval for blood to be converted to acid hematin was too long.
  - X 1 b. Non-hemoglobin substances retarded the mixture of blood.
  - XX 2 c. Samples and reagents were not measured out accurately.
  - d. Outside of the pipet was not wiped clean of blood.
  - e. Hemoglobin expressed in percent.

## WHITE BLOOD COUNT

Missteps

1. When preparing to count white cells using the hand count method, you note that the cells are unevenly distributed. Which of the following could have caused this?
  - X a. Failure to discard enough diluting solution from pipet stem.
  - XX 2 b. Insufficient mixing of pipet.
  - X c. Waiting too long after mixing to load chamber.
  - X 1 d. Failing to discard several drops from pipet stem after mixing sample.
  
2. When preparing to count white cells using the hand count method, you realize that there is too much fluid in the counting chamber. Which of the following observations made you come to this decision?
  - a. Red cells are hemolyzed.
  - XX 3 b. Sample solution ran over into the moat of the counting chamber.
  - X 1 c. Coverglass is raised.
  - d. Cells in the counting chamber are unevenly distributed.
  - e. There are too many cells in the counting chamber.
  
3. The orifice screen of your Coulter counter indicates clogging. Which of the following situations could cause this to happen?
  - XX 2 a. Diluting solution was not filtered.
  - X 1 b. Diluting solution was not refrigerated.
  - X 1 c. Anticoagulant and blood were not mixed immediately.
  - d. Tissue juice in blood sample.
  - e. Blood taken from cold and cyanotic skin.

## WHITE BLOOD COUNT

Missteps

4. You are ready to do a white count using a Coulter counter when you note that you are unable to get a count and the mercury drops in the vacuum tube. Which of the following situations would explain this observation?
- XX 2 a. A loose connection in the apparatus causing air bubbles in mercury column.
- b. Too much fluid in the counting chamber.
- c. Diluting solution was not filtered.
- d. Raised coverglass.

Errors

5. You have just completed a white count by the hand count method, and the count seems unusually low. Which of the factors listed below could have given this result?
- XX 2 a. Finger squeezed to obtain blood sample.
- X b. Patient had an infection in his finger above the puncture site.
- X 1 c. Sample taken from pipet stem rather than from mixing bulb.
- d. Did not use an accurate counting pipet.
6. You have just completed a white count by the hand count method, and the count seems unusually high. Which of the factors listed below could have given this result?
- XX 3 a. Too much blood drawn into pipet.
- X b. Sampling pipet was contaminated.
- c. Too much diluent drawn into pipet.
- X d. Did not use accurate counting chamber.
- X e. Did not use accurate counting pipet.

## WHITE BLOOD COUNT

Errors

7. In doing a number of white blood counts by the hand count method you find that the total count from two chambers varies more than 5%. Which of the following errors would account for this?
- XX 3 a. Improper loading of the counting chamber.
- X b. Counting too many squares.
- X c. Counting too few squares.
- d. Counting nucleated red cells.
8. You have just completed a white blood count using the Coulter counter, and the count seems unusually high. Which of the factors listed below could have given this result?
- X a. Dirt in mercury.
- XX 2 b. Solution was contaminated.
- X 1 c. Too little solution with amount of blood.
- X d. Counted nucleated red cells.
9. You have just completed a white blood count using the Coulter counter, and the count seems unusually low. Which of the factors listed below could have given this result?
- X a. Solution was contaminated.
- XX 2 b. Too much solution with amount of blood.
- X 1 c. Blood sample stood too long in lysin solution.
- X d. Finger was squeezed when blood was obtained.

**DIFFERENTIAL****Missteps**

1. In doing a differential, the cells are seen on top of one another. What could cause this? The:
  - a. drop of blood was too large.
  - b. angle of the spreader was too small.
  - XX 3 c. angle of the spreader was too large.
  - d. Blood was taken from an area of good circulation.
  
2. In doing a differential, the slide does not have a feather edge. Why?
  - X 1 a. Slide did not have a smooth edge, without chips or cracks.
  - b. Angle of the spreader was too small.
  - c. Spreader was slightly thicker than it is normally.
  - XX 2 d. Drop of blood was too large.
  
3. As you begin a differential, you note that the cells are too faint to see. What could cause this?
  - a. Cells are hypochromic.
  - XX 3 b. Slide was not in the stain long enough.
  - c. You spread the cells out too thinly.
  - d. You used the wrong power objective.
  - e. Blood was taken from a very pale person.

**DIFFERENTIAL****Missteps**

4. As you begin a differential, you note that there are holes in the blood smear. What could have caused this?

- XX 3 a. Grease on the slide.  
b. Slide was wet before the stain was put on it.  
c. Drop of blood was too small.  
e. Smear was not spread evenly.

5. As you begin a differential, you note that there is an unidentifiable object in the blood smear. Which of the following could have caused this? The:

- a. angle of the spreader was much too small.  
XX 2 b. slide was not clean.  
c. blood smear was made with coagulated blood.  
d. technicians hands were not clean.  
X 1 e. smear has an abnormal cell in it.

6. As you are doing a differential you note that the cells are so dark one cannot distinguish between the nuclei. What could have caused the cells to appear this way? The:

- XX 3 a. slide was left in the stain too long.  
b. cells are hyperchromatic.  
c. rinse water was too acidic.  
d. cells were allowed to dry before they were stained.  
X e. precipitate at the end of the stain is all over the slide.

**DIFFERENTIAL****Missteps**

7. As you are doing a differential you note that the chromatin and the cytoplasm of the cells cannot be distinguished. What could have caused the cells to appear this way? The:
- X a. rinse water pH was too alkaline.
  - X b. rinse water pH was too acid.
  - XX 2 c. length of time the slides were in the stain was not proportional to length of time they were in the buffer.
  - X d. stain lost some fluid.
  - X 1 e. pH was not observed.

**Errors**

8. As you finish a differential, you realize that the count of certain leukocytes is too high. What could cause this?
- XX 3 a. Same field was counted more than once.
  - b. Too many leukocytes were counted.
  - c. You counted the cells on the bottom and left side of the slide.
  - X d. A mistake was made in the classification of cell types.
  - e. Blood was centrifuged too fast.
9. As you look at a slide to do a differential count, you note that the blood cells are distorted, which prevents proper classification. What could have caused this to happen?
- a. Cells were spread out with too much force.
  - b. You forgot to clean the lens.
  - XX 2 c. Wrong anticoagulant was used.
  - d. Not enough light is on the slide.
  - X 1 e. Used oxalated blood.



**RED BLOOD COUNT****Missteps**

1. When preparing to do a red blood count by the hand count method, you note that the cells are unevenly distributed. Which of the following could have caused this?
  - a. Too much fluid in counting chamber.
  - b. Too little fluid in counting chamber.
  - XX 2 c. Insufficient mixing of pipet.
  - X 1 d. Waiting too long after mixing to load chambers.
  - e. Sampling pipet was contaminated.
  
2. The orifice screen of your Coulter counter indicates clogging. Which of the following situations could cause this to happen?
  - X 1 a. Solution was not refrigerated.
  - b. Force used to mix the anticoagulant and blood caused the cells to hemolyze.
  - XX 2 c. Solution was not filtered.
  - d. Malfunction of vacuum pump.

**Errors**

3. You have just completed a red count by the hand count method, and the count seems unusually low. Which of the factors below could have given this result?
  - X 1 a. Tissue juice in blood sample.
  - XX 2 b. Did not discard first five drops from sampling pipet.
  - X c. Failure to count nucleated red cells.
  - X d. Blood taken from cold skin.

## RED BLOOD COUNT

Errors

4. You have just completed a red count by the hand count method, and the count seems unusually high. Which of the factors listed below would have given this result?
- a. Cells on line at top and left side of each square counted.
  - X 1 b. Cells on lower line and right side counted.
  - c. Counting chamber inaccurate.
  - XX 2 d. Blood on outside of sampling pipet was not wiped off.
  - X e. Cells and diluent not thoroughly mixed in sampling pipet.
5. In doing a number of red blood counts by the hand count method, you find that the total count from two chambers varies more than 5%. Which of the following errors would account for this?
- X 1 a. Chamber and/or coverglass was dirty.
  - XX 2 b. Improper loading of counting chamber.
  - X c. Counting too many squares.
  - X d. Counting too few squares.
6. You have just completed a red blood count using the Coulter counter, and the count seems unusually low. Which of the factors below could have given this result?
- a. Cells on lower line and right side were not counted.
  - XX 2 b. It was necessary to squeeze the finger when obtaining blood sample.
  - X c. Results not corrected according to formula of correction.
  - d. Moisture in mercury.
  - e. Blood taken from cyanotic skin.

## DUKE BLEEDING TIME

Missteps

1. You have made a finger puncture to determine Duke bleeding time, but there is no free flow of blood from the puncture. Which of the following reasons would cause this to happen?
  - a. Puncture site was rubbed too hard prior to making the puncture.
  - XX 3 b. Puncture was not made deep enough.
  - c. Puncture was done crosswise on the finger.
  - d. Patient's hand was held too high when making the puncture.
  - X e. Patient's circulation was poor.
  
2. You are trying to do a Duke bleeding time determination, but you are unable to determine the bleeding time. What would cause this to happen?
  - a. Patient was bleeding too fast to determine correct time.
  - b. The patient's blood coagulated before time was up.
  - XX 3 c. Failed to start the stopwatch.
  - d. Puncture was made too deep.
  - e. Puncture site was rubbed with too much alcohol.

Errors

3. The bleeding time was shorter than one minute for a Duke bleeding time determination. Which of the following would account for this?
  - a. Forgot to remove first drops of blood.
  - b. Did not rub puncture site long enough prior to making puncture.
  - X 1 c. Did not make the puncture deep enough.
  - X d. Did not start the stopwatch as soon as the blood began to flow.
  - XX 2 e. Squeezed the finger getting tissue juice along with the blood.

## DUKE BLEEDING TIME

Errors

4. The bleeding time was much longer than three minutes for a Duke bleeding time determination. Which of the explanations below would account for this?
- a. Caused rapid circulation by rubbing the puncture site prior to puncturing.
  - XX 3 b. Touched the finger with filter paper, disturbing coagulation process.
  - c. Made the puncture too deep.
  - d. Let the antiseptic dry before making the puncture.
  - e. Held the patient's hand too low while making the puncture.
5. The Duke bleeding time was prolonged or shortened. Blood is running down the patient's hand. Which of the following reasons would cause this to happen?
- XX 3 a. Did not allow the puncture site to dry before making the puncture.
  - b. Held the patient's hand too high while making the puncture.
  - c. Forgot to remove first drops of blood from the finger.
  - d. Caused rapid circulation by rubbing puncture site prior to the puncture.
  - e. Caused excess bleeding by making the puncture too deep.

## LEE-WHITE COAGULATION TIME

Missteps

1. When a Lee-White coagulation time has been ordered, you are unable to get 5 ml. of blood when doing a venipuncture. Why?
  - X a. You pulled the plunger out too fast.
  - XX 2 b. You ran the needle through the vein and into the tissue.
  - c. The needle was too small for the amount of blood needed.
  - X 1 d. The wall of the vein is covering the bevel of the needle.
  
2. When doing a Lee-White coagulation time, you are unable to determine clotting time. Why?
  - a. You did not use silicone coated tube.
  - XX 3 b. You did not start the stopwatch.
  - c. A hematoma formed at the time of taking the venipuncture.
  - d. You transfixed the vein while removing the needle.

Errors

3. When doing a Lee-White coagulation time, the clotting time was completed in less than laboratory limits. Which of the statements listed below might explain this? You:
  - X a. did not make a clean puncture.
  - X b. drew blood rapidly.
  - X 1 c. drew air bubbles into blood sample.
  - X d. forced blood into tube from syringe.
  - XX 2 e. used too large a test tube and tipped tube too much.
  - X f. did not cover water bath.

**LEE-WHITE COAGULATION TIME****Errors**

4. When doing a Lee-White coagulation time, the clotting time is completed in well over the laboratory limits. Why?
- X a. Used a tube coated with silicone.
  - X 1 b. Tubes you used were too small.
  - XX 1 c. Used plastic instead of glass tubes.
  - X 1 d. Forced blood from syringe into tube causing hemolysis of the red blood cells.
  - X e. Temperature of the water bath was too low.

**CAPILLARY COAGULATION TIME****Missteps**

1. There is no free flow of blood when you are obtaining the sample for a capillary coagulation time. Why?
  - a. There is much scar tissue on the finger.
  - b. Puncture site was rubbed too much.
  - XX 3 c. Puncture is not 3mm. deep.
  - d. Puncture was done in the wrong place.
  - X 1 e. Puncture was made in a cold, clammy finger.
  
2. In doing a capillary coagulation time, the fibrin thread has not formed after breaking off all the capillary tube. What could have caused this to happen?
  - a. Too much care was taken in breaking the capillary tubes.
  - XX 2 b. Fibrin thread is being broken along with the capillary tube.
  - c. Test was done with non-coated capillary tubes.
  - X 1 d. A heparinized capillary tube was used.
  
3. You do not know the amount of time between the appearance of blood and the time the blood clots. Why?
  - a. Stopwatch was set at zero.
  - X 1 b. Stopwatch was not stopped when the fibrin thread was found.
  - X c. Stopwatch was not started when the blood began to flow.
  - d. Stopwatch was started when the finger was pricked.
  - XX 2 e. Did not wind the stopwatch.

**CAPILLARY COAGULATION TIME****Missteps**

4. In obtaining blood for a capillary coagulation time, the blood will not flow into the capillary tube from the finger stick. What could cause this?
- XX 3 a. Too much time passed between the puncture and attempt to fill the capillary tube.
- b. Finger stick was too deep.
- c. First two drops were wiped off.
- d. Alcohol was not allowed to dry before the finger stick was made.

**Errors**

5. After you have obtained a capillary coagulation time, you realize that it is low. Which of the following could cause this result?
- a. Alcohol was not allowed to dry before puncture was made.
- XX 3 b. First two drops were not wiped off.
- X c. Stopwatch was started late.
- X d. Stopwatch was not set at zero.
- e. Stopwatch was not stopped when the fibrin thread was found.
6. After you have obtained a capillary coagulation time, you realize that it is uncommonly high. What could have caused this result?
- X a. Stopwatch was started early.
- XX 3 b. Inaccurate reading of the stopwatch.
- c. Stopwatch was started after the 0 mark.
- d. Puncture site was rubbed too much.
- e. Puncture was made too deep.



## SEDIMENTATION RATE

Missteps

1. You are about to start a sedimentation rate and find that the blood has clotted. Which of the following could have caused this?
  - a. The force used in mixing the anticoagulant and blood hemolyzed the red cells.
  - X b. Anticoagulant was added to the blood too late.
  - c. Blood had been standing at a temperature cooler than room temperature.
  - XX 3 d. Blood and anticoagulant were not properly mixed.

Errors

2. A sedimentation rate is high. Which of the following technical errors could have contributed to this result?
  - a. Red cells were hemolyzed due to rough handling.
  - b. Diameter of tube less than 2mm.
  - c. Anticoagulant used caused erythrocytes to shrink.
  - d. Too much anticoagulant used in proportion to blood.
  - XX 3 e. Wrong type of anticoagulant used.
  
3. A sedimentation rate is low. Which of the following technical errors could have contributed to this result?
  - X 1 a. Red cells hemolyzed due to rough handling.
  - X b. Sedimentation tube used not chemically clean and dry.
  - c. Erythrocytes became spherical because blood sample stood longer than one hour before test was started.
  - XX 2 d. Tube placed in slanted position.

**PROTHROMBIN TIME****Missteps**

1. You find less than 4.5 ml. of blood in vacutainer when drawing blood for a prothrombin time by the fibrometer method. Which of the following could explain this? The:
  - a. wrong size vacutainer was used.
  - b. tourniquet was on too tight.
  - X c. suction on the vacutainer caused the vein to collapse.
  - d. puncture was done in a vein that had much scar tissue.
  - XX 2 e. vacutainer was not left in the vein for a long enough time.
  - X 1 f. vacutainer was old and there was no longer a vacuum in it.
  
2. When drawing blood for a prothrombin time by the fibrometer method you find that the blood has clotted. Which of the following reasons would explain this?
  - a. Withdrew plunger too quickly.
  - XX 3 b. Blood and anticoagulant were not mixed soon enough.
  - c. Detergent traces were left in tube.
  - d. Tourniquet was left on while blood was being drawn.

**Errors**

3. Why would a control prothrombin time be longer than 14 seconds?
  - X a. Plunger was withdrawn too quickly.
  - X b. Tourniquet was left on while the blood was being drawn.
  - X c. Venipuncture was not clean.
  - X d. Blood was forced into tube through needle.
  - XX 3 e. Traces of detergent were left in tube.

## PROTHROMBIN TIME

Errors

4. In doing a prothrombin time, the unknown is greatly prolonged. Which of the following could have caused this?
- X a. Centrifuge was set too high.
  - X b. You centrifuged too long.
  - X c. You did not remove cells immediately after centrifugation.
  - X 1 d. Reagents were not kept in refrigerator.
  - XX 2 e. Thromboplastin and/or synplastin, plasma and pipets were not preheated.
5. In doing a prothrombin time the control prothrombin was longer than 14 seconds and unknown was greatly prolonged. Which of the following could have caused these two reactions?
- XX 2 a. Test was not run within two hours.
  - X b. Plasma was left standing at 37°C for an hour.
  - X c. Synplastin and/or thromboplastin had deteriorated.
  - X 1 d. Regular distilled water was used to reconstitute the synplastin.
  - X e. Plasma was not kept in the refrigerator.
6. In running a prothrombin time, the prothrombin time for the unknown was much slower or longer. Why?
- X a. Control was not run along with test.
  - X 1 b. There is a slight deterioration of thromboplastin or synplastin.
  - XX 2 c. Blood and anticoagulant were not in proper proportion.
  - d. Did not use regular distilled water.
  - X e. Correct anticoagulant was not used.

## CREATININE

Errors

1. In doing a blood creatinine, you obtain high results. Which of the following explanations might account for this?
  - XX 3 a. Period between adding alkaline picrate and reading tubes was incorrect.
  - X b. Absorption was too great.
  - X c. Alkaline picrate solution used before it had stood for 20 minutes.
  - X d. Reaction in blood of creatinine with picric acid and sodium hydroxide.
  - e. Alkaline picrate solution used after it had been standing for one hour.
  
2. In doing a blood creatinine, you obtain low results. Which of the following explanations might account for this?
  - XX 2 a. Pipeted incorrectly.
  - X b. Wrong strength picric acid used.
  - X 1 c. Not read within 15 minutes, so color faded.
  - d. Alkaline picrate solution used before it had stood for 20 minutes.
  - X 1 e. Dilution made, but results not multiplied by dilution factor.
  
3. In doing a blood creatinine, you obtain a cloudy filtrate. Which of the following statements might explain this reaction?
  - a. Absorption was too great.
  - b. Whole blood used in which only half of color is due to creatinine because RBC contain other substances that give the same reaction.
  - c. Period between adding alkaline picrate and reading tubes was incorrect.
  - XX 3 d. No balance between protein precipitating agents because they were not properly prepared.
  - e. Used wrong strength picric acid.

## BLOOD UREA NITROGEN

Missteps

1. You are doing a blood urea nitrogen test by a manual method and you notice that the solution is turbid. Which of the following explanations could have caused this?
  - X a. NaOH was not standardized against a standard acid.
  - b. Test tube was left open and ammonia got in.
  - X c. You waited longer than five minutes to read the tubes.
  - XX 3 d. NaOH is old and it collects CO<sub>2</sub> from the air.
  - X e. You did not wait five minutes to read the tubes.
  
2. In the BUN test by a manual method, the blank is slightly bluish instead of straw-colored. What would have caused this?
  - a. Reagent was stored in the wrong type of bottle.
  - XX 3 b. Urease has deteriorated.
  - c. Bottle of ammonia was opened nearby.
  - d. Water bath was at the wrong temperature.
  - e. Test tubes were incubated too long.
  - f. You used standardized NaOH.
  
3. You are doing a BUN test by the Warner-Chilcott column chromatograph method but the small green line that forms is fuzzy. Which of the following reasons could have caused this?
  - a. Test tube was sealed as soon as chromatographic strip was dropped in.
  - b. Test tube was not inverted twice.
  - XX 3 c. Test tube was left open and ammonia floating in room got in.
  - d. Test tube was disposable.

## BLOOD UREA NITROGEN

Missteps

4. In reading a BUN test on a colorimeter the needle on the colorimeter is fluctuating. What has happened?

a. Solution in the vial is the wrong color.

b. Solution in the vial is moving.

c. Vial was not put in the colorimeter in proper position.

XX 3 d. Malfunction of colorimeter.

5. In the autoanalyzer method of the BUN test the needle of the graph is moving all around. What has happened?

X 1 a. Antifoam reagents were not added to the diacetylmonoxime.

X b. Antifoam reagents were not added to the saline.

c. Water bath is dirty.

XX 1 d. Solution is turbid.

X 1 e. One of the reagents has run out.

6. You are doing a BUN test on the autoanalyzer but only the base line is recorded on the graph. Why would this be true?

a. Diacetylmonoxime has run out.

b. Reagent bottle is only half full.

c. Machine was not allowed to warm up long enough.

XX 3 d. Autoanalyzer colorimeter bulb has gone out.

## BLOOD UREA NITROGEN

Missteps

7. You are trying to do a BUN test on the autoanalyzer but the autoanalyzer has stopped working. Which of the following explanations would account for this?
- a. Autoanalyzer colorimeter bulb has gone out.
  - b. One of the reagents ran out.
  - XX 2 c. Dialyzer membrane has a hole in it.
  - X d. Water bath is dirty.
  - X 1 e. Tubes of the autoanalyzer have become unhooked.

Errors

8. You are doing a blood urea nitrogen test by the manual method. The results are low. Which of the explanations below would account for this?
- XX 3 a. While decanting the supernatant of the solution A Nessler's reagent, much of the mercury was discarded.
  - b. Someone walking by the work place was smoking.
  - c. A bottle of ammonia was opened near the work bench.
9. In doing a BUN by the kit method the results were low. Which of the following would cause this to happen?
- a. Laboratory assistant was smoking.
  - XX 3 b. Reagent that has degenerated was used.
  - c. A bottle of ammonia was opened near the work bench.
  - d. A newly reconstituted reagent was used.
  - e. Acid cleaned glassware was used.

## BLOOD UREA NITROGEN

Errors

10. You are doing a BUN test by the phenate-hypochlorite method and the result you get is high. Which of the following would account for this?
- a. Test was not run soon after the blood was collected.
  - b. Sample was diluted but not multiplied by dilution factor.
  - XX 2 c. Oxalate was used as an anticoagulant.
  - X 1 d. Reagent that has degenerated was used.
11. In doing a BUN by a colorimeter method the results you obtain are high or low. Why would this happen?
- X a. Reagents were stored in the wrong type of bottle.
  - XX 2 b. Amount of reagent pipeted in was more or less than needed.
  - c. Water bath was dirty.
  - X 1 d. Dirty pipets or test tubes were used.
  - X e. Colorimeter was not adjusted to the blank before a reading was taken.
12. You are doing a BUN test by a colorimeter method and the results are high. Which of the following explanations would account for this?
- X a. Laboratory assistant was smoking.
  - b. Test was not run soon after the blood was taken from the patient.
  - X c. Someone walking by the work bench was smoking.
  - XX 3 d. A bottle of ammonia was opened nearby.



## BLOOD UREA NITROGEN

Errors

13. You are doing a BUN by a colorimeter method and the results are low. Which of the following explanations would account for this?
- a. Someone walking by the work bench was smoking.
  - X b. Test was not run soon after blood was taken from the patient.
  - c. Laboratory personnel were smoking.
  - d. Water bath was dirty.
  - XX 2 e. Sample was diluted but results were not multiplied by the dilution factor.
14. In doing BUN tests the results are either high or low. Which of the reasons below would cause this?
- X 2 a. Test tubes were incubated too long.
  - XX 2 b. Water bath was at the wrong temperature.
  - c. Test was done on the blood serum.
  - d. Test was done with acid cleaned glassware.

## URIC ACID

Errors

1. In doing a uric acid test by the modified Koch method, high results were obtained. Which of the reasons below would account for this?
  - a. Using urea cyanide that was kept in the refrigerator.
  - X b. Calculations were figured incorrectly.
  - c. Results were not read within an hour.
  - XX 3 d. Using a dilute standard solution that stood more than a month.
  
2. You are doing a uric acid test by the modified Koch method and you get low results. What could have caused this?
  - XX 3 a. Using urea cyanide that was not kept in the refrigerator.
  - b. Solution placed in the colorimeter was cloudy.
  - X c. A dilution was made but the results were not multiplied by the dilution factor.
  - d. Using urea cyanide that was kept cold in the refrigerator.
  - X e. Calculations were figured incorrectly.
  
3. You are doing a uric acid test by the modified Koch method. However, you find that the quality control is incorrect. Which of the following would explain this?
  - XX 3 a. Sodium cyanide you used is old.
  - b. Results were not read within an hour.
  - c. Urea cyanide was kept cold in the refrigerator.
  - d. Dilute standard solution has stood two weeks.

## URIC ACID

Errors

4. In doing a uric acid test by the filtrate method you find that the filtrate is cloudy. Which of the following would account for this?
- a. You did not read the results within an hour.
  - X b. You did not let the filtrate settle long enough.
  - XX 3 c. You used a wrong dilution of reagents for the filtrate.
  - d. You centrifuged the solution too long.
5. Low results were obtained when you did the uric acid test by the filtrate method. Why is this?
- X 1 a. Results were not read within an hour.
  - X 1 b. Pipeting was not done correctly.
  - c. Solution was not allowed to centrifuge long enough.
  - XX 1 d. A dilution was made but the results were not multiplied by the dilution factor.
  - X e. Reagent used was contaminated due to dirty pipets that were used.
6. You are doing a uric acid test by the filtrate method and you obtained high results. What would the explanation be?
- a. Solution was centrifuged too long.
  - XX 3 b. Solution placed in the colorimeter is cloudy.
  - X 2 c. Pipeting was not done correctly.
  - X 1 d. Reagent used was contaminated by dirty pipets that were put in it.
  - e. Results were not read within an hour.

## TOTAL PROTEINS

Errors

1. You obtain low results doing a total protein test, colorimetric method. Which of the following explanations would account for this?
  - X 2 a. Tubes were not heated slowly and liquid boiled above the 35cc. mark.
  - XX 3 b. More than 1cc. of serum was pipeted into the test tube.
  - c. Water free of nitrogen compounds was used.
  - d. Tubes sat 30 minutes before they were read.
  
2. You are doing a total protein test, colorimetric method and you obtain high results. What would explain this?
  - a. Tubes were heated too long.
  - XX 2 b. Hemolysis has taken place.
  - X 1 c. Distilled water used was not free of nitrogen compounds.
  - d. Tubes not allowed to sit 30 minutes before they were read.
  - X e. More than 1cc. of serum was pipeted into the test tube.
  
3. In doing a total protein test by the biuret method, low results were obtained. Why would this be true?
  - a. Triple distilled water was used.
  - b. Hemolysis has taken place.
  - XX 2 c. Tubes were not allowed to set 30 minutes before they were read.
  - X 1 d. Less than 1cc. of serum was pipeted into the test tube.

**TOTAL PROTEINS****Errors**

4. You are doing the biuret method of a total protein test, the results are high. Which of the reasons below would account for this?
- a. Less than 1cc. of serum was pipeted into the test tube.
  - XX 3 b. A cloudy test was put in the colorimeter.
  - c. Tubes were heated too slowly.
  - X 1 d. More than 1cc. of serum was pipeted into the test tube.

## ALBUMIN

Missteps

1. You try to find the amount of albumin in the serum by the modified Kingsley method but the sodium sulfate crystallized. What would cause this?
  - a. Twenty-three percent sodium sulfate was used.
  - XX 3 b. Temperature of the solution was below 25°C.
  - c. Water was not triple distilled.
  - X d. Temperature of the glassware was below 25°C.
  
2. In trying to find the amount of albumin in the serum by the electrophoresis method you have difficulty in reading the results. Which of the following would explain this?
  - XX 3 a. Electrophoretic sheet was placed at an angle.
  - X 1 b. Timing was too short.
  - X 1 c. Timing was too long.
  - d. Rinsing was done with alcohol.
  - X e. Buffer is old.

Errors

3. You are testing for albumin by a colorimetric method and you obtain low results. What would explain this?
  - XX 3 a. Tubes were not heated slowly and the liquid boiled above the 35cc. mark.
  - X 1 b. Tubes were not heated to high enough temperature.
  - c. More than 1cc. of serum was pipeted into the test tube.
  - X 1 d. Less than 1cc. of serum was pipeted into the test tube.

## ALBUMIN

Errors

4. You are testing for albumin using the electrophoresis method. Your results are low. Why is this?
- a. Test was done on a mixture of proteins.
  - X b. Whatman No.1 filter paper was used.
  - c. Rinsing was done by alcohol.
  - XX 1 d. Old buffer was used.
  - X e. There was a variation in pH of the solution.
5. In testing for albumin by the electrophoresis method your results are high. Which of the following explanations would account for this?
- a. Test was done on a mixture of proteins.
  - XX 3 b. Temperature increased so dye uptake increased.
  - X 1 c. Time increased so dye uptake increased.
  - X d. Standardized electrophoretic paper was not used.
  - X e. There was a variation in the pH of the solution.
6. In doing a test on albumin by the modified Kingsley method low results were obtained. Which of the following would account for this?
- XX 2 a. Test tube with serum-salt and ether was not mixed enough.
  - b. Twenty-three percent sodium sulfate was used for the test.
  - X 1 c. Test tube with serum-salt and ether was shaken violently.
  - d. Cloudy solution was put in the colorimeter.

## ALBUMIN

Errors

7. High results were obtained for albumin by the modified Kingsley method. Which of the following explanations would account for this?
- XX 3 a. Globulin adhering to the pipet was not wiped off.
  - X b. Twenty-three percent sodium sulfate was used for the test.
  - c. Test was done on a mixture of proteins.
  - d. Less than 1cc. serum was added to the test.
8. In the biuret method of albumin, high results were obtained. Why is this?
- X 1 a. Sodium sulfate solution was not made up to 23%.
  - b. Temperature of the solution was above 25°C.
  - XX 2 c. Cloudy test was put in the colorimeter.
  - d. Water was triple distilled.



## GLOBULIN

Missteps

1. You try to find the amount of globulin in the serum by the modified Kingsley method, but the sodium sulfate crystallized. What would cause this?
  - a. Twenty-three percent sodium sulfate was used.
  - XX 3 b. Temperature of the solution was below 25°C.
  - c. Water was not triple distilled.
  - X d. Temperature of the glassware was below 25°C.
  
2. In trying to find the amount of globulin in the serum by the electrophoresis method, you have difficulty in reading the results. Which of the following would explain this?
  - XX 3 a. Electrophoretic sheet was placed at an angle.
  - X 1 b. Timing was too short.
  - X 1 c. Timing was too long.
  - d. Rinsing was done with alcohol.
  - X e. Buffer is odd.

Errors

3. In doing a globulin test by the modified Kingsley method, low results were obtained.
  - a. Cloudy test was put in the colorimeter.
  - b. Test was done on a mixture of proteins.
  - c. Distilled water was used for the test.
  - XX 3 d. Improper strength sodium sulfate was used.

## GLOBULIN

Errors

4. You are testing for globulin by the biuret method and low results were obtained. Which of the explanations below would account for this?
- a. More than 1cc. of serum was pipeted into the test tube.
  - b. A bottle of ammonia was opened nearby.
  - XX 3 c. Sodium sulfate solution was not made up to 23%.
  - d. Hemolysis had taken place.
5. High results were obtained when doing a globulin test by the biuret method. Which of the following would explain this?
- XX 3 a. A cloudy test was put in the colorimeter.
  - b. Less than 1cc. of serum was pipeted into the test tube.
  - c. Sodium sulfate solution was not made up to 23%.
  - d. Tubes were not heated slowly.
6. In doing a globulin test by the electrophoresis method, you obtained high results. Which of the following reasons would account for this? It was done:
- X a. on a mixture of proteins, as in serum.
  - XX 2 b. on a solution with a pH that is not standard.
  - c. with distilled water.
  - X 1 d. on a solution with a variation in buffer.

## GLOBULIN

Errors

7. You are doing a globulin test by the electrophoresis method, but the results come out low. Why is this?
- a. A bottle of ammonia was opened nearby.
  - X b. Rinsing was done by alcohol.
  - X 1 c. An old buffer was used.
  - XX 2 d. pH of the solution is not standard.

## FIBRINOGEN

Errors

1. In doing a fibrinogen test by Nessler's colorimetric method, you obtained high results. Which of the following explanations would account for this?
  - X a. Hemolysis had taken place.
  - X b. Distilled water used was not free of nitrogen compounds.
  - X 1 c. More than 1cc. of serum was pipeted into the test tube.
  - X 1 d. Laboratory personnel were smoking near the bench.
  - XX 2 e. Bottle of ammonia was opened nearby.
  
2. In a fibrinogen test, colorimetric method, the results are low. Which of the reasons below would explain this?
  - X 1 a. Tubes were not heated slowly and liquid boiled above the 35cc. mark.
  - X 1 b. Less than 1cc. of serum was pipeted into the test tube.
  - c. Someone walking by laboratory bench was smoking.
  - XX 2 d. While boiling, some of the solution spurted out of the tube.
  - X e. Solution was not boiled down to a sufficiently charred condition.

**BILIRUBIN****Errors**

1. In doing a series of bilirubin tests you consistently obtain low results. Which of the following might be responsible?
  - a. Not enough anticoagulant added to blood sample.
  - b. RBC hemolyzed.
  - c. Serum not allowed to stand 24 hours in contact with red cells.
  - d. Blanks contaminated with diazo reagents from test.
  - XX 3 e. Reagents have deteriorated.
  
2. As you read the results of a test for bilirubin, you notice that they are lower than usual. Which of the following could have caused this?
  - a. Standards were exposed to light.
  - b. Glassware not scrupulously clean.
  - c. Blanks contaminated with diazo reagents from test.
  - d. Reagents not added in order listed.
  - XX 4 e. Left one of reagents out of test tube.

## CEPHALIN-CHOLESTEROL FLOCCULATION

Errors

1. In doing cephalin-cholesterol flocculations by Hanger's and Hopper's methods, which of the following explanations would account for false positive results?

X a. Pipeted incorrectly.

XX 3 b. Bacterial contamination.

X c. Traces of acid on glassware.

X d. Traces of heavy metal on glassware.

X e. Serum frozen and allowed to stand at icebox temperatures from one to seven days.

2. In doing cephalin-cholesterol flocculations by Hanger's and Hopper's methods, which of the following explanations would account for false negative results?

X 1 a. Pipeted incorrectly.

X b. Reagents deteriorated because they were left out of the refrigerator.

X c. Test not run within four hours after blood was drawn.

XX 2 d. Tubes were exposed to light during developing period.

e. Traces of acid on glassware.

X 1 f. Improperly prepared reagents.

## AMYLASE

Missteps

1. When doing an amylase you note a disturbing greenish tinge transmitted to the blue color. Which of the following explanations would account for this?
  - a. Test done on whole blood.
  - X 1 b. Old starch paste was used.
  - c. Incubation time was too long.
  - d. Incorrect water bath temperature.
  - XX 3 e. Iodine was used in excess.

Errors

2. In doing an amylase by the amyloclastic method, you obtain very low results. Of the following explanations which would account for this?
  - a. Water bath temperature too high.
  - b. Incubation time too long.
  - XX 2 c. Dilution made but result not multiplied by dilution factor.
  - d. Copper and tungstate used to precipitate protein.
  - e. Large amounts of unsaturated material in test tube.
3. In doing an amylase by the amyloclastic method, you note that the color has faded. What could have caused this?
  - a. Water bath temperature too low.
  - b. Incubation time not long enough.
  - c. Test done on whole blood.
  - XX 2 d. Old starch paste was used.
  - X 1 e. Large amounts of unsaturated material in test tube.

**AMYLASE****Errors**

4. While doing an amylase by the saccharogenic method, you notice that the filtrate is cloudy. Which of the following reasons could have caused this?
- a. Old starch paste was used.
  - b. Water bath temperature too high.
  - c. Incubation time not long enough.
  - X 1 d. Copper and tungstate used to precipitate protein.
  - e. Test not run soon after blood was drawn and amylase deteriorated.
  - XX 2 f. Improper proportions of precipitating reagents.
5. After doing a number of tests for amylase you realize that results are either high or low. What could have caused this?
- XX 2 a. End point of titration passed due to dark color occurring when iodine and starch are titrated, making it hard to observe point where white cuprous oxide has gone completely into solution.
  - b. Dilution made but result not multiplied by dilution factor.
  - c. Some tests were run too soon after blood was drawn, thus giving a high amylase; other tests were not run soon enough after blood was drawn, and amylase deteriorated.
  - d. Large amount of unsaturated material on test tube.
  - X 1 e. Improper concentrations of either one or both of precipitating reagents.



**AMYLASE****Errors**

6. In the amyloclastic and saccharogenic methods of doing a blood amylase, which of the following could give you low results?
- a. Large amount of unsaturated material in test tube.
  - b. Copper and tungstate used to precipitate protein.
  - X c. Test done on whole blood.
  - X d. Old starch paste was used.
  - XX 3 e. Test not run soon after blood was drawn, and amylase deteriorated..
7. In the amyloclastic and saccharogenic methods of obtaining a blood amylase, which of the following would give you either low or high results?
- X 2 a. Incorrect water bath temperature.
  - XX 3 b. Incubation time too long or too short.
  - c. Copper and tungstate used to precipitate protein.
  - X 3 d. Did not pipet accurately.
  - e. Dilutions made but results not multiplied by dilution factor.

## BLOOD GLUCOSE

Missteps

1. By the Folin-Wu method of a blood glucose test, the filtrate is not colorless. Which of the following would explain this?
  - X a. Fresh reagents were not used.
  - X 1 b. Reagents were not mixed in the correct order.
  - XX 3 c. There was an improper proportion of reagents.
  - X d. Glassware used was contaminated.
  - e. Sulfuric acid was too weak.
  
2. You are doing a blood glucose test by the Folin-Wu method but the solution is cloudy. What has happened?
  - a. Glycolysis had taken place.
  - X 1 b. Solution was not mixed well enough to remove all proteins.
  - c. Water bath temperature was too high.
  - XX 2 d. Solution did not stand long enough to remove all proteins.
  - X 1 e. There was an improper proportion of reagents.
  
3. There is foam on the filtrate of a blood glucose test done by the Folin-Wu method. Which of the explanations below would account for this?
  - a. Blood sample had bubbles in it causing a foam on the filtrate.
  - b. Samples boiled too long causing them to foam.
  - XX 2 c. Sulfuric acid used was too weak causing a foam.
  - X 1 d. After phosphomolybdic acid was added, the foam was not removed.

## BLOOD GLUCOSE

Missteps

4. You are testing for blood glucose by the Nelson Somogyi method, however, the unknown sample is yellow instead of blue. What would cause this to be true?
- XX 2 a. Too much of one of the reagents was added to the test.
  - X 1 b. Sodium fluoride was not added immediately so glycolysis has taken place.
  - X 1 c. Barium hydroxide and zinc sulfate were not balanced.
  - d. Solution was not mixed well enough.
5. The titration check of reagents, of the blood glucose test by the Nelson Somogyi method, is outside the required range. Which of the explanations below would account for this?
- XX 3 a. Solution was not accurately weighed or measured out.
  - b. A wrong reagent was added.
  - c. The wrong indicator was used.
  - d. Bench underneath the beaker was white.
6. You are doing a blood glucose test by the Nelson Somogyi method but the solution is the wrong color. Which of the following could have happened?
- X a. There was insufficient water in the water bath.
  - XX 3 b. A wrong reagent was added.
  - X 1 c. A reagent was not added at all.
  - X d. Water in the water bath was not boiling.

## BLOOD GLUCOSE

Missteps

7. While doing a blood glucose test by the Nelson Somogyi method you notice that the tubes do not contain an equal amount of fluid. What could have caused this?
- a. A wrong reagent was added to some of the tubes.
  - X 2 b. A reagent was not added at all.
  - XX 4 c. Too little or too much of a reagent was added.
  - d. Pipet used to add a reagent was the wrong size.
8. While trying to get a result on a blood glucose test the needle is fluctuating so much you cannot get a reading. Why would this be true?
- a. Solution was the wrong color.
  - b. Colorimeter was on the wrong wavelength.
  - c. Exciter tube in the colorimeter is blown out.
  - XX 2 d. Air bubbles.
  - X 1 e. Faulty colorimeter.

Errors

9. You are doing a blood glucose test by the Folin-Wu method, however, the test results are low. Which of the following explanations would account for this?
- X a. Filtrate and alkaline tartrate solution was not mixed well enough.
  - XX 4 b. Blood sample was old, and glycolysis had taken place.
  - X c. Pipeting was not done correctly.
  - X d. Amount of time and water bath temperature was incorrect.

## BLOOD GLUCOSE

Errors

10. In doing a blood glucose by the Nelson Somogyi method, low results were obtained. Which of the following could have caused this?
- X 1 a. Precipitate was not completely dissolved before the tube was diluted with distilled water.
  - XX 2 b. Barium hydroxide and zinc sulfate were not balanced.
  - X c. Mathematics were not correctly figured.
  - X d. Glycolysis had taken place.
  - X e. Blood sample was old.
11. You are testing blood glucose by the Nelson Somogyi method but the results are too high or too low. Which of the reasons below would account for this?
- XX 2 a. Samples were boiled too long or not long enough.
  - X 1 b. Water bath temperature was too high or too low.
  - X c. Barium hydroxide and zinc sulfate were not balanced.
  - X 1 d. Mathematics were not figured correctly.
12. Control results are either high or low on a blood glucose test by a colorimeter method. Which of the following would explain this?
- X a. Test was not done immediately.
  - X b. Colorimeter was not calibrated.
  - XX 2 c. Results were read on the wrong wavelength.
  - X d. Colorimeter was not adjusted to the blank before a reading was taken.
  - X e. A special dilution was made, but after reading the graph a correction was not made for it.

## BLOOD GLUCOSE

Errors

13. After doing a blood glucose test by a colorimeter method, you obtained high results. Which of the following would account for this? Cuvet:

- X 2 a. has finger prints on the outside.
- b. was handled by the top.
- XX 1 c., has a scratch in it.
- X d. was pushed into the colorimeter too far.

**CHARACTER**

**Errors**

1. The appearance of the urine you are about to analyze is cloudy. Which of the reasons below would account for this?

XX 2 a. Urine was refrigerated.

X 1 b. Urine was left on the laboratory bench.

c. Urine had the wrong preservative put in it.

d. Urine had toluene added to it.

4

**PH REACTION****Missteps**

1. The color on the dip-stick does not match any color on the comparison chart. Why is this?  
  
XX 3 a. Reagent was neutralized by previous wetting of the dip-stick.  
  
b. Urine had thymol crystal added to it.  
  
c. Dip-sticks were not kept in the refrigerator.  
  
d. Dip-sticks were kept in a tightly closed jar.

**Errors**

2. The pH reaction on the urine indicated high alkalinity. Which of the reasons below could account for this?  
  
XX 3 a. Sample was not fresh enough.  
  
b. Sample was refrigerated.  
  
c. Toluene was added to the urine.  
  
d. Thymol crystal was added to the urine.  
  
e. Preservative was added to the urine.



**SPECIFIC GRAVITY****Missteps**

1. Due to the clouded gradations on the urinometer, you are not able to read the specific gravity. Which of the reasons below would account for this?
- XX 3 a. Urinometer was improperly cleaned.
  - X b. Container was improperly cleaned.
  - X c. Urinometer was improperly stored.
  - X d. Container was improperly stored.
  - e. Urinometer was cleaned with sulfuric acid.

**Errors**

2. With the refractometer several consecutive specific gravity readings are all high or low. What would cause this to happen?
- a. Instrument was cleaned with sulfuric acid.
  - b. Instrument was calibrated at 22°C.
  - c. Only one drop of urine was used.
  - d. Urines were mixed too much.
  - XX 2 e. There is a drift in instrument calibration.
3. The specific gravity readings were very high or extremely low on a diluted specimen using the refractometer. Which of the explanations below would account for this?
- a. Diluted urine was mixed too much.
  - b. Only one drop of diluted urine was used.
  - XX 2 c. Diluted urine was not thoroughly mixed.
  - d. Instrument was calibrated at 22°C.

## SPECIFIC GRAVITY

Errors

4. With the refractometer the specific gravity reading was low on a diluted specimen. Which of the following reasons would explain this?
- a. Only one drop of diluted urine was used.
  - b. The instrument was calibrated at zero.
  - c. Specimen was not diluted.
  - XX 2 d. Reading was not multiplied by the proportion of dilution.
5. The specific gravity readings all tend to be high or low using the urinometer. Which of the following reasons would explain this?
- X a. Foam was not removed before beginning the test.
  - XX 2 b. There was an error in reading the urinometer through four faces of glass and liquid.
  - X 1 c. Reading was not done at the exact point specified for the instrument in use.
  - d. Instrument was calibrated at 22°C.
  - X e. There was a drift in calibration of the urinometer.
6. Using the urinometer a low reading was obtained for the specific gravity test. What would cause this?
- a. Instrument was calibrated at 22°C.
  - b. Instrument was calibrated at zero.
  - XX 2 c. Correction was not made for difference in calibration and room temperature.
  - d. Specimen was not taken in a fasting state.
  - X 1 e. There was an error in reading the urinometer through four faces of glass and liquid.

**SPECIFIC GRAVITY****Errors**

7. Using a urinometer a very low specific gravity reading resulted on a diluted urine specimen. Which of the following reasons would account for this?
- XX 3 a. Failure to calculate the correction for the dilution.
- b. Only the last two digits were multiplied by the proportion of the dilution.
- c. Specimen was not diluted.
- d. Specimen was not taken in a fasting state.

**PROTEIN****Missteps**

1. You are testing for protein in the urine, but the point of contact between the urine and reagent is not visible in the ring test. Which of the following explanations would account for this?
  - a. Reagent and the specimen were not mixed thoroughly.
  - XX 3 b. Reagents were not layered on or under the urine.
  - c. Specimen is slightly acid.
  - d. Urine was left on the laboratory bench.
  - e. Specimen was not a fasting one.
  
2. When you are testing for protein in the urine, the reagent on the dip-stick turns orange, blue, or green when dipped into the specimen. Which of the explanations below would account for this?
  - a. Thymol crystal was added to the urine.
  - XX 3 b. Patient is taking medication containing dye.
  - c. Dip-sticks were not kept in the refrigerator.
  - d. Patient had eaten a big breakfast before the specimen was taken.
  - e. Specimen was not thoroughly mixed.
  
3. While testing for protein the dip-stick color did not change after it was dipped into the urine. Which of the following reasons would account for this?
  - a. Dip-sticks were not kept in the refrigerator.
  - b. Patient is taking medication containing dye.
  - c. Dip-stick jar was kept tightly sealed.
  - XX 3 d. Previous wetting of the dip-stick neutralized the reagent.

## PROTEIN

Errors

4. All of the dip-stick tests showed a trace of protein when dipped in urine. Which of the following would account for this?
- XX 3 a. Difference between the absorption color of the specimen and the reflective color on the chart was not allowed for.
- b. Every urine has enough protein to show a trace. .
- c. Urine has a high pH..
- d. Patient ate a large piece of meat before the specimen was taken.
- e. Patient was not in a fasting state.
5. The dip-stick test showed a strongly positive protein reaction in the urine. Which of the following explanations would account for this?
- a. Dip-sticks were not kept in the refrigerator.
- b. Patient was not in a fasting state.
- c. Sample was not thoroughly mixed.
- d. Sample was not taken first thing in the morning.
- XX 3 e. Urine was highly alkaline.
6. The chemical tests for protein in urine showed a definite positive reaction. Which of the following explanations would account for this?
- X 1 a. Urine was not acidified.
- X b. Mucus causes a positive protein reaction.
- c. Sample was not taken first thing in the morning.
- XX 2 d. Numerous bacteria cause a positive protein reaction.
- e. Urine was kept in the refrigerator.

## PROTEIN

Errors

7. The ring test gave a positive protein reaction in the urine, the specific gravity being normal or low. Which of the explanations below would account for this?
- a. Not taking the sample first thing in the morning.
  - b. Allowing a preservative to be added to the sample.
  - XX 2 c. Mistaking ring above zone of contact for protein ring.
  - d. Keeping the sample in the refrigerator.
  - X 1 e. Waiting too long before checking reaction on ring test.

## TEST FOR ACETONE

Errors

1. There is an unusually high acetone result in doing an acetone determination on urine. Which of the explanations listed below might best explain this?
- X a. Urine specimen was not refrigerated.
  - b. Patient was in a fasting state for several hours before the urine specimen was gathered.
  - c. Patient had eaten just before voiding the specimen.
  - XX 3 d. Diacetic acid had decomposed to acetone.
  - e. Urine specimen was not centrifuged.

## TEST FOR BILE

Missteps

1. In doing a Lugol iodine test for bile in urine, no ring forms. Which of the statements below would explain why there is no ring?
  - a. Lugol iodine solution is under the urine.
  - XX 3 b. Lugol iodine solution is mixed with the urine.
  - c. Urine has not been refrigerated.
  - d. There is bacteria in the urine.
  - e. Urine specimen is not an early morning specimen.



## TEST FOR SUGAR

Errors

1. In doing tests for sugar on urine, you find that while the dip-stick indicates a very high sugar, the Clinitest indicates a 2+ sugar. Which of the following explanations would account for such results? The proportion(s) of:
  - a. urine to water was too high in doing the Clinitest.
  - b. water to urine was too high in doing the dip-stick test.
  - XX 3 c. water to urine was too high in doing the Clinitest.
  - d. urine to water was too high in doing the dip-stick test.
  - e. both urine and water were too high in doing both tests.
  
2. In doing tests for sugar on urine, you find that while the dip-stick indicates a small amount of sugar, the Clinitest indicates a 3+ sugar. Which of the following explanations would account for such results?
  - a. Failure to watch color changes as reaction takes place.
  - X b. Handling of test tube disrupted layer of carbon dioxide formed by tablet.
  - X 1 c. Tube (Clinitest) was moved during boiling phase of test.
  - XX 2 d. Inaccurate measuring.

**MICROSCOPIC****Missteps**

1. There are very limited findings as you do a microscopic analysis of a urine specimen. Which of the explanations listed below could account for this?
  - X a. Failure to examine more than one field.
  - X b. Urine not fresh.
  - X c. Some cellular elements have disintegrated.
  - XX 2 d. Urine specimen was not centrifuged.
  - X 1 e. Too large drop of urine used.
  
2. In doing a microscopic urinalysis you find an excessive amount of amorphous crystals which obscures the organized crystals. Which of the following explanations could account for this?
  - a. Failure to mix entire urine specimen thoroughly before centrifuging.
  - b. Too small drop of urine used.
  - XX 2 c. Sample was too cold.
  - d. Contamination of the receptacle used to collect the specimen.
  - X 2 e. Drying of the urine specimen.
  
3. As you look through your microscope to do a urinalysis, you note a blurred field. Which of the statements listed below would explain this blurred field?
  - a. The drop of urine is not covered with a cover slide.
  - b. Urine was not centrifuged.
  - XX 3 c. Your microscope lens is contaminated with cellular elements.
  - d. Urine specimen is too dry.
  - e. Urine is not fresh and some cellular elements have disintegrated.

## MICROSCOPIC

Missteps

4. Which of the following statements explain finding an apparent high concentration of red blood cells with a negative reaction on occult blood dip-stick?
- a. Sediment drop taken from a catheterized specimen.
  - XX 2 b. Yeast present in specimen.
  - c. Failure to spread sediment drop evenly on uncovered slide.
  - d. Too much light on sediment sample.
5. Your findings, in doing a microscopic urinalysis, are doubtful. Which of the reasons listed below would explain why you are unable to confirm your findings?
- a. Failure to mix entire urine specimen before centrifuging.
  - b. Leaving too much liquid in test tube after centrifuging.
  - X 1 c. Drying of urine specimen.
  - d. Too much light on sediment sample.
  - XX 2 e. Throwing out urine before completely finishing all tests.
6. As you begin a microscopic urinalysis, you note that there are no cellular elements in the sample. Which of the following explanations would account for this?
- a. Failure to spread sediment drop evenly on uncovered slide.
  - XX 2 b. Too much light on sediment sample.
  - c. Inability to differentiate between red blood cells and yeast.
  - X d. Use of high power objective.
  - e. Bacteria have multiplied in urine, which stood too long.
  - X f. Improper preparation of urine.

## MICROSCOPIC

Missteps

7. As you begin a microscopic urinalysis, you note that the normal sediment is obscured by bacteria. Which of the following statements would account for this?
- X a. Specimen was voided.
  - XX 3 b. Urine not fresh.
  - c. Not enough liquid left in test tube after centrifuging.
  - d. Not enough light on sediment sample.
8. As you begin a microscopic urinalysis, you note that the cellular elements are piled on top of each other, making identification impossible. Which of the following explanations would account for this?
- a. Bacteria have multiplied in urine which stood too long.
  - b. Patient was not catheterized.
  - c. Too much light on sediment sample.
  - d. Too large urine drop on slide.
  - XX 3 e. Failure to spread sediment drop evenly on uncovered slide.

Errors

9. You have just completed a microscopic urinalysis and realize that, although the specimen was catheterized, there is a very high red blood count. Which of the statements below would explain this?
- a. Urine drop on slide too small.
  - b. Failure to mix entire urine specimen thoroughly before centrifuging.
  - XX 2 c. Injury to meatus at time of catheterization.
  - d. Drying of urine specimen.

## MICROSCOPIC

Errors

10. In doing a microscopic urinalysis, after counting ten fields, you find that the counts of WBC, RBC, and other sediments vary from one field to another. Which of the following could give this type of result?
- a. Contamination of centrifuge tube.
  - b. Lack of care in transferring sediment to slide.
  - c. Contamination of specimen.
  - XX 3 d. Inadequate mixing of centrifuged specimen.
  - e. Urine not fresh, and some cellular elements have disintegrated.
11. As you are doing a microscopic urinalysis, you note that there are unidentified crystals in the sediment which fall in an unusual pattern. Which of the following statements might explain this?
- XX 3 a. Scratch on slide or coverslip.
  - b. Specimen too cold.
  - c. Drying of urine specimen.
  - d. Contamination of urine specimen.
12. A patient has no infection, but in doing a microscopic urinalysis, you find many pus cells in the urine. Which of the following explanations might account for this?
- XX 1 a. Contaminated urine specimen.
  - b. Voided specimen.
  - X c. Dirty centrifuge tube.
  - d. Dirty slide or cover slip.

**INCREASED GLOBULIN CONCENTRATION IN BODY FLUID****Missteps**

1. In the chemical test method for increased globulin concentration in a body fluid the ring cannot be seen. Which of the following would explain this? You:
  - a. waited three minutes before checking for the ring.
  - b. did not shake the solutions.
  - c. looked for the ring against a dark background.
  - d. used 1cc. of spinal fluid.
  - XX 3 e. did not centrifuge the cloudy spinal fluid.

**Errors**

2. By any method high results for increased globulin concentration in a body fluid were obtained because:
  - a. the body fluid was centrifuged.
  - XX 3 b. there is blood in the body fluid sample.
  - c. the different proteins were not taken out of the body fluid.
  - d. the patient is on a protein diet.
3. High results for increased globulin concentration in a body fluid were obtained by the electrophoretic method. Results may be too high because the:
  - a. rinsing was done with alcohol.
  - b. patient was on a protein diet.
  - XX 2 c. test was done on a mixture of proteins.
  - d. rinsing was done with aqueous acetic acid.
  - e. paper was too long.

**INCREASED GLOBULIN CONCENTRATION IN BODY FLUID****Errors**

4. In doing an increased globulin concentration in body fluid, you obtain either low or high results for the electrophoretic method. Which of the following might explain this? There is a:
- a. variation in length of paper.
  - XX 2 b. variation in pH.
  - X c. variation in the buffer.
  - X d. slight variation in thickness of electrophoretic paper.
  - X e. slight variation in color of electrophoretic paper.
  - X 1 f. wrong timing on electrophoretic run.
5. In doing an increased globulin concentration in body fluids with electrophoretic method, low results were obtained. Which of the reasons listed below might explain this?
- XX 2 a. Rinsing was done by alcohol.
  - X 1 b. Buffer was old.
  - c. Rinsing was done by aqueous acetic acid.
  - d. Cloudy body fluid was not centrifuged.
  - e. Cloudy body fluid was centrifuged.
  - X 1 f. Wrong timing on electrophoretic run.
6. In doing an increased globulin concentration in body fluids using a chemical method, high results were obtained. Which of the statements below would explain this?
- XX 3 a. Cloudy spinal fluid was not centrifuged.
  - b. Solution was not the proper strength.
  - c. Body fluid has a variation in pH.
  - d. Solution was not properly prepared.

**INCREASED GLOBULIN CONCENTRATION IN BODY FLUID****Errors**

7. In doing an increased globulin concentration in body fluids, low results were obtained using a chemical method. Which of the reasons listed below might explain this?
- a. Cloudy body fluid was not centrifuged.
  - XX 2 b. Solution was not the proper strength.
  - X 1 c. Solution was not properly prepared.
  - d. Body fluid has a variation in pH.



## TOTAL AND DIFFERENTIAL CELL COUNT IN CEREBROSPINAL FLUID

### Missteps

1. As you look at cerebrospinal fluid under a microscope, you see many degenerated cells. Which of the explanations below would account for this? The cerebrospinal fluid was:
  - a. withdrawn too quickly from the spinal canal.
  - b. not refrigerated for the required length of time.
  - c. contaminated in transit to the laboratory.
  - d. obtained from the first tube drawn by the doctor.
  - XX 2 e. allowed to stand too long.
  
2. In preparing to do a cell count on cerebrospinal fluid you note that the fluid is coagulated. Which of the explanations given below would account for this?
  - XX 2 a. Specimen not fresh.
  - b. Too little spinal fluid, in comparison to solution, was drawn into leukocyte pipet.
  - c. Sample of spinal fluid not mixed adequately.
  - d. Spinal fluid handled too roughly.
  - e. Specimen was allowed to warm to room temperature as it was transported to the laboratory.

### Errors

3. In doing a cell count on cerebrospinal fluid, you obtain low results in the presence of cells. Which of the explanations listed below would account for this result?
  - X a. Many cells were lost in doing the smear for a differential.
  - XX 2 b. Cells not allowed to settle on counting chamber before they were counted.
  - X 1 c. Too little spinal fluid, in comparison to solution, was drawn into leukocyte pipet.
  - X 1 d. Sample of spinal fluid not mixed adequately.

**TOTAL AND DIFFERENTIAL CELL COUNT IN CEREBROSPINAL FLUID****Errors**

4. In doing a cell count on cerebrospinal fluid, you obtain an unusually high count. Which of the explanations listed below could account for this result?

- X 1 a. Sample of spinal fluid not mixed adequately.
- XX 2 b. Too much spinal fluid, in comparison to solution, was drawn into leukocyte pipet.
- c. Too much solution, in comparison to spinal fluid, was drawn into leukocyte pipet.
- d. Cells not allowed to settle on counting chamber before they were counted.
- e. Differential was done on counting chamber instead of on a smear.

## OCCULT BLOOD IN FECES

Errors

1. On a specimen known to contain occult blood, your results are negative. Which of the statements below would explain this?
  - X a. Glassware contaminated with ascorbic acid.
  - X b. Benzidine dehydrochloride used for test.
  - XX 2 c. Did not wait five minutes for appearance of blue or dark green color.
  - X 1 d. Too much hydrogen peroxide used.
  
2. On a specimen known to be free of occult blood, your results are positive. Which of the statements below would explain this?
  - X a. Pus produced positive reaction.
  - X 1 b. Glassware contaminated with iodides or formaline.
  - X c. Glassware contaminated with cuprous oxide, bromides, or nitric acid.
  - X 1 d. Waited too long to read test.
  - X e. Fats were not removed.
  - XX 2 f. Glassware contaminated with blood.

## NEUTRAL FATS IN FECES

Errors

1. In doing a test for neutral fat in feces, the result is high. Which of the following statements would explain this?
  - a. Saturated Sudan III was used to stain feces.
  - X 1 b. Osmic acid was used to stain feces.
  - c. Feces were standing some time before analysis was done.
  - XX 2 d. Reagents contained fatty substances.
  
2. In doing a neutral fat in feces, the result is low. Which of the following would explain such a result?
  - XX 3 a. Feces were standing some time before analysis was done.
  - b. Osmic acid was used to stain feces.
  - c. Pus produced a negative reaction.
  - d. The specimen was boiled too long.
  - e. Glassware contaminated with ascorbic acid.
  
3. You got a high or low result in a neutral fat in feces determination. Which of the statements listed below would explain this?
  - a. Saturated Sudan III was used to stain feces.
  - b. Starch altered the result.
  - XX 3 c. The amount of fat was not expressed in terms of dry matter.
  - d. Feces was not mixed with water.

**TITRATION OF ASPIRATED GASTRIC FLUID FOR FREE AND TOTAL ACID****Missteps**

1. When using the dimethylamino-azobenzene method you notice a orange-red color produced. Which of the following could have caused this?
  - XX 3 a. There is a large amount of organic acid present in the sample.
  - b. Did not wash hands prior to test.
  - X 1 c. There must be more than 0.5% organic acid present.
  - X 1 d. The free hydrochloric acid is cherry-red.

**Errors**

2. A low results is obtained when using the Topfer's method for total acidity. Which of the following could have caused this to happen?
  - a. Sodium chloride saturated fluid.
  - X 1 b. Stopped titrating at permanent pink color.
  - c. 0.1 NaOH strength was checked against 0.1N HCL.
  - d. More than 0.1N solution was kept in stock.
  - XX 2 e. Lowered alkalinity due to age.
3. When using Topfer's method for concentration of combined HCl, low results were obtained. Which of the following could have caused this to happen?
  - XX 3 a. Due to age the NaOH solution was low in alkalinity.
  - b. Discarded NaOH that precipitated.
  - c. Too much NaOH gave solution wrong color.
  - X 1 d. Titration with decinormal solution was stopped at violet color.

**TITRATION OF ASPIRATED GASTRIC FLUID FOR FREE AND TOTAL ACID****Errors**

4. When using Topfer's method for concentration of combined HCL high or low results were obtained. Which of the following could have caused this to happen?
- a. Solution was mixed too much.
  - XX 3 b. NaOH solution was not prepared properly.
  - c. Wrong color was obtained with too much NaOH added.
  - d. Titration was not done at 37°C.
5. When using all methods, low or high results are obtained. Which of the following could have caused this?
- a. Did not wash hands before preparing solution.
  - XX 3 b. Did not put a sheet of white paper beneath beaker on colored table.
  - c. Did not check 0.1N HCl for color.
  - d. Did not stop swirling when color change took place.

**PREPARATION OF BACTERIOLOGIC AND SEROLOGIC SPECIMEN FOR MAILING****Missteps**

1. You have prepared a sample for mailing. When the sample was received it had leaked out. Why is this?
  - XX 3 a. Plastic container was not sealed with a parafilm cover.
  - b. Plastic container was not sealed with a metal screw cap.
  - c. Plastic container was old.
  - d. Metal container was old.
  
2. The sample you prepared for mailing was received in a broken container. Why?
  - a. Sample was not put in a container made of thick glass.
  - b. Sample was not put in two containers made of metal.
  - XX 3 c. Sample was not put in two containers, one of plastic and the other of metal.
  - d. Sample was not put in two containers made of thick waxed cardboard.
  
3. A sample you prepared for mailing was sent to the wrong place because:
  - a. Sample was not sealed properly.
  - b. Sample was sent on dry ice.
  - c. Laboratory sent to has moved.
  - XX 3 d. Sample was not carefully labeled.

## PREPARATION OF BACTERIOLOGIC AND SEROLOGIC SPECIMEN FOR MAILING

Missteps

4. You prepared a serologic specimen for mailing. When the serum sample was received it was cloudy. What happened?
- a. Sample was not sent on dry ice.
  - X b. Red blood cells have diffused into the serum.
  - X 1 c. Red blood cells hemolyzed while traveling.
  - X 1 d. Excessive heat while sending the sample has coagulated the serum.
  - XX 2 e. Equipment used in preparing the sample was not sterile.
5. A specimen you prepared for mailing was received contaminated.
- X 1 a. Mailing container was contaminated.
  - XX 3 b. Poor technique was used in transferring the sterile sample into the container for mailing.
  - c. Red blood cells were not separated from the serum.
  - d. Specimen was not frozen immediately to prevent contamination.

Errors

6. High or low results were received on a specimen you prepared for mailing. Which of the following reasons might account for this?
- X a. Specimen was not frozen immediately.
  - X 1 b. Specimen was not sent on dry ice.
  - X c. Serum sample came in contact with metals.
  - XX 2 d. Sample was not prepared or handled by sterile procedure.



**STAINING OF SLIDES FOR BACTERIOLOGIC STUDY****Missteps**

1. After you have stained the slides for a bacteriologic study, the separate bacteria cannot be seen. What is the problem?
  - a. Bacteria were left in normal saline too long.
  - b. Slide was not examined soon after staining and a colony has grown.
  - c. Stain has caused the bacteria to agglutinate.
  - XX 3 d. Aqueous suspension of the bacteria is too thick.
  - e. Slide was too dry when you made the smear.
  
2. Strange bacteria and spores are seen on a slide that you stained. The smear was taken from a pure culture. What happened?
  - a. Slides were left out after they were stained.
  - X 1 b. Solution used for the slide was not free of bacteria and spores.
  - c. Tap water used for rinsing the stained slide contaminated it.
  - XX 2 d. Stain used has bacterial or fungal growth in it.
  - X 1 e. Smears dried too slowly and contamination occurred.
  
3. Stain sediment is found on a slide you stained. This would happen for which of the following reasons?
  - XX 3 a. Stain dried before slide was rinsed.
  - b. Slide was not rinsed enough.
  - X c. Dye was not accurately weighed.
  - X 2 d. Dye was impure and precipitated out.

**STAINING OF SLIDES FOR BACTERIOLOGIC STUDY****Errors**

4. You prepared and stained a slide to show flagella, but they failed to show. This was caused by which of the following reasons?
- a. Slide was decolorized too much, so the flagella do not show up.
  - b. Slide was too dry when the smear was made.
  - c. Bacteria were put in normal saline.
  - XX 3 d. Bacteria were left in water too long and have shed their flagella.
  - e. Slide was rinsed so much the flagella were rinsed off.
5. In staining the slides for bacteriologic study you used the Gram stain. When the slide was examined, however, all the bacteria were red or pink. What could have caused this?
- a. Solids from the broth culture used to make the smear has interfered with the stain.
  - XX 3 b. Slide was decolorized too much.
  - c. Slide was rinsed too much.
  - d. Aqueous suspension of the bacteria was too thick.

**FLOCCULATION TESTS FOR SYPHILIS****Missteps**

1. In doing a Kahn determination for syphilis, you cannot tell if a reaction is absent, weak, or positive. Which of the following statements might explain such an indefinite reaction?
- X a. Antigen emulsion not mixed sufficiently.
  - XX 3 b. Incorrect preparation of antigen emulsion.
  - c. Antigen emulsion less than 24 hours old was used.
  - X d. Drying of antigen emulsion.

**Errors**

2. You do a Kahn determination on a person known to have syphilis and get nonreactive results. Which of the statements listed below might explain this?
- a. Antigen emulsion less than 24 hours old.
  - XX 3 b. Antigen bottle not corked tightly when not in use.
  - X 1 c. Light caused antigen emulsion to deteriorate.
  - d. Antigen emulsion stored at room temperature.
  - X e. Antigen emulsion refrigerated.
3. In doing a Kahn determination and/or VDRL test for syphilis you obtain nonreactive results on a series of known syphilitics. Which of the statements listed below would explain these inaccurate results?
- XX 2 a. Incorrect preparation of antigen emulsion.
  - X b. Use of antigen emulsion that has undergone some change due to wet pipets.
  - X c. Drops of antigen emulsion not of constant size.
  - X 1 d. Serum not heated before sample was tested.
  - e. Use of antigen emulsion at room temperature.

## FLOCCULATION TESTS FOR SYPHILIS

Errors

4. You obtain a series of reactive results when running Kahn determinations and/or VDRL tests for syphilis. None of the patient's have syphilis. Which of the reasons listed below would explain these inaccurate results?
- XX 3 a. Tests stood for several minutes before being read.
  - b. Use of antigen solution that had not been allowed to age for 10 minutes following preparation.
  - X c. Particles that formed during heating of serum not taken out.
  - X d. Solution not mixed well enough.
  - e. Use of refrigerated or chilled antigen solution.
5. In doing Kahn determinations and/or VDRL tests for syphilis, you obtain erroneous results--either false reactive or non-reactive. Which of the reasons given below might explain such results?
- X 1 a. Solutions not prepared in sequence given.
  - X 1 b. Antigens not stored in the dark in the refrigerator.
  - X 1 c. Glassware not thoroughly rinsed.
  - XX 3 d. pH of 0.9% saline solution not between 5.5 and 7.0.
  - e. Incorrect water bath or refrigerator temperatures.
6. You do a series of VDRL tests for syphilis and obtain erroneous results, weakly reactive and reactive results on blood that is nonreactive. Which of the explanations listed below might account for this?
- X 1 a. Old antigen suspension.
  - b. Antigen suspension that has aged more than 30 minutes.
  - X 1 c. Serial dilutions not made on zonal reaction.
  - X 1 d. Solutions not prepared in sequence given.
  - XX 2 e. Speed of shaking machines incorrect.

## FLOCCULATION TESTS FOR SYPHILIS

Errors

7. You do a series of VDRL tests for syphilis and obtain erroneous results, either reactive or nonreactive. Which of the explanations listed below could account for this?
- X 2 a. Serum not inactivated.
  - X 1 b. Old antigen suspension.
  - XX 2 c. Concentration of serum antigen incorrect.
  - X 1 d. Test not allowed to stand for five minutes before reading.
  - e. Specimen centrifuged too long.

APPLICATION OF SENSITIVITY DISCS TO CULTURE  
PLATES AND READING RESULTS

Missteps

1. In preparing to read a sensitivity plate, you find that the inhibition zones have coalesced. Which of the following explanations would account for this?
- a. Culture plates were not placed in refrigerator for one hour before incubating.
  - b. Media was not fresh.
  - c. Culture was not fresh.
  - d. Antibiotics did not diffuse rapidly enough.
  - XX 3 e. Sensitivity discs were placed too close to one another.

Errors

2. You read results as resistant on a series of sulfa discs and realize that such consistency is not likely. Which of the statements below would explain erroneous results?
- a. Plates were not placed immediately into the incubator.
  - b. Discs were placed too close together.
  - XX 3 c. Sulfa did not diffuse.
  - d. Sulfa diffused too rapidly.
  - X 1 e. Sulfa and antibiotic discs were placed on the same plate.
3. You read results as resistant on a series of antibiotic discs and realize that such consistency is not likely. Which of the statements below would explain erroneous results?
- XX 2 a. Antibiotic was unable to diffuse freely.
  - X 1 b. Disc dispenser did not permanently press each sensitivity disc into the media.
  - X c. Culture was not fresh.
  - X 1 d. Media was not fresh.
  - X e. Antibiotics diffused too rapidly.

## FECAL CONCENTRATION FOR PARASITOLOGIC STUDY

Errors

1. In doing a parasitologic study on a fecal concentration, you do not see any organisms in the feces. Which of the following might explain this?
  - X a. Chemicals on the glassware have destroyed the organisms.
  - X 1 b. Temperature of the feces was above 37°C.
  - XX 2 c. Material was washed with clear water.
  
2. In the parasitologic study of fecal concentration there are unidentifiable objects in the feces. Which of the following might explain this?
  - XX 3 a. Centrifuged material was not washed.
  - b. Microscope was on the wrong power.
  - X c. Feces on the slide had dried.
  - X d. Glassware had grease spots on it.
  
3. In a parasitologic study on a fecal concentration, few or no organisms were seen in the feces. Which of the following could have caused this?
  - a. Organisms were concealed by the neutral fat.
  - XX 3 b. Both top and bottom of centrifuged material were not studied.
  - c. Saline was used to wash the feces.
  - d. Centrifuged material was washed several times before you looked for organisms.
  - e. Feces on the slide has begun to dry.

## FECAL CONCENTRATION FOR PARASITOLOGIC STUDY

Errors

4. In the parasitologic study of the feces no larvae were found, only ova. Why?
- a. Only the outer surface of the stool was studied.
  - b. Only the middle of the stool was studied.
  - XX 3 c. The test was not performed soon after the collection of the feces.
  - d. A small portion of the feces was mixed with water and this was studied.
  - X e. All of the stool was not studied.
5. In a specimen from a patient known to have amebic dysentery you are looking for ameba in feces but cannot find any. Which of the following could cause this result?
- X a. Temperature of the specimen was below 37°C.
  - b. Fecal material was washed with saline.
  - c. Fecal material was too moist.
  - XX 2 d. You looked at only one feces specimen.
  - X 1 e. You did not examine the feces within one hour.
6. You find ameba in a feces specimen but cannot identify the ameba as to pathogenic or nonpathogenic. Why?
- XX 3 a. Feces were washed in cold saline.
  - b. Feces were washed in warm saline.
  - c. Glass slide on which the feces was placed was cleaned with alcohol.
  - d. Glassware was not acid cleaned.



## FECAL CONCENTRATION FOR PARASITOLOGIC STUDY

Errors

7. After doing a parasitologic study on feces, you report the presence of worms. Following differential diagnosis by the doctor you learn that no worms were present in the patient's feces. What caused you to erroneously report the presence of worms?
- X 1 a. Shreds of mucus appear as pieces of tapeworm.
  - XX 3 b. Poorly masticated celery or greens identified as round worms.
  - X 1 c. Cells from oranges identified as pinworms.
  - X 1 d. Fibers of banana look like tapeworms and ova.
  - e. Poppy seeds look like ameba.
8. You identified hookworm larvae as *stercoralis strongyloides*. Which of the following reasons could have led you to make this error:
- a. They are both perfectly round.
  - b. They are both the same size.
  - XX 3 c. Their movement is alike and vigorous.
  - d. Their buccal cavities are the same size.
9. You are doing a parasitologic study on feces and find many larvae but few ova. The reason for this is:
- XX 3 a. ova develop into larvae quickly.
  - b. only the outer surface of the stool was studied.
  - c. by the time the organisms are in the feces they are in the larvae stage.
  - d. the ova are concealed by the many larvae.

Errors

10. While examining the feces in a parasitologic study, you find unidentifiable objects in a specimen containing trophozoites because the:

- XX 3
- a. specimen was not examined soon after collection and many trophozoites degenerated.
  - b. specimen was centrifuged with too much force which ruptured the trophozoites.
  - c. specimen was washed in normal saline which caused the trophozoites to degenerate.
  - d. temperature was kept at 37°C which destroyed the trophozoites.

## BASAL METABOLISM

Missteps

1. When preparing the machine to do a basal metabolism, you note that the solution is cloudy. Which of the following explanations would account for this?
  - a. Machine has oxygen leak.
  - b. Too much oxygen in soda lime.
  - XX 3 c. Too much CO<sub>2</sub> in soda lime.
  - d. Machine not level.
  - e. CO<sub>2</sub> content of air too high.
  
2. When preparing the machine to do a basal metabolism, you notice that the flutter valve lips will not close properly. Which of the following explanations would account for this?
  - a. Machine has oxygen leak.
  - b. Inefficient soda lime.
  - c. Water in base of machine.
  - d. Water in breathing tube.
  - XX 3 e. Flutter valves lost elasticity.
  
3. When preparing the machine to do a basal metabolism, you note that the indicator is on zero. Which of the following explanations would account for this?
  - a. Machine has oxygen leak.
  - XX 3 b. Oxygen tank is empty.
  - c. Soda lime is inefficient.
  - d. Flutter valves lost elasticity.
  - e. Machine is not level.

## BASAL METABOLISM

### Missteps

4. As you run the machine preliminary to doing a basal metabolism, you note a hissing sound. Which of the following statements would explain this hissing sound?
- a. Machine is not level.
  - b. Oxygen tank is empty.
  - XX 3 c. Machine has oxygen leak.
  - d. Water in base of machine.
  - e. Water in breathing tube.
5. The patient cannot breathe as you begin a basal metabolism test. Which of the following explanations would account for this problem?
- X a. Soda lime is moist.
  - XX 2 b. Flutter valve is stuck together.
  - X c. Water in base of machine.
  - X d. Water in breathing tube.
  - e. Machine has oxygen leak.
  - X 1 f. Oxygen tank is empty.

### Errors

6. You note that the results of a basal metabolism test are unusually high. Which of the following reasons could have caused this?
- XX 3 a. Machine has oxygen leak.
  - X 1 b. Patient has perforated ear drum.
  - X 1 c. Patient cannot grasp mouth piece adequately.
  - X d. Patient has tight clothing on.
  - e. Inefficient soda lime.
  - f. Singer or athlete has large lung capacity.

**BASAL METABOLISM****Errors**

7. You note that the results of a basal metabolism test are unusually low. Which of the following reasons could have caused this?
- a. Clock running too slow.
  - X b. Inefficient soda lime.
  - c. Machine has O<sub>2</sub> leak.
  - XX 2 d. O<sub>2</sub> leaked into spirometer through oxygen set cock.
  - X 1 e. Singer or athlete has large lung capacity.
  - f. Patient cannot grasp mouth piece adequately.
8. The results of a basal metabolism test are somewhat higher than normal. Which of the explanations given below would explain this?
- a. Clock running too fast.
  - X 1 b. Leak around nose clip or mouthpiece.
  - XX 2 c. Patient not completely relaxed physically, mentally, and emotionally.
  - X 1 d. Leak of O<sub>2</sub> from spirometer.
  - e. Patient had too much sleep.
  - X 1 f. Patient did not lie down for 30 minutes immediately preceding test.

**ELECTROCARDIOGRAM****Missteps**

1. You are doing an electrocardiogram with a new machine. The film comes out burned. What has happened?
  - a. Electronic eye was not operating correctly.
  - b. Electrodes were strapped on too tightly.
  - XX 2 c. Stylus was overheated.
  - d. Patient has a metallic article on.
  
2. While doing an electrocardiogram with a new machine, the film comes out with no tracing on it. What would cause this to happen?
  - XX 2 a. Stylus was not heated enough.
  - b. Electrode straps were loose.
  - c. Stylus has a plastic coating.
  - X d. One electrode was not hooked up.
  - e. Stylus was too close to the film.
  
3. You got a blurred tracing on the electrocardiogram film of a new machine. What caused this?
  - a. Stylus has accumulated a plastic coating.
  - XX 2 b. Electronic eye was not operating correctly.
  - c. Patient is tense and nervous.
  - d. Electrodes are dirty.

**ELECTROCARDIOGRAM****Missteps**

4. You are doing an electrocardiogram with a new machine, and the machine stops. What has happened?
- a. Machine is too close to the wall.
  - b. A good electrode connection has not been made.
  - c. There is concealed electrical wiring in the wall.
  - d. Patient is touching the wall, the metal on the bed or the floor.
  - XX 2 e. Transister is not functioning correctly.
5. There is a wandering base line on the electrocardiogram you are doing. What is wrong?
- X 2 a. Machine was not warmed up.
  - X 2 b. Lead selector switch was moved while the machine was running.
  - c. Needle is not centered properly.
  - X 2 d. Machine is too close to the wall or to the patient.
  - X 2 e. Patient is making a sound.
  - X 2 f. Patient is tense and nervous.
  - XX 3 g. Electrode connection is not good.
6. You are doing an electrocardiogram. The base line on the electrocardiograph paper is totally irregular. Why is this?
- X 1 a. Patient is tense or uncomfortable.
  - XX 3 b. Patient is moving or speaking.
  - X 1 c. Electrode strap is loose, or not enough paste was used.
  - X 1 d. Machine was not warmed up, or the electrode tube is loose.
  - X e. Patient fuse has blown.
  - X 1 f. Cable has a break in it.
  - X 1 g. Electronic tube and parts are dirty.

**ELECTROCARDIOGRAM****Missteps**

7. There is a regular sawtooth base line on the electrocardiogram you are doing. This is caused by:
- a. machine being left on too long.
  - XX 2 b. not connecting electrodes properly.
  - X c. putting the patient too close to the wall.
  - d. stylus temperature was too high.
8. You are doing an electrocardiogram, but you cannot get a tracing because the base line is not distinct. What could have caused this?
- X 2 a. Temperature of the stylus was not set properly.
  - b. Standardization button was pushed too hard.
  - XX 3 c. Stylus had accumulated a plastic coating.
  - d. Machine was run too long.
  - e. Electrodes were put on too tight.
  - f. Stylus was too small.
9. As you are running an EKG, you note the following: The machine operates at all lead positions; the stylus goes off-scale, then drifts back on scale 30 seconds later with no EKG pulse and is apparently normal on STD position. Which of the explanations listed below would explain the above observation?
- a. Galvanometer string was not kept taut and protected when machine was not in use.
  - XX 2 b. Patient fuse is blown.
  - c. Cables are not clean.
  - d. Machine was not kept covered.



## ELECTROCARDIOGRAM

Missteps

10. As you prepare to do an EKG, you note that the patient is tense and nervous. Which of the following reasons might explain this reaction on the part of the patient?

- X a. You do not seem to be competent.
- X 1 b. Fear that the test will be uncomfortable.
- XX 2 c. Fear of the outcome of the test.
- X d. Fear of hospitalization.
- X e. Patient is uncomfortable.
- X f. Patient is worried about the cost of the test.

11. As you begin to run an EKG, you notice that the reading is not clear. Which of the following explanations would account for this?

- a. One of the straps is too tight.
- b. Patient is uncomfortable.
- c. Patient has a scar on his leg just under the electrode.
- XX 3 d. There is poor electrode contact.
- e. Temperature of the room is too warm.

12. As you prepare to place the electrode straps for an EKG, you realize that the patient has had his left arm amputated at the shoulder. What should you do?

- a. Contact your supervisor and ask him how to handle the situation.
- b. Run all leads except that one.
- XX 3 c. Place the electrode on the stump.
- d. Place the electrode on the left side of the chest.

## ELECTROCARDIOGRAM

Missteps

13. As you begin to run an EKG, the patient complains that the straps are too tight. What would you do?
- a. Explain that the straps must be that tight in order to complete the test.
  - b. Use straps which fit better.
  - c. Run the EKG quickly so that the patient is not uncomfortable for very long.
  - d. Loosen the straps until the patient is not aware that they are on his extremities.
  - XX 3 e. Loosen the straps until contact is firm but not uncomfortable.

Errors

14. The doctor asks for the test to be repeated on the EKG you have just completed. What could you have gone wrong that you did not detect by looking at the EKG?
- a. One electrode was not placed on patient who had a missing limb.
  - b. Machine was not warmed up.
  - c. Transister was not functioning correctly.
  - XX 2 d. Electrodes were placed on the wrong limbs.
  - e. Needle was not centered properly.

## ELECTROCARDIOGRAM

Errors

15. You are doing an electrocardiogram. The graph paper has A.C. artefacts on it. What could be wrong?

- X 1 a. Patient has metallic article on.
- X b. Electrical appliances or concealed wiring are interfering with EKG.
- X c. Electrodes are dirty, corroded, or the tips are loose.
- X d. Right leg electrode is not connected or the strap is loose.
- X e. Electrode has slipped or is being touched by patient or operator.
- XX 2 f. Machine was not polarized.
- X g. Patient has powdered metal all over him.

16. As you are doing an EKG you realize that the red plastic lens will not light although the machine is operating normally. Which of the following explanations would account for this observation.

- a. One or more power fuses have blown.
- b. Machine is not plugged into the electric outlet.
- c. Cables are not clean.
- XX 3 d. Indicator lamp has burned out.