R E P O R T R E S U M E S

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REORGANIZED SCIENCE CURRICULUM, 7A, GRADE SEVEN SUPPLEMENT.
MINNEAPOLIS SPECIAL SCHOOL DISTRICT NO. 1, MINN.
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THE TWELFTH IN A SERIES OF 17 VOLUMES, THIS VOLUME PROVIDES THE SEVENTH GRADE TEACHER WITH A GUIDE TO THE REORGANIZED SCIENCE CURRICULUM OF THE MINNEAPOLIS PUBLIC SCHOOLS. THE MATERIALS ARE INTENDED TO BE AUGMENTED AND REVISED AS THE NEED ARISES. THE SEVENTH GRADE SUPPLEMENT IS IN TWO VOLUMES. VOLUME 7A CONTAINS INTRODUCTORY MATERIAL, A BRIEF SUMMARY OF SUBJECT MATTER CONTENT FOR GRADE 7, AND A CHART WHICH SHOWS THE GRADE CONTENT FOR THE ENTIRE K-12 PROGRAM, FOR EACH OF THE FOLLOWING MAJOR AREAS AROUND WHICH THE CURRICULUM WAS DEVELOPED--(1) THE EARTH, (2) LIVING THINGS, (3) ENERGY, AND (4) THE UNIVERSE. THIS TEACHER'S SUPPLEMENT ALSO CONTAINS THE SECTIONS (1) CONCEPTS, AND (2) LEARNING EXPERIENCES. THE LEARNING EXPERIENCES SECTION DEALS WITH (1) THE USE OF THE MICROSCOPE, AND (2) SCIENTIFIC ATTITUDES. VOLUME 7B CONTAINS THE FOLLOWING SECTIONS--(1) BIBLIOGRAPHY, BOOKS, (2) BIBLIOGRAPHY, FILMS, (3) BIBLIOGRAPHY, FILMSTRIPS, AND (4) EQUIPMENT AND SUPPLIES. (DH)

SCIENTIFIC APPROACH TO PROBLEM SOLVING

1. Observation--first-hand experiences and observation.

2. Definition of PROBLEM--ask questions, choose one for investigation.

3. Results of other investigators--read about problem, discuss it with interested friends and resource people, examine the written material.

4. Possible solutions--list all possible guesses.

5. Choosing the best solution (HYPOTHESIS)--pick the "best guess".

6. Testing the hypothesis--planning and carrying out EXPERIMENTS to determine its truth.

7. CONCLUSION of accepting or rejecting hypothesis--draw conclusion from experiments to determine acceptance or rejection of "best guess".

8. More extensive testing of hypothesis--experiment further to determine if hypothesis always holds true.

9. Stating the THEORY and publishing results--restate the hypothesis in light of the above experimentation, publish in professional journal.

10. Finding mathematical proof--do any measuring and mathematical calculations to develop proof of theory.

11. Statement of LAW or PRINCIPLE--if no one can find a mistake in the mathematical proof or develop a contrary proof, the theory becomes a law or principle.

THE GRADE SEVEN SUPPLEMENT

to the

REORANGIZED SCIENCE CURRICULUM

Kindergarten Through Grade Twelve

(For Discussion Purposes Only)

MINNEAPOLIS PUBLIC SCHOOLS
special school district no. 1
Minneapolis, Minnesota

October 21, 1966

FOREWORD

Long before that famous October fourth, 1957, when Sputnik I rocketed into orbit, the science teachers of the Minneapolis Public Schools eagerly began work on the reorganization of the science curriculum from kindergarten through grade twelve. This reorganized science curriculum was requested by our instructional staff and developed by representative members of that staff.

The citizen of today must be science literate in order to exercise adequately his duties of citizenship. The contribution of the scientist to our way of life is the methods which he uses to attack a problem and seek its solution. These methods are unique, but more important, they are very useful; they can be applied in the solution of the everyday problem by knowledgeable children at all ages and grade levels, and by adults in all walks of life. If these methods of science are to be learned by the youth of Minneapolis, they must be learned by attacking realistic problems inside and outside the classroom. This practice in the solving of work-a-day problems trains our young citizens to think for themselves in seeking new solutions to age-old problems of our civilization.

In the Minneapolis Public Schools we recognize that science is a very important part of the liberal arts general education which should be studied by all students. We are aware of our responsibility for instruction which must be well grounded in the fundamental laws and principles in all the fields of the basic sciences and therefore propose this reorganized curriculum for teaching the ever-expanding knowledge of science.

This reorganized science curriculum does not teach itself. It is a planned developmental approach in which the teacher is the expeditor and not the limiter of learning. The curriculum has been developed to aid the student in acquiring new breadths and new depths of understanding of his environment; and with it a teacher who is well trained in science may lead the student in an ever-expanding investigation of his surroundings in this world and universe. If the curriculum is used cooperatively by teacher and students, it is an instrument which can mold a pupil of the Minneapolis Public Schools into a science-literate citizen who, if he continues advanced science training, may become a scientist of the future.

Rufus A. Putnam
Superintendent of Schools

INDIANAPOLIS PUBLIC SCHOOLS
Science Department

For discussion purposes only

SUMMARY OF GRADE-CONTENT ASSIGNMENTS

Area and Major Topics	Grade Level												
	K	1	2	3	4	5	6	7	8	9	10	11	12
Introduction to Science (Gray)	*	*	*	+	*	*	*	+	+	+	+	+	+
A. Attitudes (Including history)	+	+	+	+	+	+	+	+		+			+
B. Tools	+		+	+	+		+		*				+
C. Methods	+		+	*	+	+	+			*			
I. The Earth (Red)	+	+	+	*	*	+		+	*				
A. History of the earth					+				+				
B. Physical features	*	+		+	+				+				
C. Rocks and minerals	+	*			+				+				
D. Soils		+		+	+				+				
E. Water	*		*	+	*			*					
F. Air	+	*		+	*			*					
G. Weather and climate				+		*			*				

Key to symbols -- * major emphasis
+ content to be taught

For discussion purposes only

Area and Major Topics	Grade Level												
	K	1	2	3	4	5	6	7	8	9	10	11	12
II. Living Things (Green)	+	+	+	+	+	+		*			*		
A. Life and life processes	+	+	+	+		*		+			+		
1. Life in general	+			*		+		+			+		
2. Food taking or nutrition		*	*	+		+		+			+		
3. Digestion								+			+		
4. Absorption						+		+			+		
5. Circulation				+		+		+			+		
6. Respiration						+		+			+		
7. Assimilation								+			+		
8. Oxidation						+		+			+		
9. Excretion				+		+		+			+		
10. Reproduction and growth		*	*	*		+		+			+		
11. Responsiveness	+	*	+	+		+		+			+		
B. Classification	*	+	+	+		*		+			+		
C. Ecology	*	+	*	*	*			+			+		
D. Plant and animal economics	+	+	+	*	*			+			+		
E. Human body	*	*	*	*		*		*			+		
F. Aesthetic values	*			*				+			+		

(continued)

Grade-content assignments (continued)

Area and Major Topics	Grade Level												
	K	1	2	3	4	5	6	7	8	9	10	11	12
II. Energy (Yellow)	+	+	+	+	+	+	+			+		*	+
A. Properties of matter related to energy	+			*			*			*		+	*
B. Sources and conservation of energy	+			+		*				+		+	+
C. Mechanical energy and simple machines	*		*	*			*			*		+	
D. Gravitational energy	+			+			+			+		+	
E. Magnetic energy	*		*	+	*					+		+	
F. Sound		*	*				*			+		+	
G. Electrical energy		*		*		*				*		*	
1. Static						+				+		+	
2. Current		*		*		+				*		+	
H. Communication bands and electronics												+	
I. Heat and infrared radiation	*			*		*				+		+	
J. Light and ultraviolet radiation	*	*	*				*			+		+	
K. High energy waves												+	
L. Chemical energy				+			*			*			*
M. Atomic energy							+			+		+	

For discussion purposes only

Area and Major Topics	Grade Level												
	K	1	2	3	4	5	6	7	8	9	10	11	12
IV. The Universe (Blue)	+	+	+	+		*	+		*	+			
A. Earth	+	*	*	*		+			+				
B. Moon	*		*			+			+				
C. Sun	*	*	*	*		+			+				
D. Solar system						+			+				
E. Stars and galaxies	*		*	*		+			+				
F. Space travel		+	+	+			*			*			

Key to symbols - - * major emphasis

+ content to be taught

Note: Conservation and safety must permeate science teaching at all grade levels.

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A SUMMARY OF THE SUBJECT MATTER CONTENT

GRADE SEVEN

Introduction to science--branches of science; some kinds of research projects currently being investigated

Living things--classification and economic value; physical and biological factors of an environment; conservation; rehabilitation of injured or diseased parts of the human body; rates of maturation; factors affecting ease of learning

Water--physical characteristics, hardness, and purification; water cycle

Air--composition, industrial uses and characteristics of the layers; nitrogen cycle; value of air conditioning

CB:jew
12-20-62

ALLOCATION OF CONCEPTS BY MAJOR TOPICS AND/OR UNITS

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TABLE OF CONTENTS

For discussion purposes only

Grade Seven

ALLOCATION OF CONCEPTS BY MAJOR TOPICS AND/OR UNITS

Note: This report presents a list of unit titles or major topics within which the order of the concepts found in the Handbook has been changed and grouped under subheadings to provide a logical teaching approach.

Introduction to Science

A. Definition of science and scientists

1. The study of science results in an organized body of knowledge.
2. Scientists usually work to discover basic scientific laws and principles.
3. Among the first scientists who applied methods of controlled experimentation were Archimedes, Aristotle, and Ptolemy.
4. Most scientists seek truth for truth's sake.
5. Sometimes scientists engage in research for commercial gains.

B. Branches of science

1. Branches of scientific study have interrelated areas.
2. Basic scientific investigation includes the study of natural forces.
3. Basic scientific studies include botany, zoology, chemistry, physics, geology, meteorology, and astronomy.
4. Continuous basic research in science reveals new information regarding our environment.
5. Basic research is being increasingly emphasized.
6. Medical science research teams usually work on problems of disease prevention or disease treatment.
7. Research teams may work in applied science (technology).
8. Progress in scientific knowledge and application in recent years has been accelerated rapidly.

II. Living Things

A. Life processes of living things

Food taking or nutrition

1. Some minerals are necessary for normally functioning life processes.
2. The carbohydrates and fats supply energy for the body.
3. Proteins are necessary for growth and replacement.
4. Only plants are able to obtain carbon from the carbon dioxide of the air.
5. All chlorophyll-containing parts of a plant may carry on photosynthesis.
6. All animals are dependent directly or indirectly on green plants for food.
7. Vitamins help regulate some body activities.
8. Foods are usually classified upon the basis of chemical content and upon their use by the organism.

Digestion

1. In order to be used by the body, foods must be changed into a simple, soluble form.
2. To prepare foods for digestion they must be broken into small particles and mixed with certain body fluids.
3. If food is thoroughly chewed, the stomach is able to perform its function more effectively.
4. Some fluids formed in the body take part in the process of digestion.
5. In the stomach, foods are emulsified and mixed with some digestive fluids.
6. The process of digestion requires energy.
7. Some of the energy obtained from food may be used immediately to supply the energy required for digestion and absorption.

II. Living Things

A. Life processes of living things

Absorption

1. Water in the soil dissolves essential minerals which may be absorbed into plants.

2. Through the root system of a plant, water and some dissolved minerals are absorbed from the soil.

3. Most foods must be digested before they can be absorbed into the organism.

4. Digested foods and wastes move in and out of living cells through the cell membrane.

Circulation

1. The circulatory system of all living things carries nutrients and oxygen to the cells and waste materials away from the cell.

2. The transportation system of higher plants carries the food, water and minerals to all parts of the plant.

3. The closed circulatory system of the higher animals includes the heart, arteries, capillaries, and veins.

4. The blood is usually composed of liquid (plasma) and solids (red and white corpuscles, and platelets).

Respiration and assimilation

1. Respiration is the process of getting oxygen into all living tissues of an organism and removing carbon dioxide from them.

2. Living organisms have the ability to change simple foods into living materials.

3. Carbon, hydrogen, and oxygen obtained from food, air and water by living things may be built into protoplasm (assimilation).

II. Living Things

A. Life processes of living things

Oxidation and Excretion

1. The energy which makes possible the activity of living things is stored in food and is made available through the oxidation of food within the organism.

2. Chemical reactions are necessary for obtaining energy from food.

3. Simple foods are oxidized in all living cells of an organism to secure energy for life.

4. Oxygen absorbed into the body from the lungs is the oxidizing agent which converts food into heat and mechanical energy.

5. Carbon dioxide is a product formed during oxidation.

6. Oxidation of organic nutrients is a complex process involving many chemical reactions.

7. As living cells carry on life processes, they produce many chemical compounds, some of which may be toxic to the organism and which must be eliminated.

8. Removal of cellular wastes is essential to all living things.

9. The excretory system in an animal removes waste.

10. Sweat glands in the skin of human beings are organs of excretion which aid in the control of body temperature.

II. Living Things

A. Life processes of living things

Reproduction and Growth

1. Only living things can produce living things.

2. In sexual reproduction, a male cell from one parent or structure unites with a female cell from another parent or structure to produce the new offspring.

3. The outer structures of a bud may protect the reproductive structures of the flower.

4. Some fruit and seed crops require insect pollination for high production.

5. The color of the showy parts of a flower very often attracts pollinating insects.

6. A true seed contains an embryonic plant and its food supply.

7. During germination most seeds require warmth, oxygen and moisture.

8. Because the covering of some seeds is extremely hard, germination cannot occur until the seed coat is worn thin.

9. Scarification (scratching) of a seed cover makes it more permeable.

10. Segments of underground stems may be used to propagate some plants.

11. The amount of care and protection given to eggs usually varies inversely with the number of young produced.

12. Some species of fish, amphibia and reptiles reproduce by laying eggs while others give birth to living young.

13. Different stages in the life cycle of some animals take place in radically different environments.

14. The energy and raw materials for growth and repair are secured from digested food.

15. Disease germs may be controlled by removing conditions which are necessary for their reproduction and growth.

II. Living Things

A. Life processes of living things

Responsiveness

1. All living things are sensitive to forces outside themselves.
2. If an organism is sensitive to a stimulus, it usually responds to the stimulus.
3. All normal living things respond to sudden changes or stimuli in their environment.
4. An organism is sensitive to many internal stimuli.
5. Movement of an organism often is preceded by sensing outside stimuli.
6. The degree of sensitivity and response to a stimulus may vary within a species.
7. Plants do not have organized nervous systems.
8. The sense organs of higher animals are designed to efficiently receive only certain types of stimuli.
9. The sense organs of higher animals receive many qualitative and quantitative stimuli and change them into electrical impulses which are transmitted as nerve impulses to the brain for the interpretation and/or other responses.
10. Nerve impulses are electrical pulsations transmitted by a neuron.
11. Some nerves carry impulses which result in sensation or feeling (sensory nerves).
12. When sensory impulses have been interpreted, motor nerves may cause the muscles to move.
13. Muscles which can be controlled consciously are called voluntary muscles.
14. Exercise stimulates responses from respiratory, circulatory, excretory, and nervous systems of the body.
15. The learning process involves instincts, reflexes, habits and intelligence.
16. Learning varies with the learner and the materials to be learned.

II. Living Things

B. Histology--minute structure and organization of tissue

1. All living things (organic substances) contain the element carbon.
2. The most simple part of a living thing which carries on life processes is the cell.
3. All living things are made up of cells.
4. Similar cells of an organism working together to perform a function constitute a tissue.
5. Many tissues working together to perform a function constitute an organ.
6. Organs working together to perform a specific function are a system.
7. One complete individual is an organism.
8. Organisms are composed of single cells or many cells.
9. One-celled organisms perform all of the life processes within the single cell.
10. Complex organisms have developed specialized systems which perform certain life processes.
11. Many-celled organisms may be composed of groups of systems working together.
12. The outer covering of an organism helps protect it from injury and from the entrance of disease-producing agents.
13. Each organism carries on life processes.
14. All living things carry on metabolism.
15. Water, carbon dioxide, and light energy are combined chemically (photosynthesis) to produce numerous compounds essential to all plants and animals.

II. Living Things

C. Taxonomy (differences and similarities)

1. The outer covering of an organism protects the organism from disease and injury.

2. Most plant cells are surrounded by a rigid wall of cellulose which is outside of the cell membrane.

3. The color of an organism may attract other organisms to it.

4. In nature, the color of an organism may conceal or disguise it.

5. Many of the simpler one-celled plants and animals have similar characteristics.

6. Protozoans are one-celled animals.

7. Protozoans are jelly-like protoplasm surrounded by thin protoplasmic membranes.

8. Skeletons of animals may be either internal or external.

9. In a vertebrate animal the skeletal system helps support the body, gives it shape and protects vital organs.

10. Fish, amphibia, reptiles, birds and mammals are animals with backbones.

11. Some species of fish, amphibia, and reptiles reproduce by laying eggs, while others give birth to living young.

12. The amount of care which animals give their young tends to vary inversely with the number of young produced.

13. Carnivores, herbivores, and ominovores have certain structural adaptations suited to their methods of food-getting.

14. Fish, amphibia, reptiles, birds and mammals include species which are herbivorous, carnivorous, or omnivorous.

15. Warm-blooded animals are usually active during all seasons.

16. Some warm-blooded animals may cool themselves by formation of perspiration on the body surface or tongue which evaporates and cools the animal.

17. Cold-blooded animals must hibernate or estivate during periods of extreme temperatures.

18. Birds and mammals contain mechanisms which enable them to keep a relatively constant body temperature.

II. Living things

C. Taxpnomya (differences and similarities), (continued)

19. Plants are very often classified into five main groups: the algae, fungi, liverworte and mosses and ferns, and the seed plants.

20. Algae are simple green plants without roots, stems or leaves.

21. A true seed contains an embryonic plant and its food supply.

22. The bites or stings of some animals are poisonous in varying degrees to some human beings.

II. Living Things

D. Ecology

Adaptation to environment

1. Living things usually react to changes in their physical environment.

2. Different living things have different temperature requirements.

3. Living things are limited in the temperature range and temperature extremes which they can tolerate.

4. The temperature of warm-blooded animals is controlled by the organism, not by its surroundings.

5. Many plants in the temperate zone make seasonable adjustments to their environment.

6. In the fall in the temperate zone deciduous plants lose their leaves and store most of their sap in roots below ground.

7. Different living things have different pressure requirements.

8. Living things are limited in the pressure range and pressure extremes they can tolerate.

9. Man is more able to adjust to changes in his environment than most other organisms.

10. The life span of living things differs with species and between members of the same species.

11. Usually animals producing few offspring tend to provide protection and care.

12. Animals which are the prey of other animals often have external body structures and keen sense organs for early detection of approaching enemies.

13. Most herbivorous animals have special adaptations for mastication and digestion.

14. In nature the color of an organism may conceal or disguise it.

15. The color of an organism may attract other organisms to it.

16. The outer covering of an organism helps protect it from injury and from the entrance of disease-producing agents.

17. Lack of cleanliness usually provides a favorable environment for disease germs.

18. Living things are directly involved in the water cycle.

II. Living Things

D. Ecology

Adaptation to environment (continued)

19. Plants absorb water through their roots and give it off through their leaves.

20. Tremendous quantities of water are transpired by plants.

21. Organisms are sensitive to the amount of moisture in their environments.

22. The optimum water content of all living things is not the same.

23. Energy for life is furnished by the radiant energy of the sun.

24. Many living things are sensitive to light and will move to secure an optimum amount of light.

25. All living things have an important effect on the dynamic equilibrium in nature.

26. All organisms in a community compete for the available food supply.

27. Food, oxygen, carbon dioxide, and certain optimal conditions of temperature, moisture and light are essential to the life of most living things.

28. A species usually survives even though an environment varies from year to year.

29. There is a maximum number and/or amount of game and fish which can be supported on a given area.

30. Excessive fishing has removed relatively large numbers of the big game fish which normally eat smaller fish causing over-population, starving conditions and stunted growth in the remaining game fish.

31. To enable an area to annually produce its maximum of wild game, laws controlling the yearly harvest are published in each state.

32. Some organisms live together for mutual benefit.

II. Living Things

D. Ecology

Plant and animal communities

1. Groups of plants and animals which furnish food for each other in a consecutive order are known as a food chain.

2. Plants and animals which have similar environmental needs tend to live together in communities.

3. Man may accelerate the dispersal of living things.

4. Many herbivorous animals are usually necessary to furnish the food for one carnivore.

5. Carnivorous animals are indirectly dependent on the plant life of an area.

6. Most animals which are carnivorous have special adaptations for food getting.

7. Some gregarious animals live in large colonies as a highly organized social community.

8. Some plant and animal diseases are communicable.

9. Plants or animals cause some diseases.

10. Optimum conditions for disease germs include warmth, food supply, moisture, and lack of sunshine.

11. Antiseptics and disinfectants are usually used to inhibit the existence of disease germs.

12. Some parasitic organisms require two hosts for the completion of their life cycles.

13. Many parasitic plant and animal diseases are caused by fungi.

14. A parasite is usually harmful to its host.

15. Some organisms build and enrich the soil.

16. The decay and disintegration of dead organisms enrich the soil.

17. Some land masses are formed from the skeletal remains of large quantities of certain animals.

18. Paleontology is usually studied as a part of geology and/or biology.

II. Living Things

E. Economic value of living things

1. There are chemical color tests for proteins of which most common is the Anthroprotaic Test (nitric acid).

2. A number of chemical tests have been devised to identify carbohydrates.

3. The classification of organic nutrients as carbohydrates, proteins and fats is a chemical classification.

4. Some processed plant products used in our daily living often are classified as chemicals.

5. Spices are processed from the various parts of certain plants.

6. Living things and their products are man's natural resources for food, clothing and shelter.

7. Some synthetic fibers have qualities which are superior to those of natural fibers.

8. Man's comfort and economic status is largely determined by the beneficial and harmful effects of the living things in his environment.

9. Consumer education information should help people to secure value received from purchases.

10. Man protects useful living things by providing them with favorable environments and by destroying their enemies.

11. Domesticated animals are under constant attack from predators, disease causers and carriers, and annoying insects and arachnids.

12. Man must control pathogenic organisms which are enemies of domestic and economic plants and animals.

13. Desirable hybrid plants and animals often are very susceptible to disease.

14. Man furnishes protection for many economically important species.

15. Only a few species of insects do most of the serious damage to crops.

16. Some mammals and certain species of insects may destroy valuable crops and forests.

17. Many animal disease carriers affect the health and economic well being of man.

II. Living Things

F. Man's protection of wildlife

1. State and private game farms provide sheltered reproduction areas for wild game.

2. The taking of fish and game should be regarded as a "harvest" in which the mature are removed so that the young may have more favorable conditions for growth.

3. In conservation decisions, sentimentalism must be replaced with economic and social judgments.

4. The finds of valid research must be applied to current problems in conservation.

5. Good conservation practices have been in use for a long time in some old-world countries.

6. The people of the United States have been dilatory in practicing good conservation.

7. Societies tend to practice conservation only when natural resources approach depletion.

8. There is a maximum number and/or amount of game and fish which can be supported on a given area.

9. Excessive fishing has removed relatively large numbers of the big game fish, which normally eat smaller fish thus causing overpopulation, starving conditions and stunted growth in the remaining game fish.

10. Unregulated hunting has diminished the supply of some species of wild game to the point of possible extinction.

11. The expansion of human settlements steadily encroaches upon wildlife habitats.

12. To guarantee crop-producing land for the future, soil utilization and improvement practices must be employed.

13. When water is removed more rapidly from the ground than it is replaced by precipitation, the water table is lowered.

14. The plowing of semi-arid, flat, wind-swept grasslands tends to create "dust bowls".

15. Minerals required for plant growth must be replaced to maintain soil fertility.

16. Although nitrogen is very abundant in the air and exists in all living tissues, plants can obtain it only from soil minerals.

17. Living things help to form and change the soil.

II. Living Things

F. Man's protection of wildlife (continued)

18. Mosses and lichens aid in changing rock into soil.

19. Reforestation and improper plowing of sloping fields help to create floods.

20. The rate and amount of erosion is increased by deforestation.

21. A deforested region ceases to act as a ground reservoir for the storage of water.

22. In many places the water tables are lowered by heavy demands for water.

23. Man must control pathogenic organisms which are enemies of domestic and economic plants and animals.

24. Desirable hybrid plants and animals often are very susceptible to disease.

25. Many of man's efforts to control his environment have produced undesirable results.

26. Man can control some pests by increasing the number of their enemies.

27. The use of chemical poisons are seldom specific and when used may destroy other organisms.

28. The indiscriminate use of poisons may destroy birds, insects, and soil organisms which are beneficial to man.

II. Living Things

G. Human body

1. Individuals have responsibilities for self-imposed isolation when contact with other people would spread an infection.

2. Many animal disease carriers affect the health and economic well being of man.

3. Excrement from sick people very often contains the causative agent for the disease.

4. Biological materials harmful to man include disease causitives and carriers, and annoying ard poisonous plants and animals.

5. Physical therapy is recognized as an important factor in the rehabilitation of muscular impairment.

6. Rehabilitation of some disabled individuals may be accomplished if adequate facilities for research and treatment are available.

7. Modern medical and surgical advancements are increasing the success in removing and/or replacing body structures.

8. The human body is composed of several major systems adapted for carrying on specific life processes.

9. Each individual matures at a different rate.

10. Physical, emotional and mental maturation do not necessarily progress at the same rate in an individual.

11. Among the most common chemical activities of the human body are digestion of food, oxidation of simple foods, and assimilation (synthesis of living materials).

12. Some fluids formed in the body take part in the process of digestion.

13. People are both carnivorous and herbivorous.

14. Although it is possible for a variety of plant foods to furnish man with the essential amino acids, animal foods can supply them much more efficiently.

15. The essential amino acids needed by the body can be acquired more efficiently from animal protein than from plant protein.

16. In order for the body to build human proteins, certain essential amino acids must all be present at the same time.

17. When the human body is healthy its temperature tends to vary within a restricted range.

18. Man has very little ability to control certain body functions.

II. Living Things

G. Human body (continued)

19. The human body must be able to constantly readjust to a wide variety and a changing amount of activity.

20. During rest, the body is able to continue self-repair.

21. Usually during sleep the rate of many body activities decreases.

22. In the clotting of blood a network of fibers forms a barrier preventing further bleeding.

23. In order to expedite blood transfusions a system of blood typing has been developed.

24. Many factors are involved in blood typing, and therefore, the blood of two individuals must be carefully matched before a transfusion is begun.

25. Ultraviolet light in intense or prolonged doses on human skin causes sunburn.

26. All human beings are born with the same instincts.

27. Each part of the brain appears to have a specific function.

28. Habits are developed by repeated acts.

29. Learning is the acquiring of the ability to act in a definite way to a definite stimulus.

30. In addition to good motivation and learning methods, a favorable environment is required for the ready acquisition of knowledge and skills.

31. Learning tends to be more rapid when environmental conditions are favorable.

32. A high degree of motivation speeds learning.

33. Personal satisfaction is a strong motivator for learning.

34. Learning varies with the learner and the materials to be learned.

35. Maximum use of individual potentialities may be more fully attained by effective education, training and counseling.

36. In our civilization we need to make use of all human potentialities.

37. Knowledge and self-discipline are important factors in accident prevention.

II. Living Things

H. Aesthetic values

1. As leisure time increases, methods of relaxing and "changing pace" become increasingly important.

2. Some varieties of plants may be used to beautify streets, parks and public places as well as to landscape homes and private buildings.

3. Good manners in the out-of-doors require all citizens to preserve the natural plant and animal habitats of desirable species.

I. The Earth

Water

A. States of water

1. Physical properties of water change as it changes state.
2. Water in a measurable amount is contained in plants and animals.
3. Water exerts pressure in all directions on submerged objects.
4. Water (all liquids) is nearly incompressible.
5. Water is an important solvent.
6. Water occurs in many materials in either a free or combined form.

B. The water cycle

1. Water is continuously moving in a cycle from the earth's surface to the atmosphere and back to the earth's surface (hydrologic cycle).
2. Distillation is the process whereby water is evaporated and condensed.
3. The upper level of the ground water is known as the water table.
4. The ground water which is absorbed into the soil during a rain is a reservoir of water between rains.
5. The ground may serve as a reservoir for water.
6. Various soils absorb water at different rates.

I. The Earth

Water

C. Economics of the study of water

1. Man depends on scientific knowledge and practice to control the contamination of our water supply.

2. Water used for human consumption is purified by nature and/or through special filtration and chemical treatments by man.

3. Sewage and waste water from a community should be returned to their source in an unpolluted form.

4. The hardness of water is determined by its mineral content.

5. The cleansing action of soaps in hard water is reduced by the chemical action of soap and dissolved minerals.

6. Water is made soft by reducing the mineral content of the water.

7. The cleansing action of detergents is not reduced by the dissolved minerals in the water.

8. The washing of clothes involves a physical action of removing the dirt from the clothes.

I. The Earth

Air

A. Definition and/or description of air

1. Nitrogen is the most plentiful gas in the atmosphere.

2. Nitrogen dilutes the oxygen of the air so that life is possible.

3. The nitrogen cycle depends on the action of bacteria.

4. Nitrogen from the air is changed to soluble nitrates by the action of certain bacteria.

5. Nitrogen is given off to the air through the decomposing of dead organisms by bacteria.

6. Carbon dioxide is found in small amounts evenly distributed over the earth.

7. The changes in temperature in air account for the evaporation and condensation of water which is important for living things.

8. The stratosphere is a layer of the atmosphere above the troposphere which is usually considered to be unchanging.

9. The chemisphere is that layer of the atmosphere where solar radiation effects are most evident.

10. The inosphere protects life on the earth by absorbing ultra-violet rays.

I. The Earth

Air

B. Economic importance of air

1. The air which many living things breathe is a mixture of gases.

2. An increased amount of oxygen over the normal percentage found in the air aids breathing and combustion.

3. Pure oxygen causes too much chemical activity in living things.

4. The oxygen of the air combines readily with most of the substances on the earth's surface forming oxides.

5. The oxidation of metals is caused by the chemical reaction of the oxygen in the air with the metal.

6. Air acts as a modifier to extreme changes in temperature.

7. Air conditioning involves the control of temperature, humidity, and the amount of undesirable materials in the air.

8. Human efficiency in work situations is improved with air conditioning.

9. The spread of many communicable diseases apparently is controlled by the use of air conditioning equipment.

10. In certain industries air conditioning is necessary for the manufacture of precision products.

11. Many of our industrial and commercial operations or devices depend on air in motion.

12. Continued cooling of air causes the various gases to liquify.

13. Many industrial or domestic tools and devices depend on the use of compressed air.

14. Explosions involve the proportional mixture of fuel and air.

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EXPERIENCES

In The Lab

Conducted by Kenneth W. Perkins

THE CARE OF THE MICROSCOPE

The microscope is an important research and instructional tool in most phases of biology. For this reason, the beginning student will find that time given to learning the proper use and care of the instrument will be well spent.

1. Always keep the microscope clean. When the instrument is not in use it should be covered with a plastic dust cover and stored in a closed cabinet. The entire microscope should be cleaned before and after each use.

The lenses should be wiped clean with lens paper. This is a soft absorbent paper made especially for use on lenses; any other material, regardless of how soft it feels, may contain abrasives which will scratch optical surfaces. Never try to work with dirty lenses.

The body of the microscope should be wiped clean with a soft cloth. An occasional wiping with a touch of good grade oil will help preserve the metal surfaces.

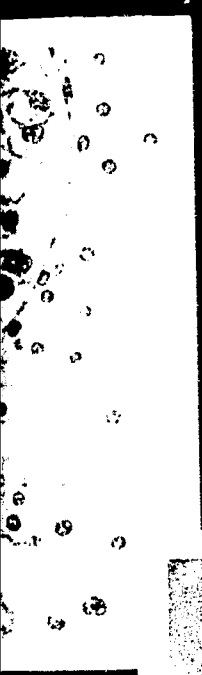
2. The microscope is a precision instrument which must be carefully aligned to function properly. Any severe shock will destroy this alignment. Whenever you are using the instrument give it the care and respect it deserves. When moving the microscope from place to place always hold it securely in both hands. Grasp the arm of the instrument in one hand and rest the base in the other.

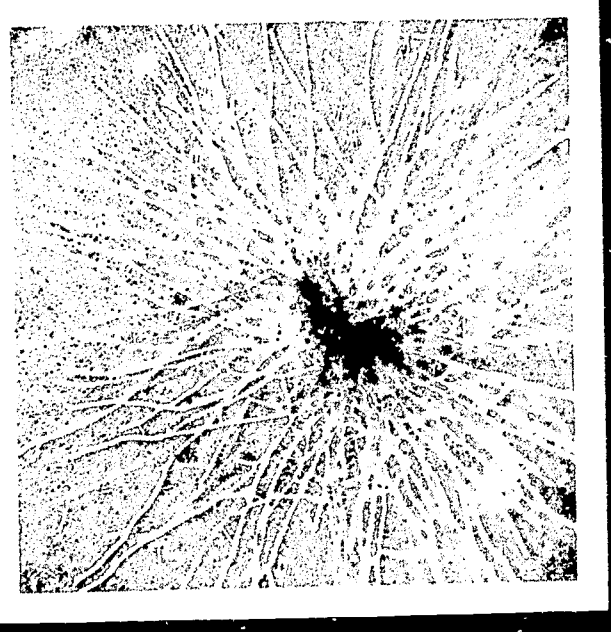
3. Never take the microscope apart. The eyepiece should be left in place except when it is exchanged for one of different magnification. Keeping the microscope together prevents dust from getting on the inside lenses and reduces the possibility of getting the lenses out of line.

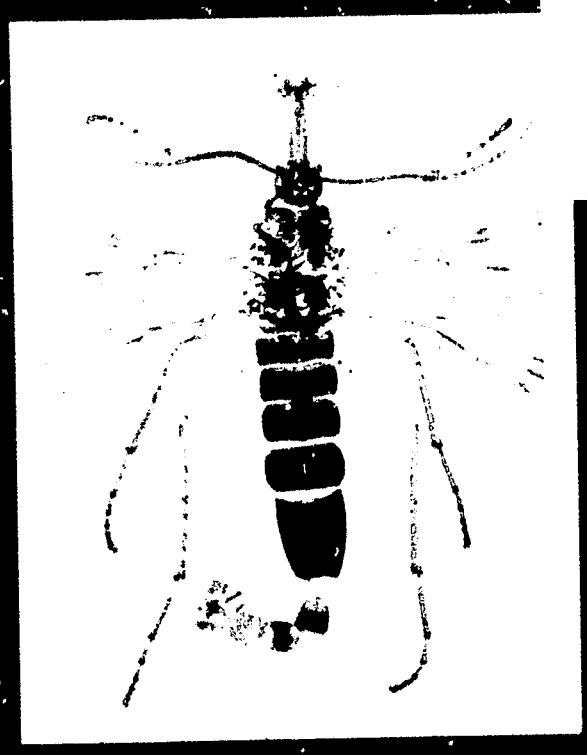
4. Keep both eyes open when you are using the microscope. This will seem difficult at first, but with a little practice it will become easy. It will also help if you learn to use either eye.

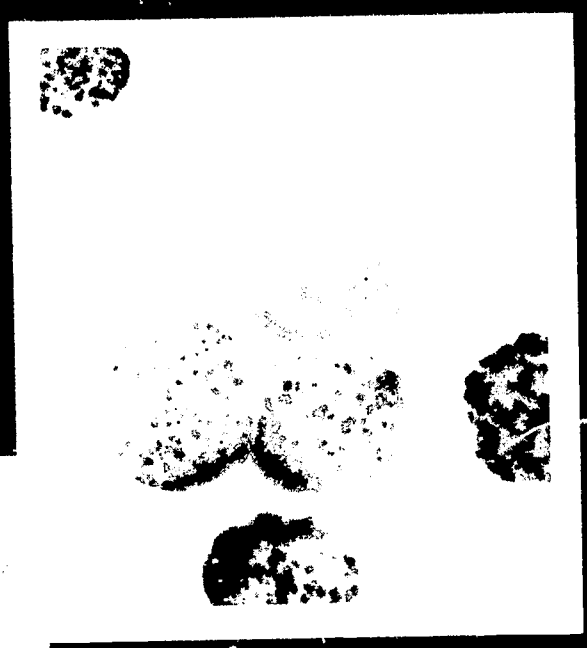
If light coming into the unused eye is distracting, try placing a piece of black construction paper on the table under the microscope. Another trick which helps is to look into the microscope out of the corner of your eye until the image is clearly in view; then slowly turn your head into a more comfortable position while concentrating on the image.

5. Always use adequate lighting. The quality of the image you obtain with the microscope depends a great deal on the quality of the light source. Microscopists often use a blue filter for a more comfortable light color.

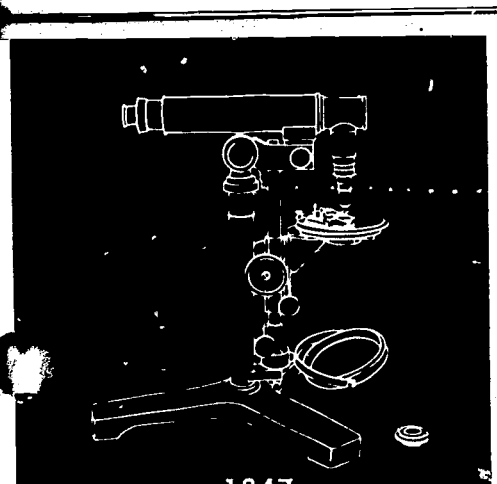


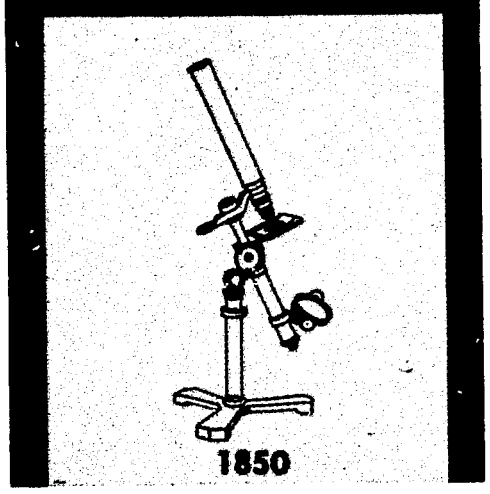






AO REPORTS ON TEACHING WITH THE MICROSCOPE





Mr. Spencer . . . and the microscope

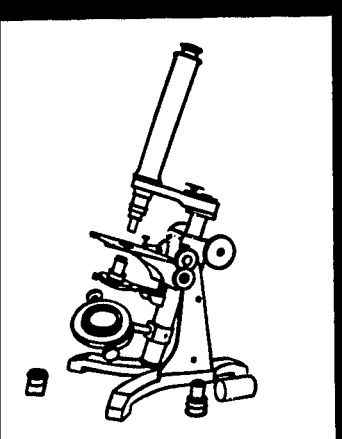
Charles A. Spencer of Canastota, New York, made the first American microscope in 1846. It won for him instant recognition as one of the world's greatest microscope makers. European manufacturers were amazed that a "backwoods American" could make such a precise instrument, and Professor J. W. Bailey of West Point, a world-famous microscopist of that day, called it "a proud triumph for American art".

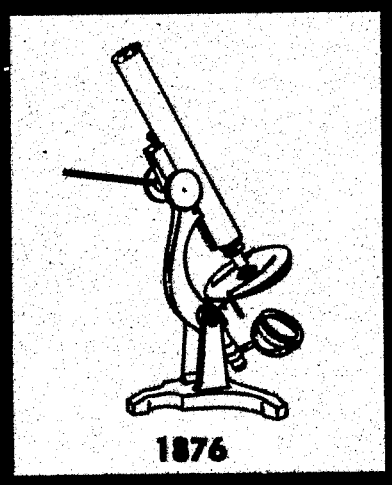
Charles Spencer died in 1881, but his son, Herbert, remained to carry on the business. In 1890 he moved to Buffalo, N. Y., to establish the Spencer and Smith Optical Company. The name was changed in 1893 to Spencer Lens Company and remained so until 1935 when it became the Instrument Division of the American Optical Company.

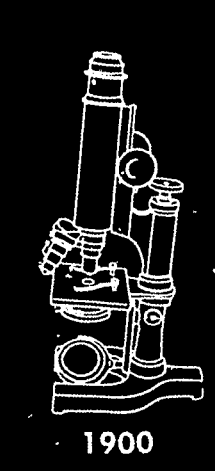
The parent American Optical Company, itself, has a continuous history dating back to 1833 and is the world's largest manufacturer of optical products.

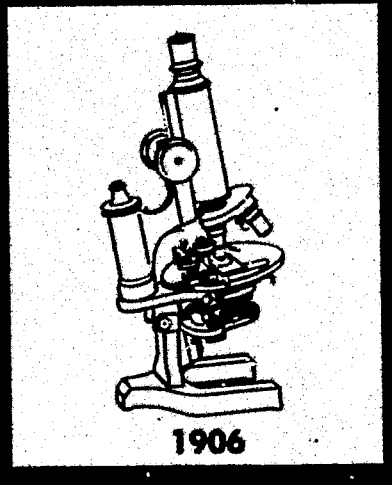
The Instrument Division has been outstanding in the progressive development and production of microscopes for over 100 years . . . was the first in America to produce apochromatic objectives, side fine adjustments, attachable mechanical stages, fork-type substages, converging tube binocular microscopes, divisible substage condensers, dark field illuminators and AUTO-FOCUS. International recognition has also been gained for pioneering such outstanding aids to the Sciences and Industry as the Phase and Interference Microscopes.

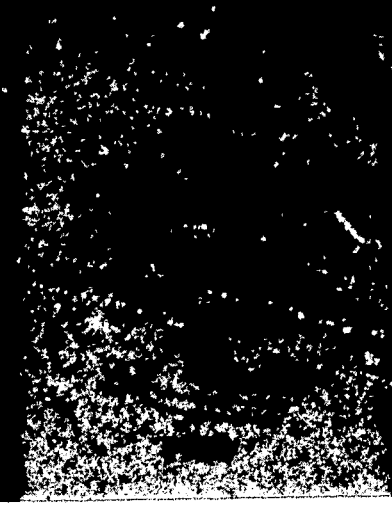
Charles A. Spencer, 1813-1881, first American microscope builder.

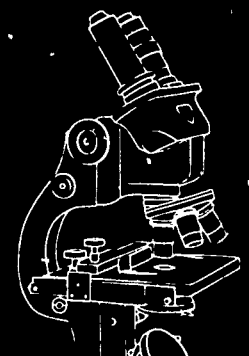


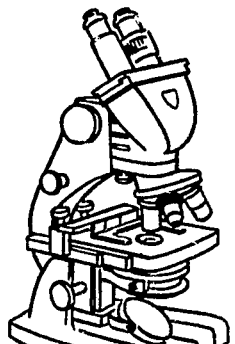












OVER 125 YEARS OF LEADERSHIP IN OPTICS

In 1958, American Optical began a series of advertisements called "AO Reports on Teaching With the Microscope!" This book contains the first thirteen of these "Reports."

We have printed them in a single volume in response to requests from hundreds of biology teachers. Their fine comments concerning the value of these experiments have been very gratifying.

We offer this book in the same spirit that prompted us to produce the original ads, hoping that these practical experiments may provide fresh ideas and added incentive for creative teaching with the microscope.

AO Reports on Teaching with the Microscope

Exposing the Embryo . . . or if not the answer, at least an insight into the old question of which came first, the chicken or the egg

Our experiment won't give your students the answer to which came first, the chicken or the egg, but it may give you some idea as to the unique potential the stereoscopic microscope provides for truly creative science teaching. You can use it to stretch your students' minds to 3-dimensional microscopic worlds beyond the ken of their every day experiences.

It's no coincidence, of course, that AO has an excellent stereoscopic microscope to offer. Perhaps you already know about our new line of Series Forty stereoscopic microscopes. More and more of them are going into High Schools, and Junior Colleges. Science teachers like their dependable performance and almost indestructible ruggedness. School administrators like their low cost.

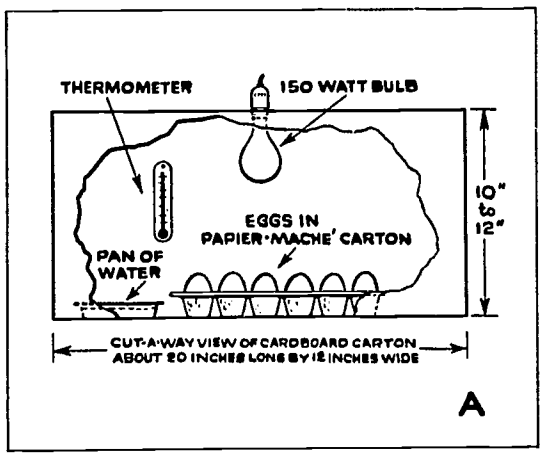
If you have Series Forty Microscopes we invite you to try this classroom tested experiment. If not, you may want information about the instrument. We'll be glad to send you our color brochure. Just write to American Optical Company, Instrument Division, Buffalo 15, New York and ask for Brochure SB40.

EXPERIMENT

Studying the growth of a living chick embryo

MATERIALS AND PREPARATIONS

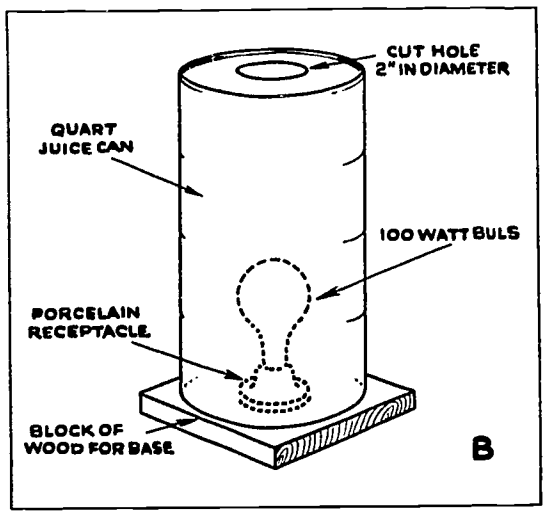
1. Supply of fertilized chicken eggs — preferably 24 hour chick embryos. These can be obtained inexpensively from any hatchery.



2. Incubator: (See diagram). Optimal temperatures are 90° - 110° F. Place small pan of water in incubator for proper humidity (about 60%).

3. Egg Candler: (See diagram B). To candle simply place egg over hole. (Candle in darkened room).

4. Set up Series Forty Microscope. Melt paraffin and keep hot. Cut "nest" from papier mache' egg carton. Have sharpened steel needle, tweezers, wide mouth medicine dropper, sharp manicure scissors, small brush and clean cover glass ready at hand.



PROCEDURE

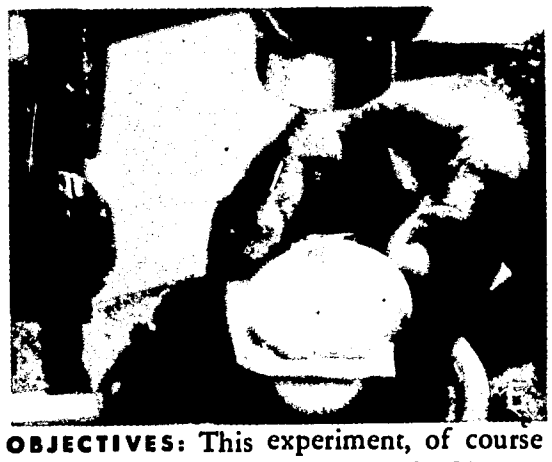
1. Select 2 - 4 day old egg. Candle egg to locate position of embryo. This will appear as a shadowy network of blood vessels (area vasculosa) radiating from an indistinct dark spot, which is the embryo.

2. Mark position of embryo on shell with grease pencil . . . do not rotate or roll egg since embryo may shift. Place egg in nest with embryo up.

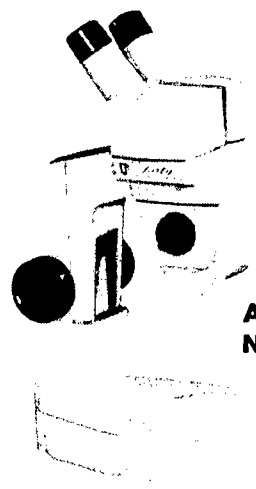
3. Cut window about size of dime over embryro. Start by carefully picking with needle until small hole is made. Then insert point of manicure scissors into hole and cut (see photo C). Use tweezers to remove pieces of shell. Very carefully puncture egg membrane (immediately under shell) and remove with tweezers. Embryo should now be exposed on top of yolk. Remove excess albumen, if necessary, with medicine dropper.

4. Seal cover glass in following way: with camel hair brush apply melted paraffin to the edges of the window. Gently place cover glass over the window. Seal edges with paraffin. (See photo D).

5. Place egg under microscope for study. (See photo E). Chick embryo will remain alive for many days and its nervous and circulatory systems can be observed and wing and leg buds can be detected in various stages of embryonic development. Keep egg incubated between observations. Use of sterile technique (wash instruments in 70% alcohol, rinse in sterile .9% saline solution) will keep the embryo alive for a longer period.



OBJECTIVES: This experiment, of course does not attempt to impart a fund of knowledge concerning embryology. However, it lends itself ideally to the achievement of many basic science teaching objectives; i. e., the principles of reproduction and heredity; instrumental and manipulatory skill; appreciations of the work of scientists and the scientific method. And finally, because this experiment has been actually used in classrooms, we know it creates an interest in the broad field of science.



AO Model No. 42

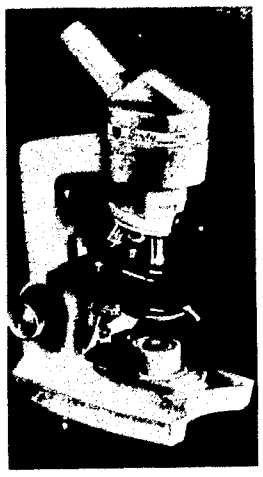
Notes . . .

AO Reports on Teaching with the Microscope

Sanguinary explorations among the monocytes and neutrophiles... or narcism in the classroom.

Someone of sublime wisdom (Schopenhauer, we think) once said that, "things in general become absorbingly interesting when related specifically to ourselves". With this in mind we herein offer a teaching experiment on the observation of red and white blood cells which provides an elementary excursion into the mysteries of the human blood stream.

The basic technique given here for obtaining blood and making stained smears is used by trained clinical laboratory technicians and physicians seeking vital diagnostic information. Used in your classroom, it can bring real drama as your students study their own blood.



You'll need good microscopes for this experiment . . . scopes with the qualities of a professional clinical laboratory instrument. Series Sixty microscope, with excellent image quality, precise fine adjustment and ruggedness, is ideal.

If your lab is equipped with these microscopes (as countless school labs are) you're all set. If not, and if you want information about them, just write to Dept. 72, American Optical Company, Instrument Division, Buffalo 15, New York and ask for Brochure SB60.

EXPERIMENT

Observation of Red and White Blood Cells

MATERIALS AND PREPARATIONS

Blood lancet or sharp needle; 2" x 2" gauze squares; 70% alcohol; microscope slides and cover glasses; vaseline; Wright's Stain (inexpensively obtainable as a ready-to-use solution from any laboratory supply house); distilled water; normal saline; medicine dropper; AO Spencer No. 66 compound microscope equipped with 10X, 43X objectives and 10X eyepiece (oil immersion 97X objective would be ideal).

Set up microscope; clean several slides with acetone and polish dry with clean cloth; rim a cover glass with vaseline; sterilize lancet or needle over flame and place in 70% alcohol.

PROCEDURE

1. Scrub middle finger of willing student "patient" with gauze soaked in 70% alcohol. Wipe dry. Grasp finger between thumb and index finger and squeeze down toward tip; a slight prick with a needle or lancet will yield abundant blood which should form in firm drops if finger is absolutely dry. (Fig. A)

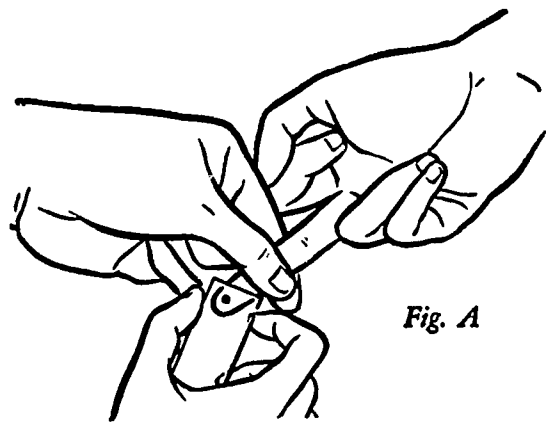


Fig. A

2. Place drop of blood on end of one slide and touch end of second slide to it (see Fig. B) at an acute angle . . . push second slide over first to make thin blood smear. Make several slides and allow to dry.

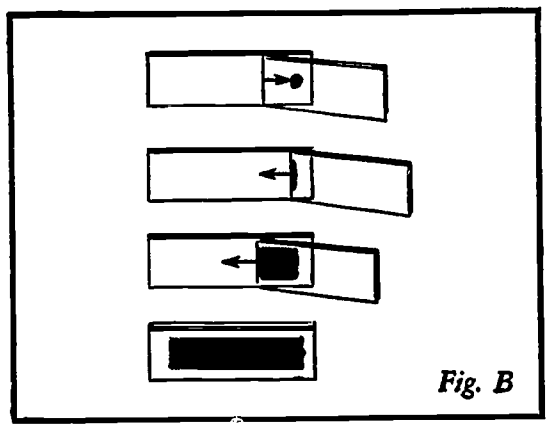


Fig. B

a. *Observation of whole red blood cells:* While smears are drying, place another drop of blood on clean slide . . . add drop of normal saline and place vaseline rimmed cover glass over mixture. Press until thin film forms and vaseline makes air-tight seal. Observe under 10X and then 43X . . . whole red blood cells can be seen suspended in the plasma-saline solution. (Fig. C)

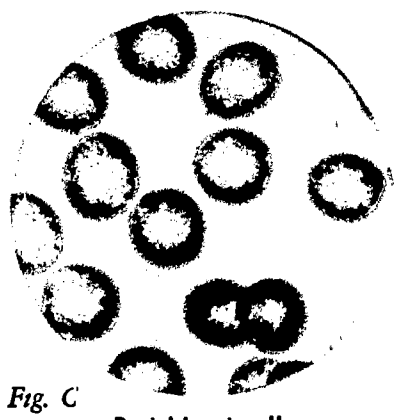


Fig. C

Red blood cells

b. *Differential staining of white blood cells:* Place dry smear on rubber stopper (stain in sink or disposable catch pan, i.e. made of aluminum foil). With dropper, cover slide with 30 drops of Wright's stain, allow to fix for 1 minute . . . add 30 drops of distilled water. Blow gently on mixture until metallic film forms. Let stand 4-5 minutes, then flood stain off with tap water. Blot dry and observe under microscope. Locate thin edge of smear with 10X and then switch to 43X (oil immersion, 97X is preferable). Red blood cells will appear a faded pink or orange color. The different kinds of white blood cells will be stained in varying shades of purplish-blue and eosin, a yellowish-orange color; pebbly clumps of platelets (necessary factor in blood-clotting) will be stained a pale blue. (Fig. D) Under oil immersion, and even under 43X, the various white blood cells can be easily differentiated as polymorphonuclears, segmented neutrophiles, monocytes, etc., by differences in nucleii, cell sizes and staining characteristics. (See Kracke and Garver: *Diseases of the Blood and Atlas of Hematology* for color plates of actual white blood cells differentially stained).

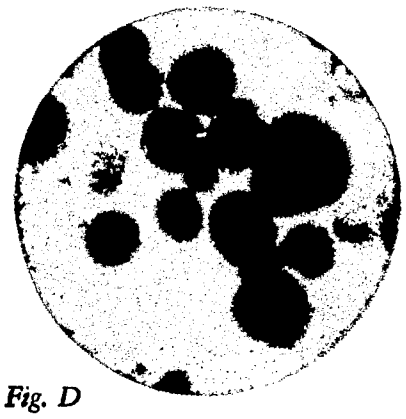
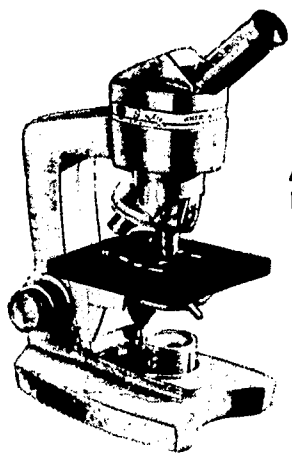


Fig. D

White blood cells from stained smear

c. *Importance of differential white blood counts:* During the course of a disease, the total white blood cell count increases or decreases. However, the doctor must also know the *type* of cell involved. For example, a high white blood cell count with a preponderance of lymphocytes indicates the possibility of mumps, whooping cough, German measles or leukemia. A large number of neutrophilic cells indicates possible rheumatic fever, localized acute infection, or scarlet fever.

OBJECTIVES: This elementary hematological experiment achieves these science objectives: a fund of knowledge about the human body and the physiology of blood; skill in the use of the compound microscope and an appreciation of its application to medicine; clinical laboratory techniques and their diagnostic importance.



AO Model No. L61SA-U1

Notes . . .

AO Reports on Teaching with the Microscope

An old box camera, some cardboard and model airplane cement . . . or do-it-yourself photomicrography.

Without question the microscope and the camera have a certain natural affinity for one another. Everyone, it seems, who has ever looked through a microscope and used a camera has had the desire to apply the one to the other and photograph the invisible detail revealed to his eye.

American Optical profits in a small way from this affinity, manufacturing a truly excellent photomicrographic camera at a most reasonable price. Your request for the $300.00 plus required for one of these precise research instruments would get short shrift, however, from your school administrators. So, without fear of losing business, we can proceed to outline our little plan for a very rudimentary, do-it-yourself photomicrographic camera set-up that would be entirely adequate for preliminary student excursions into the art of photomicrography.

TAKE ANY OLD BOX CAMERA

Our photomicrographic set-up will consist of an ordinary box camera for holding the film and a cardboard box arrangement for focusing. Any old clunker of a box camera will do . . . just make sure it has a setting for time exposure.

CONSTRUCTING ADAPTERS:

Construct two cardboard adapters, one inch high out of stiff cardboard (1/16" approx.) and model airplane cement (see fig. 1). Holes should be cut to fit snugly over microscope eyepiece.

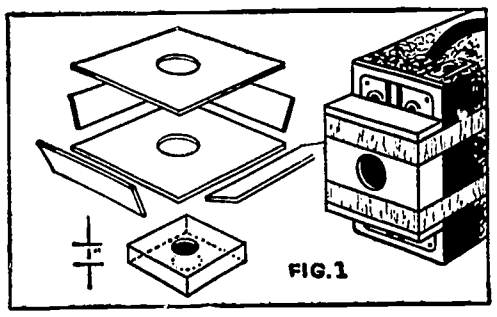


FIG. 1

PROCEDURE FOR ADAPTING CAMERA:

Remove lens from camera, (reflecting surfaces of the camera lens will produce glare, or "hot spots" on film). Tape one adapter to camera, (see fig. 1). Load camera with standard panchromatic roll film.

PROCEDURE FOR CONSTRUCTING FOCUSING DEVICE:

Construct eight inch high cardboard viewer by cementing three sides around second adapter (see fig. 2). After three sides are cemented, mount ground glass (ground side down) to cardboard shelf and then cement on fourth side.

NOTE: Ground glass *must be* same distance from face of adapter on viewer as film plane of camera is from face of its adapter (see fig. 2).

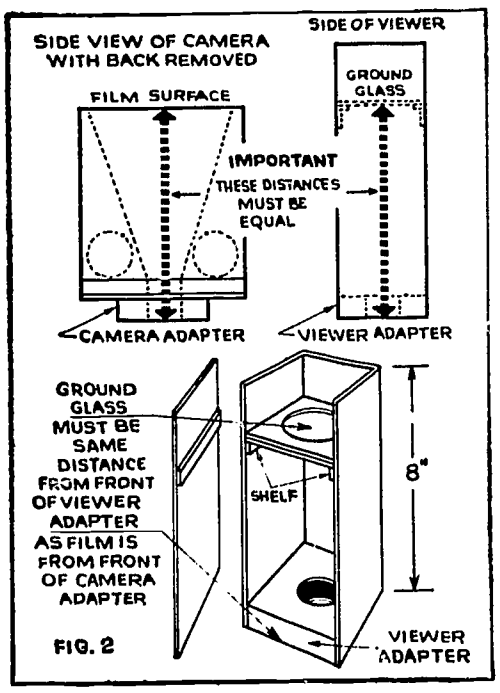


FIG. 2

PROCEDURE FOR TAKING PHOTOMICROGRAPHS:

1. Focus specimen under microscope. Be certain that the field is brightly and evenly illuminated. Then place focusing device over the eyepiece and focus microscope until image is as sharply defined as possible on the ground glass.

2. Turn *off* substage illuminator, or interpose black, opaque paper between light source and substage. Replace focusing device with camera. Set camera to time exposure and open shutter.

3. Turn *on* substage illuminator or remove black opaque paper . . . this will expose the film. After proper exposure, turn *off* substage illuminator or reintroduce black paper. Close shutter before removing camera. The camera shutter is used *only* to make the camera lightproof when it is not in use. Do not use shutter to expose film. The tripping of the shutter would create a tremor resulting in a blurred photograph. Also, be careful not to set up any other vibrations that will shake camera during exposure.

This do-it-yourself photomicrographic set-up is very convenient and very adequate. It's always ready and no elaborate adjustments are necessary.

NOTE: The following notes on microscopes, illumination and exposure are offered as guides.

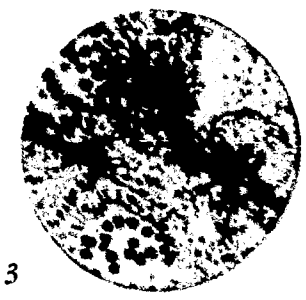


Fig. 3

A. MICROSCOPE: The microscope should be equipped with achromatic objectives and preferably, though not essential, an iris diaphragm and condenser. The AO Spencer 66 series student microscope provides just the ticket... its rugged, dependable and has the same mechanical and optical precision found in laboratory microscopes. If your lab already has number 66's you're all set to go ahead with your camera set-up. If not, you may want some information. Just write to American Optical Company, Instrument Division, Dept. 72, Buffalo 15, N. Y.

B. ILLUMINATION: A substage attached illuminator will guarantee the evenly illuminated field necessary for good photographs... the negative will show up uneveness even where the eye will fail to notice it. Here, we are using the AO Spencer 66B Microscope equipped with the low-cost 616 attachable substage illuminator.

C. EXPOSURE: Exposure is a matter of experience. If you use the microscope-illuminator set described above, you can use the following information as a guide. The Photomicrograph (see fig. 3), was taken at 100X magnification (10X eyepiece, 10X objective) with three second exposure using Kodak Verichrome Pan film. Our trials showed that one to three second exposures yielded good results. For other magnifications you can use the following rule of thumb as a guide.

1. 430X magnification (10X eyepiece, 43X objective). Expose 4 times as long as 100X.
2. 970X magnification (10X eyepiece, 97X oil immersion objective). Expose 2 times as long as 430X.

Notes . . .

AO Reports on Teaching with the Microscope

Measurements through the microscope...or how to clock a speeding protozoan

We don't know who he was or when it happened, but the man who made the first measurement and recorded it, probably became the world's first true scientist. Man has been gathering and recording measurement data ever since... virtually nothing escapes his tape measure. The astronomer uses light-years to measure the infinite reaches of the universe; the microscopist uses microns to measure a universe that recedes into infinite smallness; in between lies a vast army of scientists measuring everything on or beneath the earth... indeed, the earth itself... using every conceivable unit of measurement.

The scientific method requires, essentially, the gathering and recording of data... this can be, in itself, an exciting thing. Students can find this to be particularly true as they use the microscope to measure the "unseeable". We hope the following tips on making measurements through the microscope will give your students a new appreciation of this aspect of the scientific method.

MEASUREMENTS THROUGH THE MICROSCOPE

1. ESTIMATE SPECIMEN SIZE

If the field size provided by the objective—eyepiece combination is known, the size of comparatively large specimens can be estimated simply by determining how much of the field the specimen covers. Approximate field sizes provided by the three standard magnifications are as follows:

100X (10X obj., 10X eyepiece) = 1500 microns
430X (43X obj., 10X eyepiece) = 350 microns
970X (97X obj., 10X eyepiece) = 150 microns

To determine field sizes of other low power objective/eyepiece combinations, simply focus on a millimeter scale using oblique illumination (light directed onto surface of scale to reflect off and up into optical system of microscope). You can convert millimeter readings into the microscopists' standard unit of measurement, the micron. One micron is equal to 1/1000 of a millimeter.

2. CROSS-HAIR EYEPIECE

A cross-hair in the eyepiece will mark off the field of view into approximately equal quadrants, thus making it easier to estimate specimen size, particularly if specimen covers less than half the field. Here's how to make a cross-hair disc and insert in eyepiece.

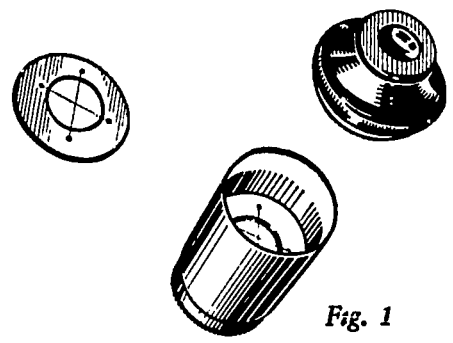


Fig. 1

A. Select a thin washer of proper diameter (approximately ⅞") to fit inside eyepiece. Use human hair (preferably blonde because it is finest) and model airplane cement to fashion a cross-hair over the washer, see fig. 1.

B. Unscrew top lens element from eyepiece. Place washer with cross-hair in eyepiece directly on diaphragm... replace top lens element.

3. ESTIMATING SPEED OR MOVEMENTS OF LIVE PROTOZOA, ETC.

Interesting exercises into the realms of relativity and mathematics can be worked out using live protozoa. Observe protozoa under low power and use stop watch to calculate time required for one specimen to traverse entire field or portions of field divided by cross-hair. Microscope magnifies size only, not time. Converting microns per second to the familiar miles per hour results in increased student understanding of the various units of measurement.

4. EYEPIECE MICROMETER

Exact measurements can be made by means of a scale, or micrometer disc, placed in the eyepiece. The divisions in the eyepiece micrometer disc have arbitrary length. The apparent length depends upon the total magnification used. Therefore, before the disc can be used to measure a specimen, it must be calibrated for use with each combination of objective and eyepiece against a stage micrometer. A stage micrometer has divisions of true length. The AO Spencer stage micrometer, Catalog Number 400, has a 2mm scale divided into 200 parts... each part measuring .01 mm. Every tenth part on the scale is numbered, see fig. 2. If you want complete information about eyepiece micrometers and stage micrometers just write to: Dept. 72, American Optical Company, Instrument Division, Buffalo 15, New York.

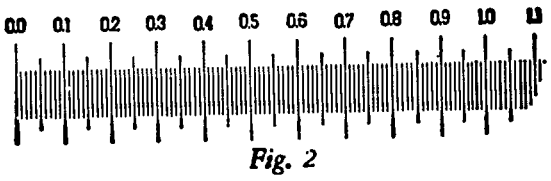


Fig. 2

PROCEDURE

A. Unscrew top lens of the eyepiece... insert eyepiece micrometer, *ruled side down* on the diaphragm within the eyepiece. Replace top lens.

B. Place stage micrometer on microscope stage...focus sharply with 10X objective. Rotate eyepiece and move stage micrometer until both scales are in juxtaposition along the same axis and both scales are even at one end, see fig. 3. Now count the number of arbitrary divisions of the eyepiece micrometer that fall within a specific true distance on the stage micrometer. In fig. 3,

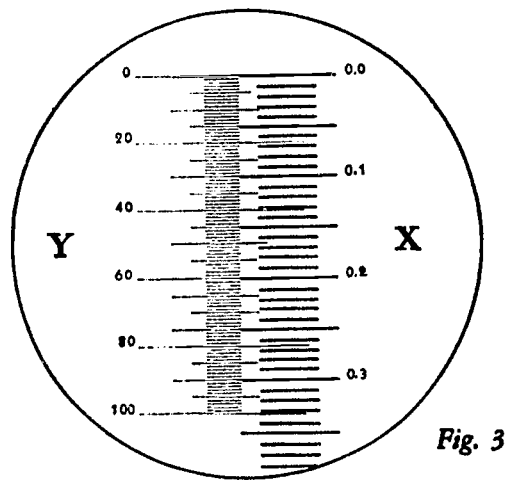


Fig. 3

for example, the first 21 divisions of the eyepiece micrometer (Y) fall within 7 divisions of the stage micrometer (X). We can find the calibration constant (C) simply by dividing the true distance (X) by the number of divisions of the eyepiece micrometer (Y); i.e.:

$$C = \frac{X}{Y}$$

$$C = \frac{7(.01)}{21}$$

$$C = .003 \text{ mm; or } 3 \text{ microns}$$

Now, using this as an example, if a specimen is measured against the eyepiece micrometer scale and found to span, let us say, 10 divisions, we can determine its size by multiplying the number of divisions it spans by 3 microns, i.e. 30 microns.

NOTE: The eyepiece micrometer must be calibrated at each magnification. Once calibrated, the constant should be noted and then the eyepiece micrometer need not be recalibrated if those same magnifications (and tube length) are used.

Notes . . .

AO Reports on Teaching with the Microscope

Tranquilizers for Paramecium . . . or the care, feeding and observation of infusoria.

Generations of microscopists from Leeuwenhoek and Hooke down to present day biologists and medical workers have spent endless hours studying the ameba. You would think it had no further secrets left to fascinate present-day scientists. But not so! The ameba and its companion denizens of the primeval slime have come to us in unbroken genealogy from a period eons before the age of dinosauers . . . from the very beginning of creation itself. As a basic uni-cellular living organism, the ameba is more intensely studied today than ever before by scientists seeking the final elucidation of the life processes. Protozoa remain fascinating subject matter for student microscopists in the Biology classroom. With all this in mind, we offer the following generally well-known tips on the care, feeding and observation of the wee beasties.

MATERIALS:

Glass dish, approximately 8″ in diameter, 4″ deep (ordinary casserole pyrex dish); piece of plate glass; several petri dishes; timothy hay; pondweed; Methylene Blue; carmine or indigo powder; iodine; microscope slides; cover glasses; compound microscope; stereoscopic microscope.

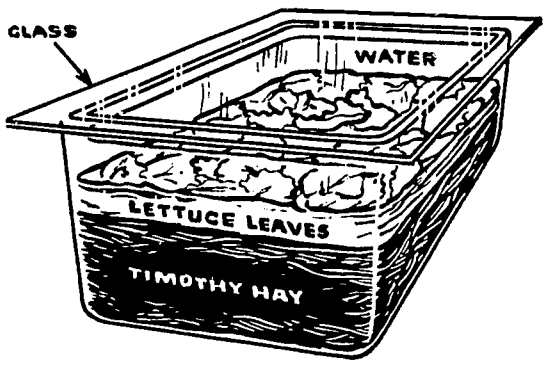


Fig. 1

HAY INFUSION:

Half fill 8″ dish with loosely packed timothy hay. Boil about two quarts of tap water for 5 minutes. Allow to cool and pour enough into dish to just cover hay. Add a 1 inch layer of the pondweed, Ceritophyllum. If out of season, or otherwise unobtainable, use unwashed lettuce leaves. Add more water to bring to within half-inch of top of dish. Cover with plate glass (see fig. 1). Keep in warm (normal room temperature), well lighted room . . . avoid strong, direct sunlight. Prepare several such cultures over a two-week interval. A brown, slightly odoriferous scum should appear. If scum disappears, or if whitish mold appears, discard culture. In a favorable culture, ameba will appear in 6 to 8 weeks. Additional protozoa will also be present, including Paramecium, Stentor, Euglena, and rotifers. Culture should thrive for 6 months or longer. Several such cultures will assure a plentiful supply of protozoa at all times during the school year. Occasionally add a malt tablet or few grains (pulverized) of rice as nutrient.

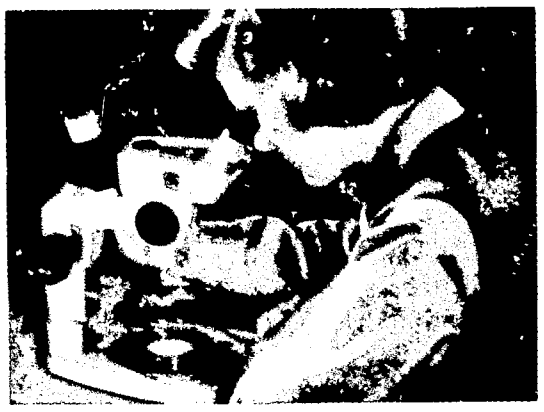


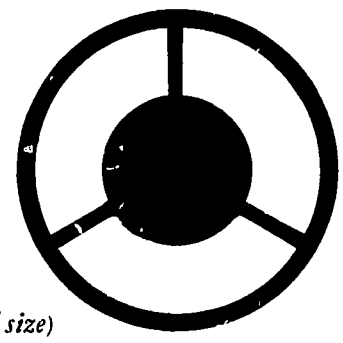
Fig. 2

OBSERVATION THROUGH STEREOSCOFIC MICROSCOPE:

Use a pipette to transfer some culture to petri dish . . . search the bottom of the culture dish for ameba, look along the sides where light is strongest for Euglena and look beneath decaying vegetable matter for Paramecium. Place petri dish on microscope stage. The stereoscopic microscope provides the unique advantages of three-dimensional magnification, long depth of focus and wide field of view to reveal, *in toto,* a teeming aquatic jungle of ameba, scooting paramecium, turgid rotifers and spinning ciliates (see fig. 2). If your school does not have a stereoscopic microscope, you may want information about the AO Spencer Cycloptic Microscope, Series 56F-1. Write to American Optical Company, Instrument Division, Dept. 72, Buffalo 15, N. Y. We'll be happy to send complete information at no obligation to you.

The stereoscopic microscope can also be used to establish "pedigree stock", or pure cultures. Simply hunt down the desired specimens with a wide mouth medicine dropper and innoculate a favorable culture medium such as Chalkley's fluid. Prepare Chalkley's fluid as follows:

NaCl	0.1gm
KCl	0.004gm
$CaCl_2$	0.006gm
Water (distilled) . . .	1000cc



(actual size)

Fig. 3: Star diaphragm for dark field

OBSERVATIONS WITH THE COMPOUND MICROSCOPE:

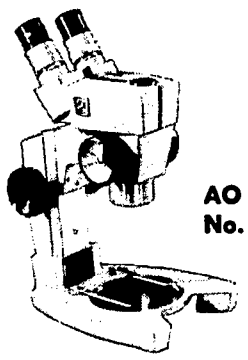
DARK FIELD. It is difficult to see detail in live, unstained protozoa. Cutting down light intensity helps. If your microscopes have substage filter holders you can use star diaphragms to achieve dark field effect for better observation of general morphology. Make a star diaphragm out of stiff, black opaque cardboard. Use illustration (actual size) as pattern (fig. 3). Star diaphragm is slipped into filter holder and adjusted until best dark field effect is obtained.

STAINING. To see cilia, flagella and trichocysts, irrigate slide with very dilute iodine solution as follows: place drop of iodine at edge of cover glass on one side and place filter paper at edge of cover glass on opposite side. This will pull iodine under cover glass. To stain entire organism, proceed as follows: pipette some culture into Petri dish. Add Methylene Blue (not to be confused with Methyl Blue) until culture takes on definite blue tint. Observe drop of tinted culture under 10X and then 43X. Organisms will be stained blue for a short while and then gradually will return to normal.

FEEDING. To distinguish between food vacuole and macronucleus of ameba, add a pinch of finely pulverized Carmine or indigo powder to culture specimen on slide. Use cover glass and observe under 10X and 43X. Colored powder is rapidly ingested by ameba and accumulates in food vacuole. Powder grains can also be seen swirling into gullet of paramecium as they get caught in current set up by cilia.

Fig. 4. Photomicrograph of an ameba

SLOWING DOWN PROTOZOA. If the ameba is the tortoise of their aquatic jungle, the paramecium is the hare . . . they literally flash in and out of field of view. Adding a drop of water soluble methyl cellulose (or egg albumen) will slow paramecium and other ciliates and flagellates considerably. You can narcotize them motionless with a small drop of very dilute methyl alcohol. Once anesthetized, your students can attempt photomicrography with their do-it-yourself photomicrographic camera set-up described in an earlier AO Report on teaching with the microscope. If you are using stains, you might want them to experiment with color film.



AO Model No. 56M-1

Notes . . .

AO Reports on Teaching with the Microscope

Husbandry of Molds or Gentleman Farming in the Classroom

By: Mr. William Altfeld
New York School of Printing
New York, New York

This unique experiment is reproduced exactly as submitted by Mr. Altfeld. He has used it, with much success, in his general science classes at the New York School of Printing. We submit it to you as a fine way to introduce students to the study of microscopic common, non-green plant life, as well as to the importance and use of the microscope in biology. In a very simple way, it extends the field of microscopic creativity by utilizing ordinary, "everyday" materials...indeed, the dust from the very air that surrounds us.

Mr. Altfeld suggests using the AO Spencer Series Sixty Microscope. He didn't have to say that . . . but we are not unhappy that he did. You see, we know the AO Series Sixty combines superb optical performance with rugged construction . . . is designed to service even the most active class. Full facts on the Series Sixty are yours for the asking. Just write American Optical Company, Instrument Division, Dept. 72, Buffalo 15, N. Y. Complete information will reach you by return mail.

EXPERIMENT

Growth and microscope study of our common molds.

MATERIALS AND PREPARATIONS

1. AO Spencer No. 66 Compound Microscope with 10X eyepiece and 10X and 43X objectives.

2. A microscope lamp is also a worthy accessory.

3. Box of clean slides and cover slips.

4. Tweezers and teasing needles.

FOR THE MOLD CULTURES THEMSELVES

1. Thoroughly cleaned food jars with twist off caps e. g. those used for jam, peanut butter, mayonnaise etc:

2. Squares of stale bread (cut down to 1″x1″);

3. Newspaper;

4. Water;

5. Normal dust from the air.

PROCEDURE

1. Crumple a small handful of newspaper.

2. Sprinkle (do *not* soak) the newspaper with water until it is damp, but not limp.

3. Place the ball of damp paper into the bottom of a cleaned food jar (Fig. 1). With the cover on, this will provide a moisture chamber essential to the germination of mold spores.

4. Take a 1″ x 1″ square of stale dry bread and rub one side of it along a dusty surface of a table.

5. Carefully insert the square of bread into the prepared jar with the dusty side up (see Fig. 1).

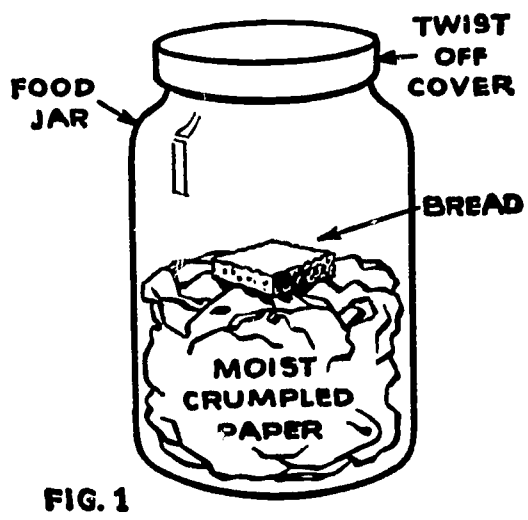


FIG. 1

6. With the cover of the jar replaced, the culture is now placed in a dark, warm, part of the room for several days.

7. A variety of colorful molds may be the reward for the careful mold gardener. However, the most common bread mold, Rhizopus nigricans ... a black mold with cottony mycelia will tend to steal the show.

8. After the molds have made their appearance, we can open our jars, and prepare to delve into the tiny world with the microscope.

9. With tweezers we snip off a sample of our common black mold. Place the sample on a clean slide into a drop of water. With teasing needles we separate the mass of hyphae. Then we prepare a temporary mount with a cover slip.

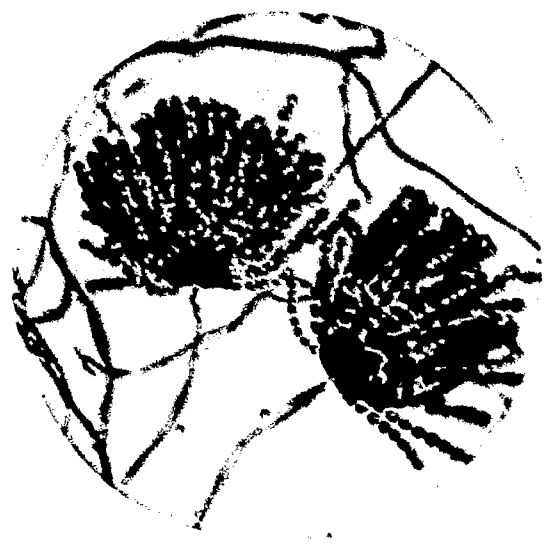


FIG. 2

10. Place slide under microscope and examine at 100X for an over-all view of the hyphae with their spore cases. Under higher power, 430X, we can observe the myriad spores which will have escaped their spore cases(see Fig. 2).

OBJECTIVES

The beginning students of biology will be able to appreciate the following facts:

1. Instructive experiments may be done with simple materials found in the home.

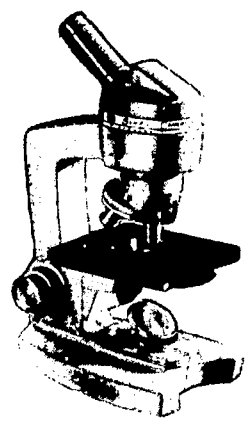
2. Molds do not originate from decaying matter, but rather from tiny "seed-like" spores, which themselves, germinate on decaying matter, and aid in that decay.

3. Mold plants are of many varieties just as our higher green plants.

4. The microscope is an essential tool in the understanding of the reproduction and growth of tiny plants.

Success with simple experiments may arouse students to try many others and so maintain an active interest in the science of life.

AO Model No. 60PD-S1



Notes . . .

AO Reports on Teaching with the Microscope

Chemoreception in Protozoa...and what makes Daphnia's heart beat faster

Two Biology teachers, one from Middletown, Connecticut and the other from right here in Buffalo, N. Y. submitted teaching experiments that reached us on the same day. In some respects, these two experiments are so much alike as to suggest a sort of pedagogical telepathy. However, they are definitely different and we were happy to get both. Each has a certain classic simplicity, showing the straight line between cause and effect with a neatness that's sure to delight your young student scientists. Since both are relatively short we offer them together with the thought that you may be able to combine them in a single 45-50 minute period.

EXPERIMENT

Effects of Drugs Upon the Heart

By: Ted Stopyra
Middletown High School
Middletown, Connecticut

MATERIALS AND EQUIPMENT

1. AO Spencer Series Sixty Microscope.

2. Daphnia (water fleas) obtainable from any aquarium supply store where they are sold as food for tropical fish; or from biological supply house.

3. Concave microscope slides (or plain slides).

4. Medicine droppers.

5. Different types of drugs (pill or liquid form) which may be diluted to strengths, as desired. The following drugs may be obtained from a co-operative physician.

- **A.** Tranquilizers—Compazine.
- **B.** Barbitol—Aberate
- **C.** Depressants—Altarax
- **D.** Stimulants—Dexedrine Sulfate, Wyamine Sulfate.
- **E.** Alcohol—40%, 50%, 60%, 95%.

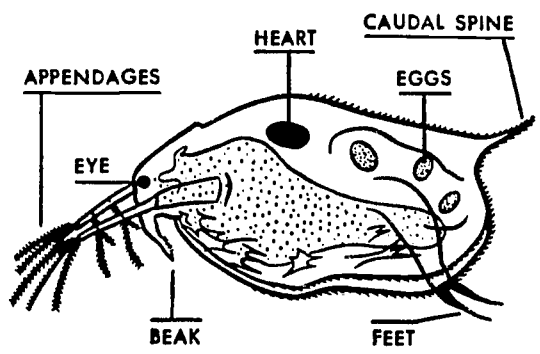


Fig. 1 **DAPHNIA**

PROCEDURE:

1. Select one or two of the Daphnias from a culture with medicine dropper and deposit on concave slide. With same dropper, withdraw as much water as possible from slide, leaving just enough to keep Daphnia alive.

2. Place slide under microscope and observe under 10X objective. One observes the transparent animal immediately with the heart beating very rapidly.

3. Place a drop of one of the diluted drugs on the slide; the heart will react immediately. By repeating the experiment with remaining drugs one can observe the relative effects of tranquilizers, depressants and stimulants on the heart.

EXPERIMENT

The Reactions of Protozoans to Nutrients and/or Dissolved Substances

By: D. S. Po-Chedley
D'Youville College
Buffalo, New York

MATERIALS AND PREPARATIONS

1. Culture of Paramecia or Euglena (obtained from biological supply houses and easily subcultured in finger or stacking bowls).

2. Capillary pipettes: prepared by drawing out medicine dropper so that the bore is about 1mm diameter.

Capillary tubes—about ½ in. long—prepared the same way, or, 1mm diameter capillary tubes can be purchased from scientific supply house.

3. AO Series Forty Microscope.

4. Syracuse dishes, or watchglasses or Petri dishes.

Fig. 2

PROCEDURE:

The plan is to keep the fluid additive in a restricted region long enough to permit the cells to differentiate between it and their normal environment.

1. Fill Syracuse dish half full with water.

Fill capillary tube with a test solution, viz: sugar, salt, glacial acetic acid, formic acid, alcohol, calcium carbonate, etc. (the tube fills easily via capillary attraction).

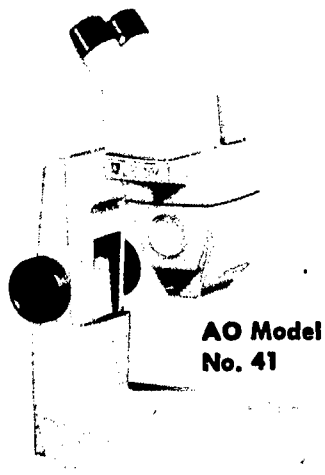
2. Use the stereoscopic microscope and capillary pipette to gather a quantity of the organisms.

3. Place the Syracuse dish in focus under the stereoscopic microscope, carefully lay in the nutrient tube with forceps, (Fig. 2) add the microorganisms (Fig. 3)—observe results.

Fig. 3

OBJECTIVES:

This experiment illustrates a protoplasmic property called chemoreception. The cells either respond positively, by clustering around the open regions of the capillary tubes where diffusion of the test fluid occurs or they may respond negatively, by contacting the material and rapidly moving away. It may kill instantly so that a ring or arc of dead cells form at the periphery of the diffusing substrate. This principle, of chemoreception, here associated with the single cell reactions of protozoa may be projected to study the behavior of more complex organisms.



Notes . . .

AO Reports on Teaching with the Microscope

From Oblique Prisms to Rhombic-based Octahedrons . . . or Cubism on the Scope Stage

Perhaps more than any single other form, the crystal never ceases to awe and impress. The formation of its distinctive geometric shape, which differs a thousand times over is a fascinating process to watch. Possibly this interesting experiment sent us by Mr. Breslau and Mr. Payenson will help you create sufficient student interest in the Microscopic world of Chemical Crystallography to encourage them to further study.

Of course, the criterion that determines what the student sees is the quality of the microscope's optical system. The AO Series Sixty Student Microscopes have an excellent optical system coupled with a low price tag that makes it a very attractive buy for many schools. The easy-to-use focusing adjustments make it ideal for classes where acquisition of subject matter is the primary concern. Rugged construction invites hard classroom usage . . . they are built to service the most active class for years.

EXPERIMENT

By: Abraham Breslau and Irving Payenson
Bushwick High School
Brooklyn, New York

"The recent 1957 Chemistry syllabus issued by the Bureau of Secondary Curriculum Development of the New York State Education Department includes a unit on 'Solutions and Near Solutions'. Topic III of this unit is on crystals, and includes such understandings as the geometric shape of crystals and the formation of crystals from solutions. A common procedure to illustrate these understandings is to demonstrate crystallization by cooling a hot saturated solution of a salt such as potassium nitrate in a test tube so that precipitation results. Crystal form may be shown by using models or a few specially grown crystal samples. The demonstrations have their limitations in their impression on the student. We believe that the following experiment overcomes some of these limitations".

OBSERVING THE FORMATION OF CRYSTALS FROM SOLUTION

MATERIALS AND PREPARATION

Copper sulphate, alum, sulphur, sodium chloride, carbon disulphide, small erlenmeyer flasks, stirring rods, slides, AO Spencer Series Sixty Student Microscopes.

Each student will have a microscope and a single slide. The class is instructed to set up the microscopes to focus at low power of 100x (10x objective and 10x eyepiece) at any specks on the slide. The instructor can prepare the following materials at the demonstration table while the students are thus engaged.

Place a small erlenmeyer flask containing approximately 80ml. of a saturated copper sulphate solution and 5 grams excess solid on a tripod with gauze over a bunsen burner. Prepare similar flasks of alum and sodium chloride solutions. A clear solution of roll sulphur in 5 ml. of carbon disulphide is prepared in a stoppered test tube.

(CAUTION: Carbon disulphide is extremely inflammable. Do not heat the solution or place near open flame).

PROCEDURE:

1. The students are directed to keep slide clamps off the stage and move the slide to the edge of stage. The microscope should not be tilted.

2. As soon as the copper sulphate solution starts to boil, the instructor picks up the flask with suitable means (pot holder or forceps) and, walks through the class placing a single drop of solution on each students' slide with a stirring rod.

3. The student immediately moves the slide under the objective and watches the drop, preferably at an edge, as it cools. Meanwhile, the instructor heats the second flask.

4. The procedure is repeated for the next salt solution, using a different spot on the same slide for comparison purposes.

5. After all burners have been extinguished, the instructor opens the sealed test tube and places a drop of cold carbon disulphide solution on each students' slide. From this, the student will observe sulphur crystals develop by evaporation.

Photomicrograph of sodium chloride crystal

OBJECTIVES:

1. The student is more impressed and usually more understanding of the basic concept of crystal formation and development. "He was there when it happened".

2. It demonstrates the process of crystal formation from solution by cooling.

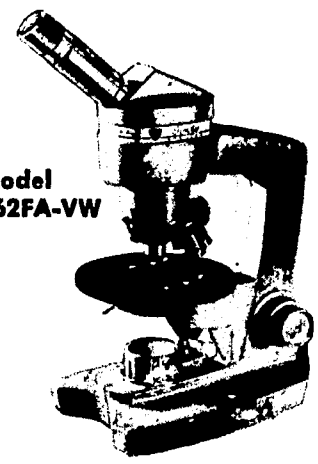
3. It demonstrates the process of crystal formation from solution by evaporation.

4. Some idea of the many geometric crystals forms possible are graphically presented.

5. The student is exposed to a new and interesting field of study.

6. The term "precipitation" is meaningful and realistic.

This experiment can be performed with three substances in about twenty minutes with a class of thirty-five students. There is no difficulty in explaining the subject, performing the experiment, cleaning up for the next class and discussing the results in a forty minute period. Cleaning the slides is easily facilitated by passing a single facial tissue to each student.



AO Model No. L62FA-VW

Notes . . .

AO Reports on Teaching with the Microscope

A Short Course on Carassius auratus Hematal or who slipped Fin the Mickey

One of the most fascinating sights a student can observe in a biology course is the complex network of the blood circulatory system in action. Although the system may not be viewed in its entirety, the student is able to see a large enough portion, with the help of a microscope, to identify arteries, veins and capillaries . . . visually establish the particular function of each.

Subject for the experiment is a goldfish, picked for reasons which our author, Mr. Ted Stopyra, explains below. Observation medium for the experiment is the AO Spencer Series Sixty Microscope which we have picked for what might at first seem selfish reasons . . . but realistically not so, when you consider that this is an instrument ideally suited for student microscopists.

With construction that's foolproof and rugged, the Series Sixty Microscope defies wear. Incorporating the finest optical elements, you have an instrument that will provide precise, long term service even under constant use by the most active class.

EXPERIMENT

Circulation of Blood

By: Ted Stopyra
Middletown High School
Middletown, Connecticut

To demonstrate blood in action a goldfish was selected over the frog for many reasons. Frogs pose a problem in keeping them alive for any length of time. The goldfish on the other hand can be kept alive indefinitely.

The problem of keeping and feeding the goldfish is a minor chore as compared to the frog. In addition, the anesthetizing, the maneuverability and transparency of the fish's fin far surpasses the web of the frog for this experiment.

MATERIALS AND PREPARATION

1. AO Spencer Series Sixty Student Microscope
2. Lantern glass slide 3½" x 4¼"
3. Living goldfish (the Fantail or Common Comet species). Preferably two inches or more in body length.
4. Absorbent Cotton
5. Chloretone Crystals (Chlorobutanol-hydrous) 1 oz.
6. Pipette
7. Beaker of water
8. Cover slip

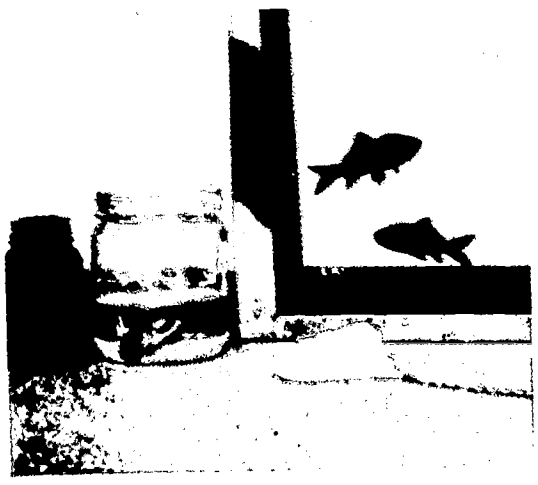


Fig. 1

Chloretone is mixed by adding one ounce of Chloretone crystals to eight ounces or 236 c. c. of water in an amber glass bottle. Shake the contents and let the solution stand. The chloretone solution keeps well even though the crystals are slightly soluble.

PROCEDURE:

1. To anesthetize the goldfish you place four ounces, or 118 c. c., of water in a beaker or wide rim container such as a mason jar. Then add one or two teaspoons of Chloretone solution to the water, stir and place goldfish into solution. In a few minutes the goldfish slows down and rolls over on its side. (Fig. 1) The fish will remain anesthetized for an hour or two.

2. When the fish obtains the side position, remove the fish from the Chloretone solution and wrap a layer of dripping wet absorbent cotton around its body and place on a lantern slide. It is best to saturate the cotton with water from the tank or cor tainer the goldfish came from originally. When covering the body with cotton, place it in such a way that the mouth is not covered and the posterior tail is exposed.

Fig. 2

3. Place the prepared slide under the microscope (Fig. 2) and focus under low power.

OBJECTIVE:

To provide a visual demonstration of blood circulation in a living animal containing a backbone.

1. Once the specimen is focused, one readily notices the movement of blood through the blood vessels. Arteries are identified by the flow of blood toward the fin. Veins on the other hand are recognized by the flow of blood toward the head. Connecting these vessels are hair-like structures called capillaries. Blood cells flow through these capillaries one at a time.

2. By changing the objective to 43x and adding a cover slip, the lymph vessels and capillaries become very clear. Lymph vessels are recognized by the slow rate of movement of corpuscles through them in comparison to the blood vessels.

3. To observe coagulation one just has to pierce the fin with a pin, thereby rupturing many capillaries.

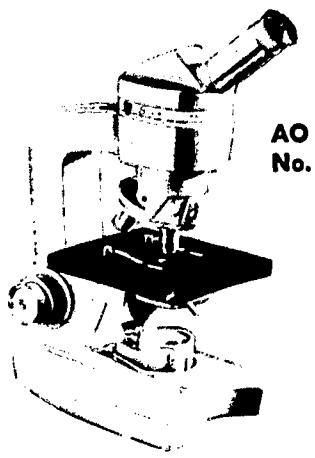
Fig. 3

RECOVERY:

1. One method of reviving the fish is to put it in a pail of fresh water. Ordinarily it would swim off at once. However, this does not always happen. The preferred method is to subject the fish to artificial respiration. This is administered by holding the fish between two fingers and pushing it through the water rapidly. (Fig. 3)

Seldom does a fish fail to revive because the water is forced through the mouth and out the gills. A rapid motion introduces more oxygen to the gills, and the more oxygen absorbed the speedier the recovery.

The length of artificial respiration depends upon how long the fish was under the microscope. It is best to continue the use of artificial respiration until the fish swims out of one's fingers.



AO Model No. L60PE-S1

Notes . . .

AO Reports on Teaching with the Microscope

Oral Bacteriological Jungles or A Poem for Young Lovers

Here is an experiment that usually develops some mighty thoughtful discussion on the part of participating students. It will give every red-blooded American boy and girl reason to pause, temporarily at least, and consider the "dangers of a kiss".

We don't take a stand on the issue . . . our prime purpose for pursuing the subject is solely in the interest of science. But, if we can sell some of the finest microscopes on the market, at the same time . . so much the better. If you desire more information on the AO Spencer Series Sixty Microscope which we recommend in this experiment just write American Optical Company, Instrument Division, Buffalo 15, New York. Ask for SB60.

EXPERIMENT

Examination of cells found in the mouth.

By: Professor Walter Lener
State University Teachers College
Geneseo, New York

MATERIALS AND PREPARATION:

AO Spencer Series Sixty Microscope, glass slides, methylene blue dye or India ink, container of water (if faucet is not handy), blotting paper or soft cloth, toothpicks, bunsen burner (optional).

Wash microscope slides with soap and water. Wipe dry. (The teacher may have a supply of cleaned and dried slides on hand, if this is more feasible). Student(s) performing the experiment should wash hands with soap and water and dry them thoroughly.

PROCEDURE:

1. The student places one finger in mouth to gather an accumulation of saliva.

2. Rub this wet finger against the microscope slide.

3. Scrape inside of cheek and along gum with toothpick. Deposit accumulated saliva and matter on wet portion of slide.

4. Allow the film of moisture to dry on the slide.

5. Quickly pass the slide three times through the flame of a bunsen burner. (This is helpful, but not absolutely essential. Flaming fixes the cells more firmly to the slide.)

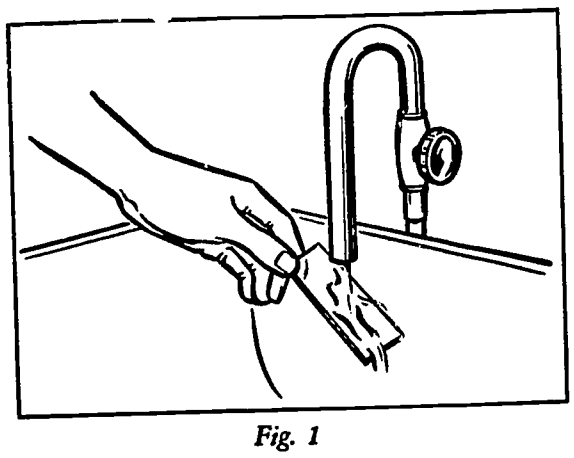


Fig. 1

6. Cover that portion of the microscope slide that has the dried saliva (i. e., where the moist finger touched it) with the methylene blue and allow the methylene blue dye to remain on the slide for two minutes.

7. Place the slide under a gentle stream of water and wash off the excess dye (Figure 1). (If a water tap is not available the excess dye may be washed off the slide with water forced from the glass tubing of a medicine dropper.)

Fig. 2

8. *Blot* the slide dry. (If the slide is rubbed dry, many of the cells may be rubbed off it.) Some difficulty may be experienced by the student in determining which side of the slide they rubbed with their moist fingers after blotting it dry. If slides are first marked on one surface with a glass marking pencil, or if a tiny piece of cellophane tape is fixed to one surface, and the finger is rubbed on the marked surface, this problem will not occur.

9. Examine under the microscope (Figure 2), first with the 10x, then with the 43x objective. (The 97x objective would be ideal because of the small size of the bacterial cells).

OBJECTIVES:

1. Observe the epithelial cells (Figure 3). Compare the relative sizes of the total cell and the nucleus.

2. Observe the bacterial cells. Compare the bacteria to the epithelial cells. Notice the configurations of the bacteria. (The terms diplococcus, streptococcus and staphlococcus take on new meanings as the students see the bacteria from their own mouths.)

A closely related exercise which will show the bacterial cells to even better advantage can be accomplished by:

1. Placing a drop of saliva on a cleaned microscope slide.

2. Adding one drop of India ink to the drop of saliva.

Fig. 3

3. Mix the two drops thoroughly with a tooth pick and spread the mixture as thinly as possible across the surface of the slide.

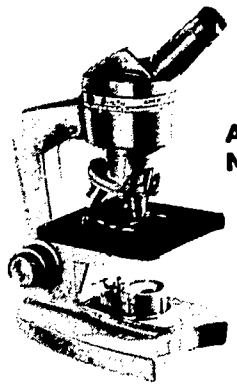
4. Permit the mixture to dry.

5. After the mixture has dried, examine the slide under the microscope, first using the 10x, then the 43x, and then the 97x objective, if available.

(The background will be black or dark gray, the bacterial cells will be colorless).

After examining the slides the students might be in a mood to appreciate the following poem which, I believe, appeared in the Yale humor magazine:

Before I heard the doctors tell the
dangers of a kiss,
I had considered kissing you the
nearest thing to bliss,
But now I know biology and sit
and sigh and moan,
Six million mad bacteria and I
thought we were alone.



AO Model No. L61PE-T1

Notes . . .

AO Reports on Teaching with the Microscope

The ABC's of Blood Typing...or for every agglutinogen there's an agglutinin.

Using the internationally accepted Landsteiner classification system, human blood can be classified into one of four types; A, B, AB or O, according to the presence and type of agglutinogen in the red blood cells. Agglutinogen A = type A; agglutinogen B = type B; agglutinogens A and B = type AB; no agglutinogens in red blood cells = type O. In addition, there is an agglutinin factor in the serum of each individual which is, necessarily, compatible to his agglutinogen factor:

Agglutinogen	Blood Type	Agglutinin
A	A	Anti B
B	B	Anti A
A and B	AB	None
None	O	Anti A and Anti B

Blood can be typed by mixing unknown whole Blood (or red blood cells in suspension) with agglutinins (anti sera) of known factors. If the two are incompatible, agglutination, or clumping of red cells will occur.

There are many clinical tests for blood typing...some very complicated and some relatively simple.

The experiment below by Dr. Frank E. Wolf is simple enough for the classroom but accurate, and will serve to acquaint the student with the basic clinical laboratory methods used in blood typing and cross checking preparatory to making blood transfusions. Also, much to our delight, it emphasizes the important role the microscope plays in the clinical laboratory.

Using the AO Series Sixty Microscope the student also gains the added experience of working with a low-cost model of the more expensive laboratory scopes . . . featuring the same high-quality optics plus coarse and fine focusing adjustments. If you have not already done so . . . why not let us show you how little it costs to equip your classes with this exceptionally fine instrument. Write American Optical Company, Instrument Division, Dept. 72, Buffalo 15, New York. Ask for SB60.

EXPERIMENT

Determining Individual Blood Types.

By: Dr. Frank E. Wolf

Professor of Biology

State Teachers College

Fitchburg, Mass.

MATERIALS AND PREPARATION:

Sterile, disposable blood lancet (obtained from any biological supply house), glass slides; wax marking crayon; anti A and anti B typing sera (obtainable from medical supply house); wooden applicator sticks or toothpicks; absorbent cotton; flask of 70% alcohol; AO Spencer Series Sixty compound microscope.

PROCEDURE:

1. Prepare slide (Fig. 1).
   - **a.** Draw vertical line near mid-point with wax marking crayon.
   - **b.** Mark A in upper left corner, and B in upper right.

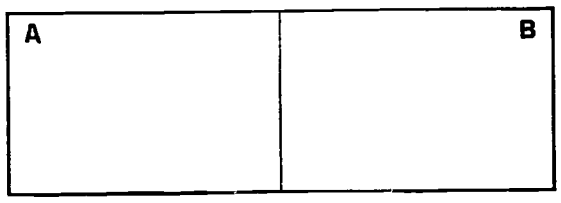


Fig. 1

2. Prepare to draw blood.
   - **a.** Scrub finger with alcohol and cotton sponge.
   - **b.** Wipe dry.
   - **c.** Shake bottle of alcohol with lancet through cork, remove cork and make small puncture with lancet.
   - **d.** Wipe off first drop of blood with dry cotton.
   - **e.** Place a *small* drop of blood on both sides of slide.
   - **f.** Place alcohol sponge over punctured finger.
3. Apply anti sera.
   - **a.** Break an applicator stick in half.
   - **b.** Place a small drop of anti A sera on the A side and a small drop of anti B sera on the B side, over the blood.
   - **c.** Mix blood and sera on A side with one stick and *immediately discard;* repeat on B side with different stick.
4. Read.
   - **a.** Tap slide with finger.
   - **b.** Read under low power of microscope (Fig. 2) within 15-20 seconds.

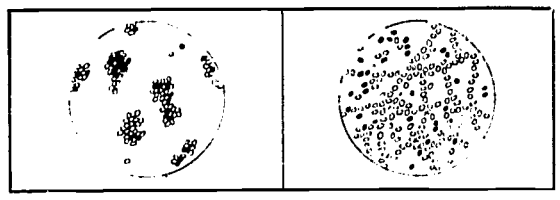
Fig. 2

PRECAUTIONS:

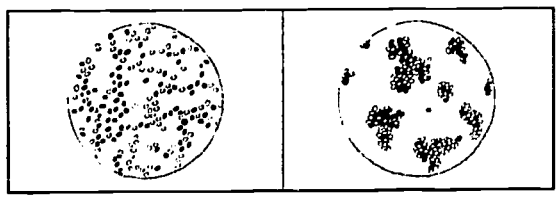
1. Mix each side of slide with a *different stick.*
2. Agitate by tapping slide to overcome rouleaux-formation or dilute serum with a salt solution.
3. Do not run drops of blood and sera into marking crayon; red wax may be mistaken for clumped cells.

INTERPRETATIONS:

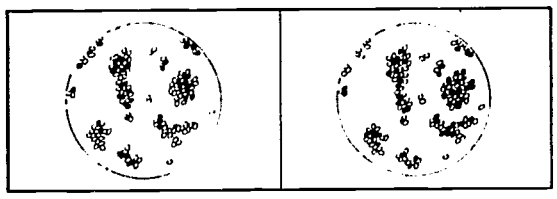
1. Determining blood types: Observe for agglutination on both sides of slide. Use illustrations below to help determine blood types.



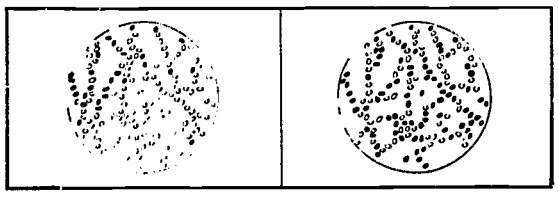
Type A



Type B



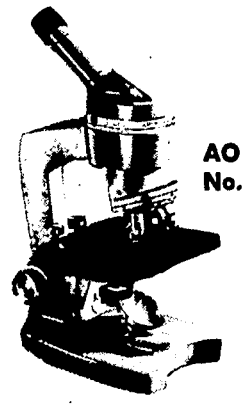
Type AB



Type O

2. Importance of blood typing.

The prime purpose of blood grouping is to provide definite information necessary for immediate or future selection of a suitable donor for a blood transfusion. A cross-match of donor's red blood cells with recipient's serum and recipient's red blood cells with donor's serum should precede any transfusion to prevent the possibility of fatality. (More advanced classes can carry grouping a step further to include the Rh Factor).



AO Model No. X62UA-VW

Notes . . .

AO Reports on Teaching with the Microscope

Osmotic Action and Reaction or Social Life Among the Molecules

Here are two very short experiments that could be incorporated in a single class session. Both provide a brief, though enlightening introduction to the study of osmosis.

The first experiment by Dr. Frank E. Wolf presents the subject in its "growing phase". Mr. John A. Burns contributed the second experiment which is concerned with the "net movement" of osmosis. Both give an excellent visual demonstration of circulation and activity that takes place when a solvent and a solution tend to equalize their concentrations.

EXPERIMENT

Simulated Life Processes

By: Dr. Frank E. Wolf
Professor of Biology
State Teachers College
Fitchburgh, Mass.

Early in some biology courses, it is customary to make comparisons between living and non-living things. Sometimes a chemical garden demonstration is used to motivate an exploration into these differences. The garden meets some of the criteria of both categories: the "plants" apparently grow, reproduce, move, etc. All of these life processes are in some way dependent upon osmosis, for which the chemical garden is also an excellent demonstration. The following demonstration goes one step further. With the aid of the AO Spencer Cycloptic Stereoscopic Microscope, the process of *circulation* may be observed in a chemical garden "plant".

MATERIALS AND PREPARATION:

AO Spencer Cycloptic Stereoscopic Microscope, small containers such as one dram screw top vials or microtechnique test tubes, water glass (sodium silicate), ferric chloride and/or nitrates of cobalt, nickel, manganese, iron, lead, and copper; sulfates of copper, aluminum, iron, and nickel; chlorides of cobalt, manganese, and copper.

Fig. 1

Dilute the water glass one part to three parts of water for a relatively slow reaction; or one to one for a faster reaction; forty percent is probably the most convenient, all-around strength.

PROCEDURE:

Fill a small container with the diluted water glass and add a small lump of ferric chloride or other compound listed. Observe under the stereoscopic microscope (Figure 1).

OBJECTIVES:

1. Observe the membrane-like sacs "growing" from the ferric chloride. Note that as the sac forms a tube, "cells" appear.
2. Focus on the inside of a growing tube and note the process of "circulation" taking place (Figure 2).

Fig. 2

NOTE: The stronger water glass solutions cause faster reactions with better views of circulation, but less well-defined cells. The weaker solutions are recommended for less experienced viewers because the reaction is slower and easier to follow. In either case, the demonstration proves exciting and quite interesting.

EXPERIMENT

To observe effects of molecular action included in study of osmosis.

By: John A. Burns
Vestal Central School
Vestal, N. Y.

MATERIALS AND PREPARATION:

Two AO Spencer Series Sixty Microscopes, two microscope slides with cover slips, water, molasses, carmine red dye, and two probes or needles.

PROCEDURE:

Prepare two slides; the first a temporary mount of carmine dye in water, the second a temporary mount of the dye in molasses. Both may be easily made by dropping 2-3 drops of water (or molasses) on slide, then transferring a few grains of the carmine dye on the end of a needle into the water (or molasses) and stirring. Add cover slip, place each slide under high power (43X) of microscope (Figure 3), and focus until vibration of tiny dye particles is observed.

Fig. 3

OBJECTIVES:

1. Look for vibrating movement of dye particles in water slide. This "jiggling" of minute particles is called Brownian Movement, and is caused by rapid-moving water molecules hitting against visible dye particles in random fashion. Even though the water molecules can't be seen, their presence is revealed by their effect on the dancing dye particles.
2. Now look for slower, more sluggish vibration of dye particles in molasses slide. Large, slow-moving sugar molecules bounce the dye particles far less vigorously.

APPLICATIONS:

Students can visualize relative size of water and sugar molecules by observing their activity on dye particles. The small water molecules are active, move rapidly and therefore can be imagined as minute. By comparison the sugar molecules can be visualized as huge, due to their sluggish effect on the dye particles.

By combining the ideas of molecular sizes and activities with the concept of membrane permeability, an understanding of osmosis evolves. Students can then understand basic reasons why the standard carrot, potato, or beef bladder osmometer operate as they do, and thus can see how absorption can occur in plants, animals, and in the human body.

Notes . . .

AO Reports on Teaching with the Microscope

A tax-free anti-pollution program . . . or nature's answer to man's profligacy!

Pollution is the sad legacy man leaves behind in his headlong rush to inherit the earth. A provident nature works hard to restore balance and order.

Mr. Verne Gowe sends this fine experiment which illustrates nicely how nature uses biological action to help purify streams and lakes.

You'll need microscopes and a colony counter for this experiment. American Optical makes a very excellent, inexpensive colony counter we would like to sell you. It is universally used by school, clinical and industrial laboratories. However, in a spirit of complete unselfishness, we pass along Mr. Gowe's instructions for a do-it-yourself counter that should prove adequate. This same generous spirit moves us to tell you about the excellent microscopes you can buy from American Optical (you really wouldn't want to try to make your own). If you need microscopes for your school and refuse to compromise quality and performance for price, then write to us at Dept. 72. Ask for brochure SB60. There's no obligation, of course.

EXPERIMENT

The Effect of Biological Action on Pollution

By: Verne Gowe
Warren Township High School
Gurnee, Ill.

MATERIALS AND PREPARATION:

1. AO Spencer Series Sixty Microscope with 10x eyepiece and 10x and 43x objectives. **2.** Bacterial colony counter. **3.** A 4x hand lens. **4.** Clean slides and cover slips. **5.** Screw top collection jars. **6.** Nutrient agar. 7. Petri dishes. **8.** Pipettes—1 ml.

PROCEDURE:

A. Collect water samples

1. Choose a stream that has pollution entering from storm tiles or other sources. In most areas this is not too difficult to find.

Fig. 1

2. With *sterile* screw-top jar, collect a water sample at the source of pollution. Take three additional samples at different stations down stream from the source of pollution. Make all sample collections at the surface of the water.

3. Make careful observations along stream for other sources of pollution and factors that might have an effect on results.

B. Microscopic Examination

1. Observe a few drops from each sample under 100x (10x objective and 10x eyepiece) of the microscope for an over-all view of what might be present (Fig. 1). Check for algae, rotifers, protozoa s (Fig. 2).

2. Under high power, 430x (43x objective and 10x eyepiece) identify as many of the microscopic forms as you can.

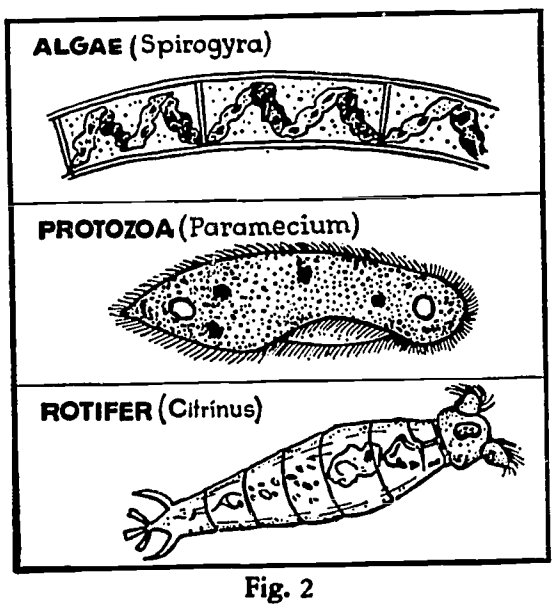


Fig. 2

C. Make pour plates

1. Melt a bottle of sterile nutrient agar by heating it in a pan of water. After the agar is completely melted, cool to 42° - 45° C.

2. Place 1 ml of water from source of pollution in a sterile petri dish using a sterile 1 ml pipette. Pour enough agar in to just cover the entire bottom. Mix by swirling gently. Let the agar-bacteria mixture stand until it hardens. Invert the dish and store in a dark place to incubate for two days at room temperature.

3. Follow this same procedure for each of the other samples. Label each for identification.

4. After incubation, pour plates of the samples should be observed for bacterial colony growth. Colony counts should be made with a bacterial colony counter (Fig. 3). Note the difference in counts according to the distance from the source of pollution. Make a graph or charts of the quantities and types of colonies found at different stations.

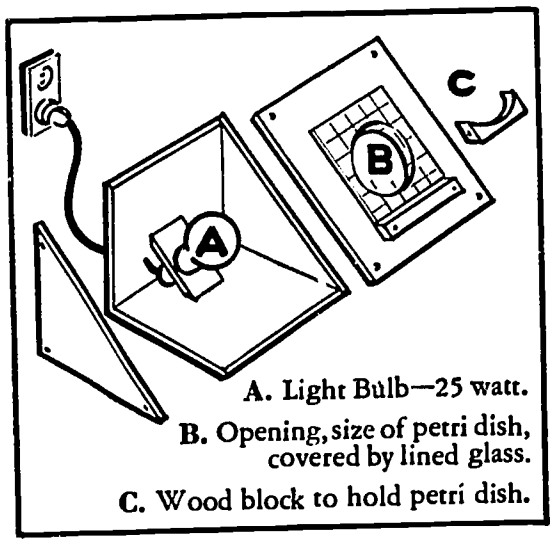
5. Compare the kinds and numbers of organisms seen under the microscope with the bacterial colonies. Make charts to show comparison.

Fig. 3

D. How to make a Colony Counter

A simple bacterial colony counter can be made as follows:

1. Build a wooden light box with a hole the size of a petri dish in the slant side (Fig. 4). Place a glass plate over the opening and rule vertical and horizontal guide lines about ½" apart on this plate. With a 4x hand lens you will be able to count the colonies within each guide-line square.



A. Light Bulb—25 watt.
B. Opening, size of petri dish, covered by lined glass.
C. Wood block to hold petri dish.

Fig. 4

OBJECTIVES:

This experiment not only awakens an interest in conservation of our streams through better sanitation controls but also illustrates:

1. A basic bacteriological method used in Public Health Laboratories.

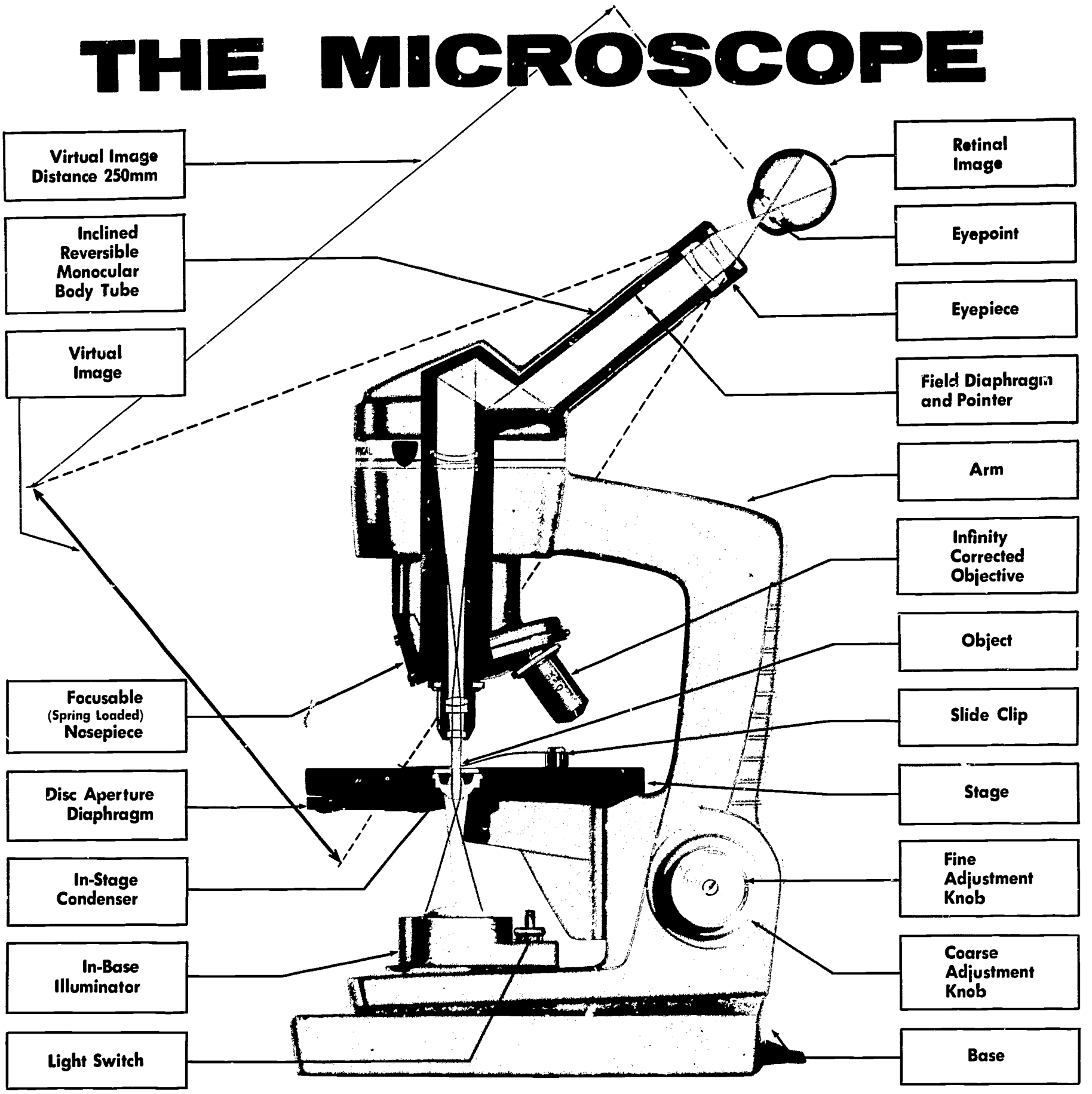
2. The effect of microscopic organisms on pollution.

3. Nature's method of stream purification.

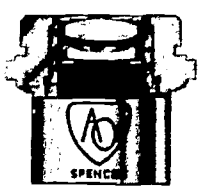
4. Interdependence among living organisms.

Notes . . .

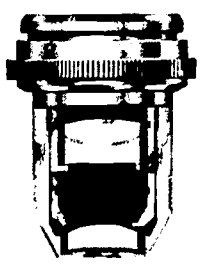
THE MICROSCOPE



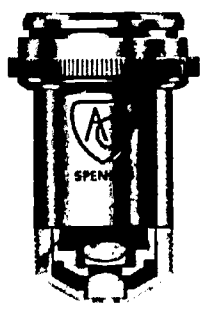
Optical and Mechanical Features of Series SIXTY Microscope



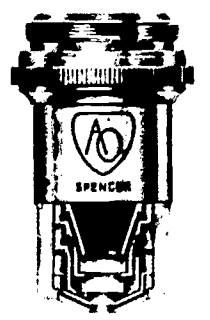
Cross section of scanning objective, 4X.



Cross section of low power objective, 10X.

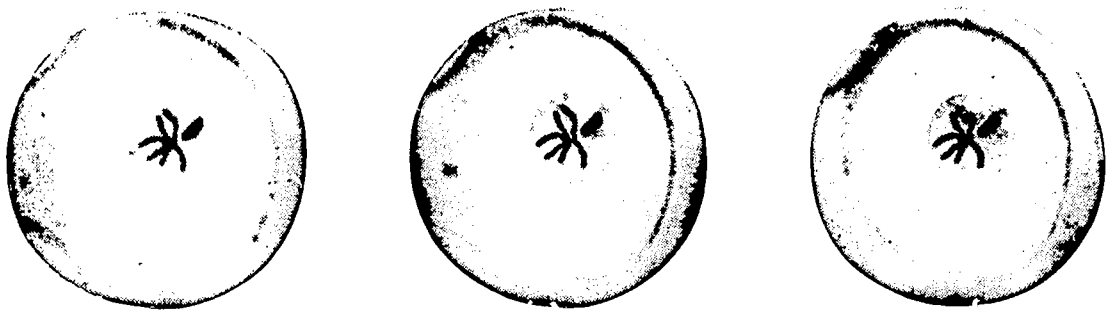


Cross section of "high dry" objective, 43X.



Cross section of oil immersion objective, 97X.

Terms Used in Microscopy



The three photomicrographs show the relationship of numerical aperture to resolving power, and the failure of magnification to provide increased detail. All three specimens are magnified 650X. The one at the left was taken with a 10X, N.A. 0.25 objective and enlarged photographically. The center picture was taken with a 43X, N.A. 0.66 objective and also enlarged photographically. The one at the right was taken with a 90X, N.A. 1.30 objective. Note the superiority of contrast and sharpness of image in the right hand picture.

Illumination: The full capabilities of a microscope cannot be realized unless the illuminator is efficient. Microscopes may be illuminated in several ways. Daylight, but not direct sunlight, can be used with a mirror tilted and adjusted to reflect the light uniformly into the condenser and through the specimen. Daylight is of variable quality and not always available. Consequently, artificial light is more reliable than daylight.

The In-base illuminator is ideally suited for good results because it is an integral part of the instrument . . . assures correct alignment and fully illuminates the field of view . . . also satisfies the numerical aperture requirements of all available objectives 4X, 10X, 43X and 97X. If multiple electrical outlets are not conveniently available, a table globe type microscope illuminator is also suitable and, if centrally located, can be used for four microscopes simultaneously.

Virtual Image: The apparent size and position of the object specimen. See chart on opposite page. This image (not a real or retinal image) seen through the microscope appears to be about 10″ away from the eye . . . approximately the same distance at which average print is read.

Magnification: The ratio of the apparent size of an object as seen through the microscope (virtual image) to the size of the same object as it appears to the unaided eye at a distance of 10″. The ratio is linearly expressed in terms of "diameters," "power," "X," or "times."

The total resultant magnification of an eyepiece-objective combination equals the product of the initial magnifications of the two. For example—the 10X eyepiece used in combination with a 10X objective produces a linear resultant magnification of 100X.

Magnification alone is not the aim of the finest microscope. The amplified or enlarged image isn't helpful unless more detail . . . resolution . . . becomes apparent. Therefore, always use the lowest practical power objective which effectively reveals the detail in which you are interested.

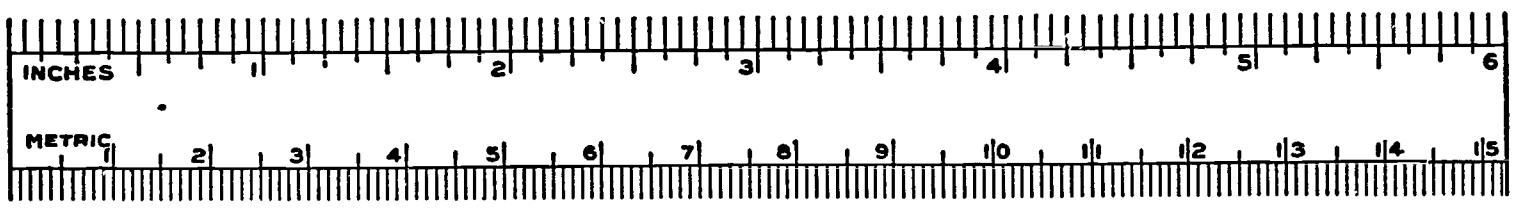
Numerical Aperture (N. A.): A designation, usually engraved on objectives and condensers, expressing mathematically the solid cone of light delivered to the specimen by the condenser and gathered by the objective. It is a criterion of resolving power. The higher the numerical aperture of an objective, the greater its resolving power, provided the N.A. of the condenser is equal to or greater than the N.A. of the objective. For example, a stained preparation of bacteria can be most effectively resolved if viewed with a 97X N.A. 1.25 oil immersion objective used in combination with an Abbe condenser having a corresponding N.A. of 1.25.

Resolving Power (Resolution): The ability of a microscope to reveal fine detail. It is stated as the least distance between two points or lines at which they are seen as two, rather than as a single blurred object. Resolving power is a function of numerical aperture and serves as an indication of which objective should be used to depict any degree of detail.

Definition: The faithfulness with which the instrument magnifies and reproduces specimen detail. The brilliance, clarity, distinctness and sharpness of the microscope image.

Working Distance: The distance between the front mount of the objective, when the microscope is focused on a thin specimen preparation, and the top of the cover glass. The greater the initial magnification of the objective . . . the shorter the working distance. Most objectives are corrected for use with a cover glass thickness of 0.18mm. For this reason, as well as to prevent specimen liquids from touching the objective, such cover glasses should always be applied to the specimen preparation.

Depth of Focus: The thickness of the specimen which may be seen in focus at one time. The lower powered objectives, because of their longer focal lengths and greater depth of focus, are usually more suitable for the study of the general arrangement of the specimen . . . also, the field of view is larger and the image brighter.



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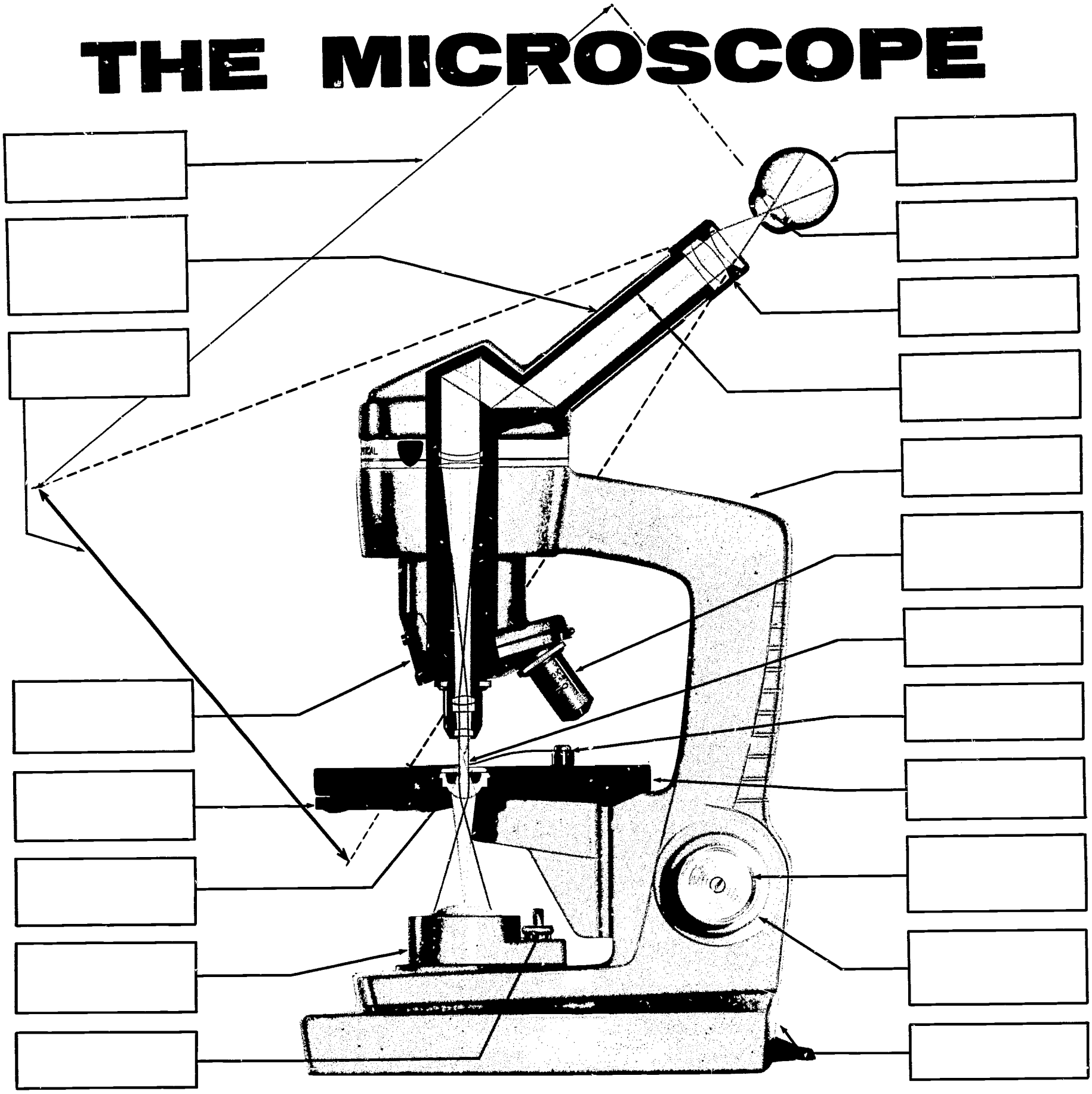
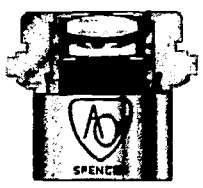
THE MICROSCOPE



Optical and Mechanical Features of Series SIXTY Microscope



Cross section of _____

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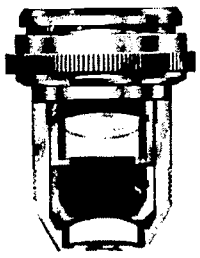

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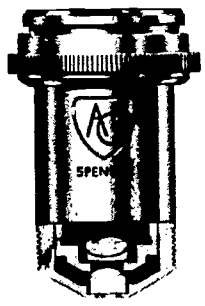

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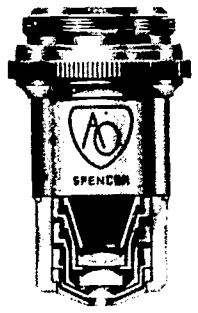

Cross section of _____

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Questions on the Microscope

1. Microscopes may be illuminated with ..... or .....
.....
(direct sunlight, daylight, artificial light)

2. Artificial light is ..... reliable than daylight.
(more, less)

3. The image seen with the microscope, which appears to be about as far away as a book is held when reading, is called the ..... image.
(real, virtual, retinal)

4. "Magnification 100X" refers to ..... magnification.
(linear, area)

5. The total magnification of a microscope is the product of the magnifications of the .....
..... and .....
(body tube, condenser, eyepiece, objective)

6. Magnification is the ..... of the apparent size of the object as seen through the microscope ..... the size of the object as it appears to the unaided eye at a distance of approximately 10 inches.
(ratio.....to, product.....and, sum.....and)

7. N.A. means .....
(normal angle, normal aperture, numerical aperture)

8. N.A. ..... is a number commonly seen: N.A. .....
..... and N.A. .....
..... are not. (0.25, 500, 60°)

9. The greater the N.A., the ..... the resolving power.
(greater, lesser)

10. ..... is the ability of the microscope to separate small details. (definition, magnification, resolution)

11. ..... is the faithfulness with which the optical system produces, with magnification, the specimen and its details.
(definition, magnification, resolution)

12. Working distance is the distance between the front of the objective when it is focused on a thin preparation, and the .....
(top of the cover glass, bottom of the slide, specimen)

13. Greater depth of a specimen can be seen at one time with objectives of .....
..... focal length than with objectives of .....
..... focal length. (long, short)

14. Objectives of ..... focal length are generally more satisfactory for studying the general arrangement of a specimen.
(long, short)

15. Objectives of ..... focal length usually have greater resolving power, magnification, and N.A. than objectives of .....
..... focal length. (long, short)

16. A cover glass ..... be applied to specimen preparations.
(should, should not)

17. Magnification is expressed in units known as .....
(millimeters, diameters, angles)

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PROPER CARE OF SERIES SIXTY MICROSCOPE

Series SIXTY Microscope is a precision instrument made from valuable materials by expert craftsmen and should be treated accordingly. If properly used and cared for, it will literally last a lifetime without appreciable wear or change in appearance and performance.

The following rules, cautions and maintenance hints should be observed:

1. Microscope Stand and Mechanical Parts

a. Use both hands when carrying the instrument. One, firmly grasping the arm of the microscope; the other, beneath the base. Avoid sudden jars.

b. The dove-gray finish is Epoxy . . . tough and durable . . . resists chipping, staining and corrosive action of common laboratory chemicals. Clean with very mild soap or detergent solution when required. Other metal surfaces may be similarly cleaned. Dampen, do not soak, your lint-free cloth for this purpose. Finally, wipe off thoroughly and buff with dry lint-free cloth.

c. Since Series SIXTY Microscope has obsoleted the need for inclination joints, and rack and pinion focusing adjustments, the customer's chore of cleaning and relubricating these non-essential parts has been reduced to nil. All moving parts are protected within the microscope stand and lubricated with permanent type special purpose lubricant recently developed by the American chemical industry. Consequently, disassembly of parts and replacement of these "lifetime" lubricants is unnecessary under normal laboratory working conditions.

d. Store your microscope in a clean, dry place and keep it covered with the supplied plastic cover when the instrument is not in use.

2. Optical Parts

Eyepieces, objectives, condensers and reflecting optical elements are locked-in to safeguard against tampering, damage, loss and prevent dust from entering into the internal optical system.

Do not clean optical parts unnecessarily. If the specimen image appears to have deteriorated and lacks definition—

a. Check the quality of the specimen preparation by using a better area of the slide or insert a slide of known results or turn the nosepiece turret to another objective. If the image quality is improved by the latter, but not the former—cleaning of the bottom-most lens of the objective is indicated.

b. Blurred specks appearing in the field of view are generally caused by dust, lint or smears contaminating the eyepiece or specimen cover glass. If the specks move upon rotation of the eyepiece, clean the topmost lens of the eyepiece. If the specks move upon the slight displacement of the specimen slide, clean the cover glass.

Glass surfaces should never be touched with the fingers because they will leave a greasy smear and, frequently, corrosive perspiration. If a glass surface definitely requires cleaning—

c. Dust if off with a small, clean, dry, warmed camel hair brush. Or, blow it off with an aspirator. An all rubber infant's ear or enema syringe is also ideal for this purpose.

d. Wipe off with a clean, lint-free soft linen cloth or lens paper moistened slightly with distilled water . . . and carefully wipe dry with circular motion.

e. If a film persists, repeat step "c" using a mild soap or detergent solution or xylene. Never supersaturate your cloth or lens paper . . . promptly wipe the surface dry before allowing it to air dry.

f. If the specimen image still does not appear clear, remove the locked-in objective from its turret by means of a snap-type wrench #K1423 available from AO Instrument Division @ $5.00 net.

g. Then, carefully examine the objective with a magnifier to determine the trouble . . . and clean thoroughly. Recessed lenses can best be cleaned at the outer periphery by using a moistened cotton swab with a slight twirling motion. A soft lint-free cloth or lens paper wrapped around the end of a rounded, soft wooden stick can serve the same purpose.

Objectives and eyepieces are carefully aligned at the factory and must not be taken apart. Entrust this type of work only to authorized AO-Spencer service dealers or our factory Customer Service Dept.

The Mirror, In-base Illuminator and Condenser are not very sensitive to the presence of dirt. It makes sense, nevertheless, that good housekeeping be exercised on these parts and that they be kept reasonably clean by following the above cleaning methods.

MAINTENANCE FOR ELEMENTARY TYPE MICROSCOPES

Like every precision mechanical product, microscopes will last longer and provide better performance if cleaned and lubricated at regular intervals. The actual work involved is simple and not too time-consuming. The cleaning and lubricating procedures described here are generally applicable to any make microscope. With a few easily available tools and a fair amount of patience, your efforts will be so rewarding that you will want to give your microscopes such attention regularly. In some instances students can do this work and gain valuable experience for their efforts.

I. MATERIALS

The tools, accessories and lubrication material listed will simplify the task and help yield more satisfying results.

(1) Small camel-hair brush ½ inch (hardware store)

(2) Infant ear syringe (drug store)

(3) 2 good quality screw drivers (1) ⅛ inch wide and (1) jeweler's type medium

(4) Lens paper

(5) Dropper bottle distilled water

(6) Dropper bottle xylene

(7) Mild detergent solution

(8) Spanner wrench for inclination joint (available from manufacturer)

(9) Good slides with detail for testing all powers, etc.

(10) Can light oil (Pike Oil)

(11) Small can cup grease (any gasoline station)

(12) 1 lb. roll of cotton or clean lint-free cloths

(13) Box cotton swabs

(14) Selection of Allen wrenches

(15) Magnifying glass

II. CLEANING and LUBRICATING

The microscope consists of two essential components . . . optical and mechanical. Each will require separate attention.

A. Optical

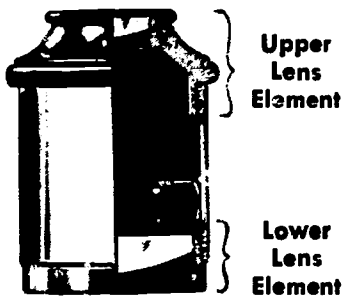


FIGURE 1

1. Eyepieces: Tilt the eyepiece toward a good light. You can readily observe any dirt and film that may be on outer surfaces. Loosen dirt with camel-hair brush, blow off loosened particles with syringe. If oil or other grease film remains either breathe on surface or sparingly apply distilled water and wipe off with lens paper or clean lint-free cloth. If film persists apply xylene *very* sparingly to lens paper or cloth and wipe off promptly. Circular motion should be used for cleaning and polishing. You can determine the necessity for cleaning inner surfaces by focusing the microscope on a specimen and rotating the eyepiece. If dust and dirt spots rotate, cleaning is indicated. Unscrew lower and upper lens (Fig. 1) elements and clean as described for outer surfaces.

2. Objectives: Never attempt to take objectives apart. Clean the exposed front lens of all objectives and the back lens only of the 16mm (10X) objective. The eyepiece, or suitable plug (cork or plastic) should be kept in the body tube at all times to prevent the back lens elements of the objectives from becoming dusty and dirty.

A magnifying glass (Fig. 2) should be used to examine the front lens of the objectives for dirt or oil film, or damaged lens. Clean the lens with distilled water, or use xylene sparingly if necessary . . . wipe clean promptly. Dried blood can be removed easily with peroxide. Cotton swabs are used to advantage because the front lens is recessed slightly.

The 4mm (43X) is more vulnerable to soiling because of the short working distance. Take special pains to keep this objective meticulously clean because the slightest surface film causes image quality to deteriorate.

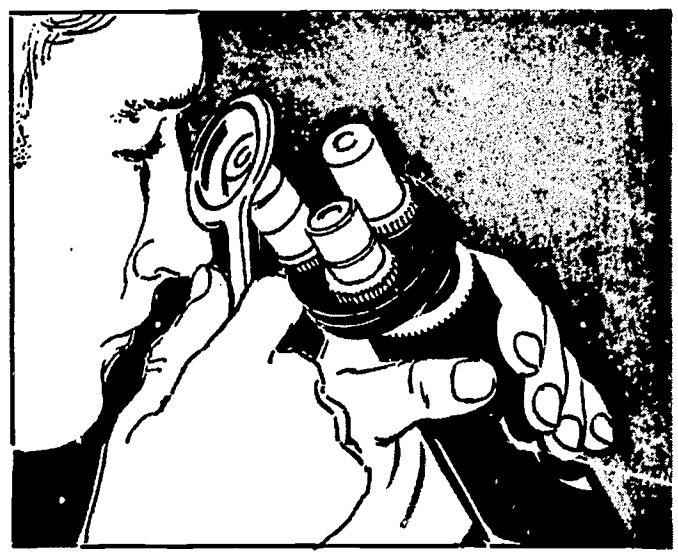
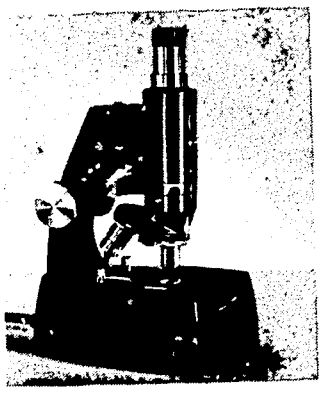


FIGURE 2

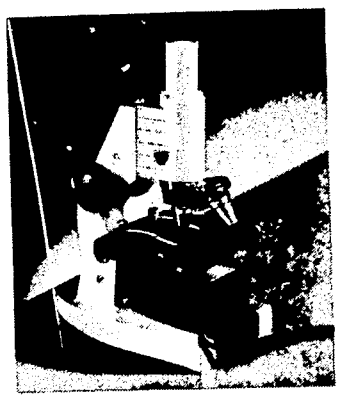
3. Mirrors: Mirror surfaces should be cleaned with distilled water or xylene. Use liquids sparingly and always promptly wipe dry.

B. Mechanical

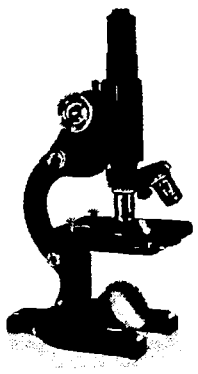
1. Cleaning and lubricating coarse adjustment: The coarse adjustment is the most vulnerable mechanical part of the microscope. The exposed, lubricated surfaces collect dust and grit deposits which, if not cleaned off regularly, will cause abrasive wear to the slideways.



AO Spencer 78



AO Spencer L73



AO Spencer 66

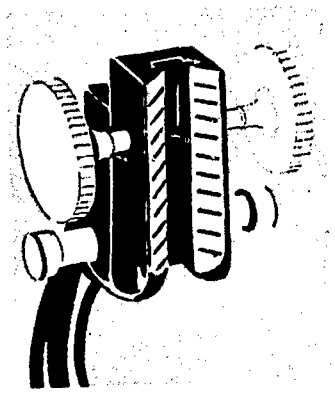


FIGURE 3

a. AO Spencer 66 Series

Rack off body tube. Clean all slideway surfaces and rack with xylene. Wipe off with clean lint-free cloth and re-grease slideways sparingly. Rack and pinion gear should not be lubricated. All AO Spencer Microscopes with separate coarse and fine adjustments, such as the 66 series, have horizontal grooves cut into the slideway (see Fig. 3). These grooves trap dust and grit to prevent abrasive wear across the precisely milled and lapped surfaces. Be sure these grooves are cleaned thoroughly. After cleaning and lubricating, replace body as follows: fit rack into milled slot and lower gently until stopped by pinion gear; cautiously engage pinion gear into rack and lower body tube by means of coarse adjustment focus knobs to desired position. You should notice a marked improvement . . . action will be smoother and easier.

b. AO Spencer 73, 78 and 79 Series

The 73, 78 and 79 Microscopes have a single focusing adjustment. Since very little of the rack and slideways are exposed, cleaning of mechanical parts is generally unnecessary. Only occasional lubrication is required. To lubricate simply rack up body to limit of excursion and sparingly apply Pike Oil to exposed portion. Rack body up and down several times to distribute oil.

c. At times you may desire to remove the complete body from the Student Microscope Series 73, 78 and 79 for re-lubrication. Removal can be accomplished by the following procedure:

1. Remove focusing adjustment stop screw from the top of slideway.
2. Remove screw, spring, and plunger from top of arm. If plunger sticks, omit this step and continue below.
3. a) Series 73 — remove stage by removing the two Allen-head screws which hold it to the arm.
   b) Series 78 and 79 — remove base cover plate from underside of base.
4. Series 78 and 79 — remove two Allen-head screws (front and right) which hold base to arm. Turn base on arm with third Allen-head screw left in place as pivot.
5. Take off gear box cover plate from underside of arm.
6. Push plunger out from bottom (if not removed in Step #2 above).
7. Turn focusing adjustment to bottom of excursion.
8. Slip off body tube from arm.

The old lubricant should be removed using naphtha or lighter fluid. Relubricate and assemble the microscope in the reverse order of the above steps.

2. Adjusting the tension on coarse focus:

On older instruments, especially those not serviced for many years, cleaning and relubricating may result in the body tube assembly coasting down too easily, or even too freely to support the weight of the body tube. There are simple methods for properly adjusting this tension.

a. **AO Spencer 78 Series:** Grasp the two control knobs in each hand and turn in opposite directions . . . to increase tension, turn down with the right hand and up with the left hand (Fig. 4). To reduce tension, reverse the direction of turning.

FIGURE 4

b. **AO Spencer 73 Series:** Loosen Allen screws (Fig. 5) at center of each focusing knob (do not remove screws). Now adjust for tension as described above for 78 Series. Tighten screws securely.

c. **AO Spencer 66 Series:** To increase tension, simply tighten down on screws (Fig. 6). This will tighten the block against the pinion shaft, increasing the tension. To reduce tension, back off slightly on these screws.

d. **Microscopes of other manufacture:** Manufacturers of quality student microscopes make provisions for adjusting the tension of the coarse controls. These will vary, but most employ the method described above for the Series 66, although the screws may be positioned differently (Fig. 7). Consult manufacturers' instruction manual.

CAUTION: Never shim up the rack with foil or paper to increase the friction on the slideway. This will cause wear at the wrong points making eventual major repair necessary. The fine adjustment of most microscopes require no lubrication and no adjustments or repairs should be attempted.

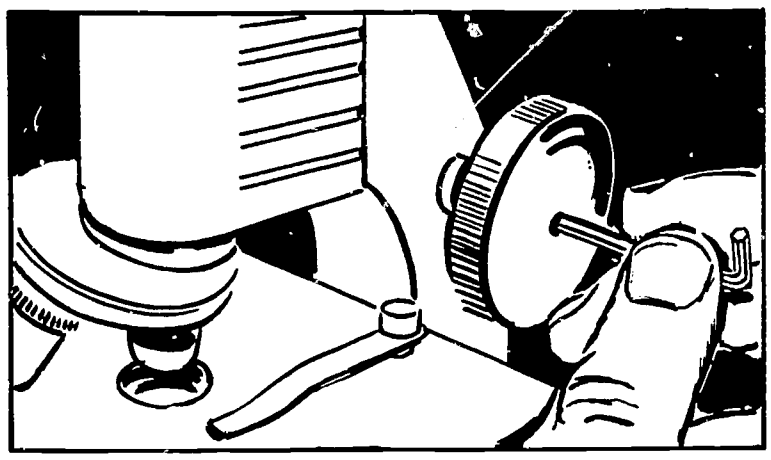


FIGURE 5

3. Adjusting tension of inclination joint: Inclination joint can be adjusted easily to increase or decrease friction. This requires a special but inexpensive wrench which should be ordered from the manufacturer (Fig. 8).

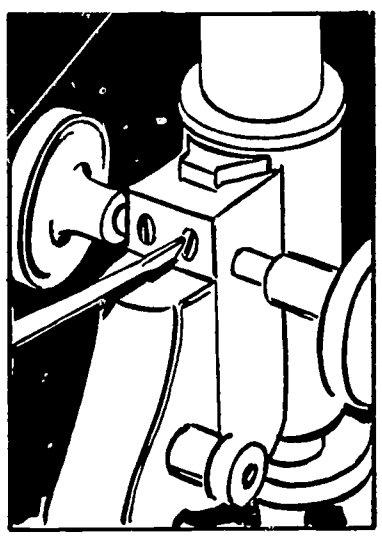


FIGURE 6

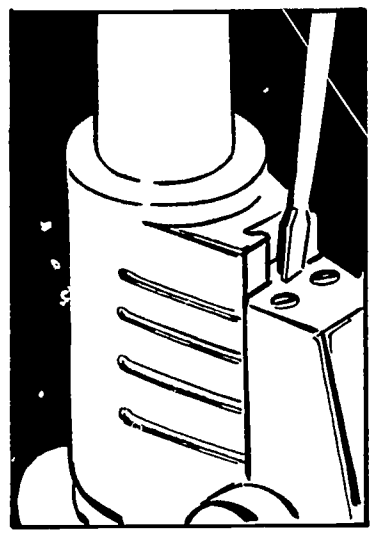


FIGURE 7

4. Cleaning microscope finish: The surface of the microscope is finished with enamel and metal plating and requires little care other than keeping it clean. These finishes resist most laboratory chemicals, and ordinarily a little mild soap and water is all that is necessary for cleaning.

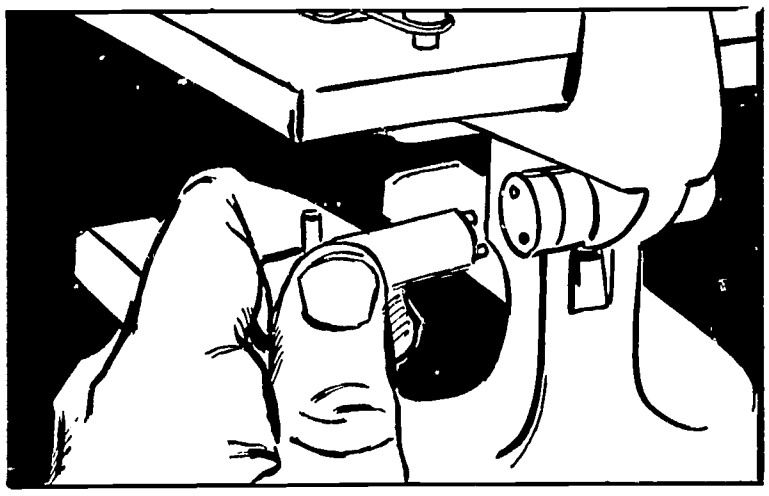


FIGURE 8

Possible Problems

Parfocality: In classrooms where there may be microscopes of more than one manufacture, objectives and eyepieces sometimes become interchanged. Match where you can . . . it is better that objectives and eyepieces on a given microscope be of the same make, preferably of the same vintage. Mixing may result in a decided lack of parfocality. A microscope is parfocal when it is possible to change magnifications from higher to lower magnification without losing the image and with only a slight turn of the fine adjustment required to refocus critically. Microscopes that have adjustable graduated draw tubes *MUST* be set at 160mm to assure parfocality.

Parcentricity: This is a term used to denote identical optical centers. In other words, when you focus on a specimen with a 10X objective and position the specimen in the center of the field, you should be able to change to the 43X with the specimen remaining approximately in the center of the smaller field of view. If this does not apply on a specific microscope, the objectives can be centered by the manufacturer or by a skilled repairman.

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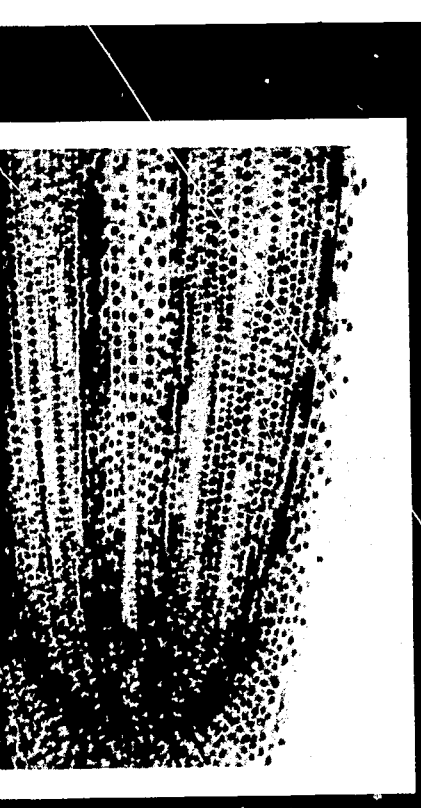

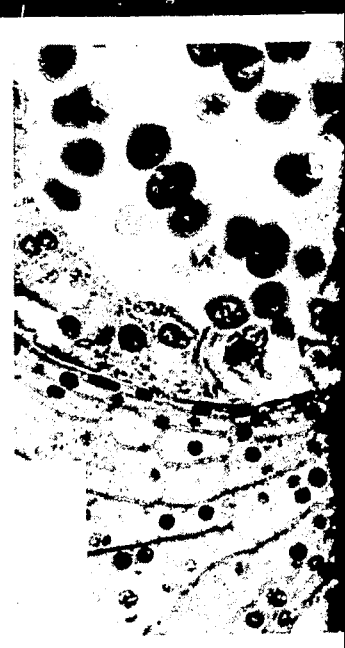

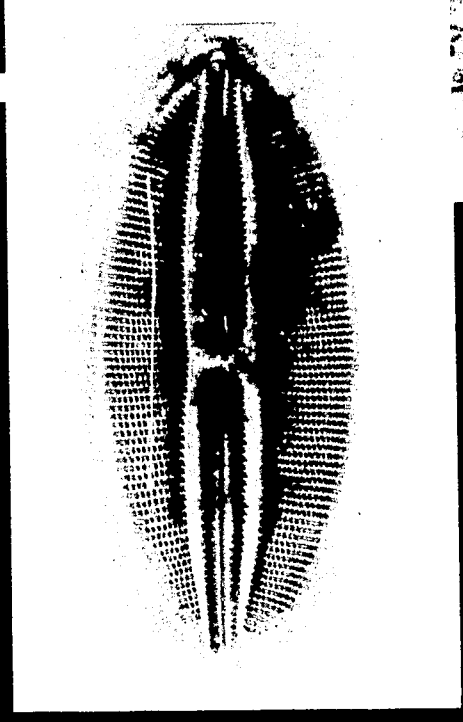

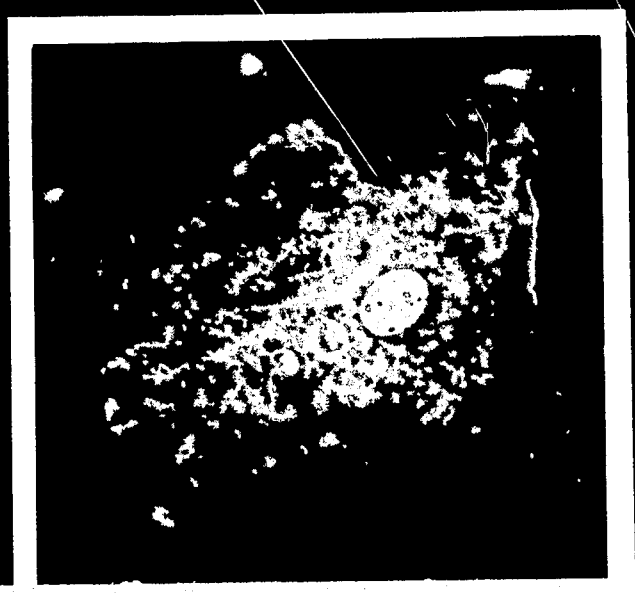

MINNEAPOLIS PUBLIC SCHOOLS
Science Office

A SCIENTIFIC ATTITUDES CHECK LIST

Directions:

All of us have heard about the attitudes of scientists as they go about their work of investigation. In our textbooks we have seen lists of these "Scientific Attitudes" and have had to memorize them to be mentally regurgitated during an examination, but few, if any, of us can put the meaning of these scientific attitudes into common everyday language. What must a person do to give evidence of having acquired or not having acquired these scientific attitudes? The purpose of the tabulation which follows is to help you determine to what extent you have acquired these scientific attitudes.

Read carefully each scientific attitude, as well as the four pieces of evidence in the second column, and choose that evidence which best fits you. Place a check in the right hand column opposite the rating for the evidence which best describes you. Now read the attitudes and check.

The purpose of this rating blank is for your own self-evaluation. After reading and checking as described above, you have some idea of how scientific you are in your attitudes. But let's make it quantitative. For each check opposite each rating that you have given yourself, write in the point values from the following table:

Poor..... 5 points

Fair..... 10 points

Good..... 15 points

Excellent..... 25 points

Now add your points for each scientific attitude and establish your total score.

40 - 60 points.	Don't plan for a career in science!
65 - 105 points.	Your greatest contribution to science will be the washing of flasks, test tubes and animal pens.
110 - 145 points.	You can with great effort perhaps become a member of a staff research team.
150 - 200 points.	You can have a future in scientific research!

A SELF-RATING CHART OF SCIENTIFIC ATTITUDES

Scientific Attitudes	Evidence	Rating	My Score
1. Desire to know	a. Cannot think of one question you would like to have answered.	Poor	
	b. Think of questions you would like to have answered but never try to find the answer.	Fair	
	c. Think of questions to which you would like to know the answer but depend on others to find the answers.	Good	
	d. Make lists of the questions you would like to have answered and then proceed to try to find the answers to them.	Excellent	
2. Willingness to spend time	a. Do not spend any time outside of science class studying science.	Poor	
	b. Do the assignments that are required.	Fair	
	c. Do the required assignments and volunteer for special reports.	Good	
	d. Do the required assignments, volunteer for special reports, and work on an individual project outside of class.	Excellent	

Scientific Attitudes	Evidence	Rating	My Score
3. Willingness to work	a. Do not help with the work to be done during class.	Poor	
	b. Work if you are asked to help.	Fair	
	c. Volunteer to help with some class equipment and demonstrations.	Good	
	d. Take a personal interest and responsibility in the appearance of the classroom. Help to clean up after class experimentation. Help to get equipment ready for class use.	Excellent	
4. Curiosity	a. Do not ask questions.	Poor	
	b. Ask questions if it is required of you.	Fair	
	c. Ask questions about things which you do not understand.	Good	
	d. Ask questions about things which you do understand and ask additional personal interest questions about other things in the field of science.	Excellent	

Scientific Attitudes	Evidence	Rating	My Score
5. Imagination	a. Do not suggest additional interesting learning activities for the class to do.	Poor	
	b. Suggest additional learning activities if you are asked to do so.	Fair	
	c. Suggest and occasionally become a leader in performing additional class learning activities.	Good	
	d. Suggest and lead class in unusual learning activities, good demonstrations and valuable experiments.	Excellent	
6. Openmindedness	a. Believe what you read and what you have been told.	Poor	
	b. Change your mind if enough people present evidence that you are wrong.	Fair	
	c. Question the statements of others and allow others to question your statements.	Good	
	d. Listen carefully to the questions others raise about your statements and then seek to submit evidence as to which idea is right.	Excellent	

Scientific Attitudes	Evidence	Rating	My Score
7. Withholding judgment	a. Accept as truth immediately what you hear and read.	Poor	
	b. Do not accept what you hear and read unless it is supported with evidence.	Fair	
	c. Find several authorities before you accept a statement.	Good	
	d. Seek the ideas of people who disagree with each other and keep both viewpoints in mind.	Excellent	
8. Respect for the ideas of others	a. Try to convince others that you are right.	Poor	
	b. Listen courteously to the ideas of others.	Fair	
	c. Engage in discussion with others who have differing ideas.	Good	
	d. Are challenged to study about the ideas of others so that you understand them better and can discuss these ideas of others from their point of view as well as your own.	Excellent	

Scientific Attitudes	Evidence	Rating	My Score
9. Excitement of discovery	a. Have no interest in the results of a learning experience or experiment except when something blows up or someone has an accident.	Poor	
	b. Like to watch others work out the calculations for an experiment so that you may copy their results in your write-up to be handed in.	Fair	
	c. Enjoy helping manipulate the materials during the experiment and make some of the necessary measurements.	Good	
	d. Know what you are looking for in the experiment and actively take a lead in setting up the apparatus in the most convenient fashion. Check to be sure all readings are accurate and records are made. Begin the necessary calculations as soon as all information is collected. Receive a thrill from finding the answers to your questions during the experiment. Enjoy discussing the experiment with those involved and those not involved in it.	Excellent	

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