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AUTHOR Silver, Barbara A.
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ABSTRACT

This unit of instruction was designed to introduce the student to the relationship between structure and function in the animal kingdom, with emphasis given to: (1) the evolution of physiological systems in the major animal phyla, (2) the complementarity of structure and function, and (3) the concept of homeostasis. The booklet lists the relevant state-adopted texts and states the performance objectives for the unit. It provides an outline of the course content and suggests experiments, demonstrations, and topics for student projects, reports, discussions, and additional activities. Also listed are relevant films, transparencies, and models available from the Dade County Audiovisual Center. Reference books are recommended, and a master sheet is provided relating each suggested activity to the specific performance objectives. (JR)

AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

ANIMAL STRUCTURES AND FUNCTIONS

5314.13

SCIENCE
(Experimental)

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION•1971

ANIMAL STRUCTURES AND FUNCTIONS

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SCIENCE
(Experimental)

Written by Barbara A. Silver
for the
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ANIMAL STRUCTURES AND FUNCTIONS

COURSE DESCRIPTION:

This course is designed to introduce the student to the relationship between structure and function in the animal kingdom. Emphasis is given to (1) the evolution of physiological systems in the major animal phyla, (2) the complementarity of structure and function and (3) the concept of homeostasis.

ENROLLMENT GUIDELINES:

This course is strongly suggested for college bound students and those who desire one credit in biology. There are no pre- or corequisites.

STATE ADOPTED TEXTS:

1. Biological Sciences Curriculum Study. Biological Science-An Inquiry Into Life. 2nd ed., New York: Harcourt, Brace and World, 1968.

2. Biological Sciences Curriculum Study. Biological Science Molecules to Man. 2nd ed., Boston: Houghton Mifflin Company, 1968.

3. Biological Sciences Curriculum Study. High School Biology. 2nd ed., Chicago: Rand McNally & Company, 1968.

*4. Otto, James H. and Towle, Albert. Modern Biology. New York: Holt, Rinehart and Winston, Inc., 1965.

5. Smallwood, William and Green, Edna R. Biology. Morristown: Silver Burdett Company, 1971.

*6. Weinberg, Stanley L. Biology An Inquiry Into The Nature of Life. Boston: Allyn & Bacon, Inc., 1966.

*No longer on state adopted list

PERFORMANCE OBJECTIVES

The student will:

1. List at least five activities associated with the act of "living".

2. Define the term homeostasis.

3. Differentiate between an organism's external and internal environment.

4. Contrast open and closed circulatory systems.

5. Investigate the nature of the circulatory systems in unicellular organisms, hydra, earthworm, frog and man.

6. Defend the statement, "Blood performs many functions in a multicellular organism and is an essential part of any transport system."

7. Trace the evolutionary development of heart structure through the following groups of organisms: invertebrate animals, fishes, amphibians, reptiles, birds and mammals.

8. Describe the flow of blood through the human heart; identifying structures and the condition of the blood.

9. Define the following terms: blood pressure, systole, diastole and pulse.

10. Identify the three major categories of foodstuffs and the form in which these substances may be used by cells.

11. Distinguish between intracellular and extracellular digestion.

12. Explain how enzymes function in digestion.

13. Describe the function of each of the organs of the human alimentary tract.

14. Distinguish between the act of breathing and the process of respiration.

15. Describe the methods of gas exchange in the following organisms: unicellular organisms, earthworms, insects, fishes, amphibians and mammals.

16. Explain how hemoglobin functions in the transport of oxygen.

17. Analyze the problems of maintaining proper water balance in organisms living in marine, fresh water or land environments.

18. Contrast the means by which the following organisms excrete metabolic wastes: unicellular organisms, hydra, planaria, earthworms, insects, fishes and man.

19. Describe the structure and function of a nephron.

20. Predict the consequences of a lack of any nervous system in a multicellular organism.

21. Compare the types of nervous systems in unicellular organisms, hydra, planaria, insects, and vertebrates.

22. Describe the structure and function of a neuron.

23. Explain how a reflex arc functions.

24. Identify the divisions of the human nervous system and their primary functions.

25. Give at least five examples of how a hormone regulates an organism's life activities.

26. Identify the major endocrine glands of man, their secretions and the consequences of normal and abnormal functioning.

27. Contrast exoskeletons and endoskeletons in terms of structure, composition and function.

28. Classify the three types of muscles according to structure and function.

29. Explain the mechanism of muscle contraction.

30. Relate the role of any of the organ systems to the homeostasis of an individual organism.

31. Describe each of the following types of behavior: taxes, reflexes, and instincts.

32. Differentiate between inherited and learned behavior.

33. Relate behavior to the physiology of an animal.

COURSE OUTLINE

I. Introduction

A. Structural adaptations for the functioning animal

B. The concept of homeostasis

II. The Transport of Materials: Circulatory Systems

A. The need for transport
1. External vs. internal environment
2. Types of circulatory systems

B. Components of a circulatory system
1. The transport fluid - blood
a. composition of blood
b. blood groups
2. The heart
a. evolution of heart structure
b. the human heart
c. blood pressure
3. Arteries - capillaries - veins

III. From Food to Fuel: Digestive Systems

A. The types of food substances

B. Process of digestion
1. Intracellular vs. extracellular digestive
2. The role of enzymes

C. Organs of digestion
1. Digestion in invertebrates
2. Vertebrate digestive systems

IV. Fuel Use By Cells: Respiratory Systems

A. Breathing vs. respiration
1. Methods of gas exchange
2. The structure and function of the lung

B. Transport of oxygen and carbon dioxide
1. Transport pigments
2. Cellular use of oxygen

V. Purifying Body Fluids: Excretory Systems

A. Excretion in aquatic organisms

B. Excretion in land organisms
1. Invertebrate land organisms
2. Vertebrate land organisms
3. The human kidney

VI. Response To The Environment: Nervous Systems

A. The nature of a nervous response

B. Nervous systems in lower animals

C. Vertebrate nervous systems
   1. The neuron
   2. Reflex arc
   3. Divisions of the nervous system
   4. Special senses

VII. Chemical Regulation: Endocrine Systems

A. The role of hormones in homeostasis

B. Types of glands and their secretions

VIII. Structural Support and Locomotion: Skeletal and Muscular Systems

A. Skeletal systems
   1. Types of skeletal systems
   2. The nature of bone

B. Muscular systems
   1. Types of muscle
   2. Muscle contraction
   3. The functional relationship between muscle and bone

IX. The Interacting Organism: Behavior

A. Patterns of behavior

B. Biological roots of behavior

EXPERIMENTS

Abramoff, Peter and Thomson, Robert G. Investigations of Cells and Organisms. Englewood Cliffs: Prentice Hall, Inc., 1968.

1. How Can Human Blood Cell Types Be Identified (Ex. 35, p. 109)
2. Structure and Function of the Heart (Ex. 33, p. 102)
3. Physical and Chemical Factors Affecting Heartbeat (Ex. 34, p. 105)
4. How Do Capillaries Function? (Ex. 37, p. 115)
5. How Can the Digestion of Starch Be Measured? (Ex. 24, p. 74)
6. The Effect of pH on the Activity of Salivary Amylase (Ex. 25, p. 76)
7. How Can O_2 Consumption in Respiration Be Measured (Ex. 28, p. 84)
8. How Can CO_2 Production in Respiration Be Determined (Ex. 29, p. 87)
9. The Effect of Temperature on Respiration (Ex. 30, p. 90)
10. The Function of Hemoglobin (Ex. 36, p. 112)
11. Spinal Reflexes in the Frog (Ex. 41, p. 127)
12. How Do Muscles Respond to Stimuli? (Ex. 40, p. 124)

Biological Sciences Curriculum Study. Biological Sciences Molecules to Man. 2nd ed., Boston: Houghton Mifflin Company, 1968. (Blue)

13. Investigating Capillary Circulation (Ex. 18-12, p. 488)
14. Investigating A Mammalian Heart (Ex. S-13, p. 769)
15. Investigating Variations in the Heartbeat Rate of Daphnia (Ex. S-14, p. 770)
16. Investigating Digestion of Fat (Ex. S-15, p. 772)
17. Investigating Digestion (Ex. 20-1, p. 519)
18. Investigating Rates of Oxygen Consumption (Ex. 19-2, p. 502)
19. Investigating CO_2 Production in Man (Ex. 19-9, p. 514)
20. Investigating Excretion in the Earthworm (Ex. 21-4, p. 543)
21. Investigating the Excretory Structures of a Fish (Ex. 21-5, p. 545)
22. Investigating Responses to the Environment (Ex. 23-1, p. 581)
23. Investigating the Eye (ex. 23-3, p. 584)
24. Investigating Chemical Receptors (Ex. 23-7, p. 592)
25. Investigating Hormonal Regulation of Secondary Sex Characteristics (Ex. 22-5, p. 564)
26. Investigating Hormonal Regulation of Tadpole Development (Ex. 22-8, p. 568)
27. Investigating Contraction in Smooth & Cardiac Muscle (Ex. 24-10, p. 617)
28. Investigating Fatigue in a Skeletal Muscle (Ex. 24-13, p. 620)
29. Investigating the Effect of ATP on Contractile Proteins (Ex. 8-17, p. 774)
30. Investigating the Behavior of One-Celled Organism (Ex. 25-4, p. 633)
31. Investigating Snail Behavior (Ex. 25-7, p. 641)
32. Investigating Human Responses to Stimuli (Ex. 25-9, p. 641)

Biological Sciences Curriculum Study. High School Biology. 2nd ed., Chicago: Rand McNally and Company, 1968. (Green)

33. Human Blood Groups (Ex. 19.3, p. 735)
34. A Heart At Work (Ex. 14.3, p. 502)
35. The Action of a Digestive Enzyme (Ex. 14.2, p. 490)
36. Chemoreceptors in Man (Ex. 14.4, p. 527)

37. Skeletal Basis of Upright Posture (Ex. 19.1, p. 722)
38. Animal Structure and Function (Ex. 14.1, p. 477)

Biological Sciences Curriculum Study. Student Laboratory Guide Biological Science An Inquiry Into Life. 2nd ed., New York: Harcourt, Brace and World, Inc., 1968. (Yellow)

39. Structure and Function in Paramecium (Ex. 18-2, p. 128)
40. A Living Invertebrate Heart (Ex. 21-1, p. 152)
41. Capillary Circulation (Ex. 21-2, p. 155)
42. Ingestion and Digestion in Paramecium (Ex. 18-4, p. 131)
43. Protein Digestion (Ex. 20-1, p. 150)
44. Regulation of Your Breathing Rate (Ex. 22-1, p. 157)
45. Contractile Vacuoles in Paramecium (Ex. 18-5, p. 133)
46. Water Balance (Ex. 23-1, p. 159)
47. Sense Reception and the Nervous System (Ex. 24-1, p. 160)
48. Control of Muscle Contraction (Ex. 25-1, p. 162)
49. Looking Inside a Contracting Muscle (Ex. 25-2, p. 164)

Otto, J. H., Towle, A., and Crider, E. H. Biology Investigations. New York: Holt, Rinehart and Winston, Inc., 1965.

50. The Blood and Circulation (Ex. 42-1, p. 305)
51. Clinical Properties of Blood (Ex. 42-2, p. 309)
52. The Heart (Ex. 42-3, p. 313)
53. Chemistry of Digestion (Ex. 41-1, p. 301)
54. Effect of Temperature on Goldfish Respiration Rate (Ex. 34-3, p. 275)
55. Reflex Actions (Ex. 44-1, p. 317)
56. Sensory Receptors (Ex. 44-2, p. 319)
57. Hearing and Equilibrium (Ex. 44-3, p. 321)
58. The Eye and Vision (Ex. 44-4, p. 323)
59. Effect of Drugs and Hormones on Amphibian Metamorphosis (Ex. 35-3, p. 285)
60. Study of Bone (Ex. 40-1, p. 293)
61. Study of Muscle Contraction (Ex. 40-2, p. 297)
62. The Earthworm - A Representative Annelid (Ex. 28-3, p. 251)
63. The Grasshopper (Ex. 31-1, p. 267)
64. Study of a Bony Fish (Ex. 34-1, p. 269)
65. Dissection of the Fish (Ex. 34-2, p. 273)
66. External Structure of the Frog (Ex. 35-1, p. 277)
67. Dissection of the Frog (Ex. 35-2, p. 281)

DEMONSTRATIONS

Note: Any of the experiments previously listed may lend themselves to a demonstration if a shortage of materials precludes total student participation.

1. Observation of heart beat in invertebrate organisms: clam, embryo snails, Daphnia and aquatic worms. (Ref. #19, pp. 70-71)
2. Model for valve function in circulatory system. (Ref. #19, p. 74)
3. Hemoglobin content of blood. (Ref. #19, p. 77)
4. Coagulation time. (Ref. #19, p. 78)
5. Blood pressure measurements. (Ref. #16, pp. 117-120)
6. Blood flow in capillaries and veins. (Ref. #16, pp. 120-126)
7. Demonstrate tests for various foodstuffs. (Ref. #16, pp. 146-150)
8. Comparison of exhaled and inhaled air. (Ref. #19, p. 85)
9. Respiration in small aquatic animals. (Ref. #19, p. 87)
10. Bell jar demonstration of breathing mechanism. (Ref. #19, p. 88)
11. Effect of excess CO_2 on rate of breathing. (Ref. #19, p. 89)
12. Study of mammalian lungs. (Ref. #19, p. 90)
13. Structure of a mammalian kidney. (Ref. #20, p. 63)
14. Some human reflexes. (Ref. #20, p. 23)
15. Reaction time and discrimination. (Ref. #20, p. 24)
16. After images. (Ref. #20, p. 28)
17. Action of insulin on the rat. (Ref. #20, p. 68)

PROJECTS

1. Maintain cultures of microorganisms or small aquatic animals for use in laboratory work.

2. Develop displays revolving around one life function as performed by various animals.

3. Construct simple models of such organs as: heart, alimentary tract, gills, lungs, kidneys, brain, eye, ear, and nose.

4. Construct working models of such things as the arm -- muscle and bone operating together.

5. Bulletin board displays on how individual organisms carry on their life functions.

6. Dissect additional animals in order to investigate further the relationship of structure and function.

7. Carry on long term studies in animal behavior comparing or demonstrating behavioral patterns such as conditioning and learning.

REPORTS

1. Biographical reports on the following scientist who have made notable contributions in the area of animal physiology:

a. William Harvey	j. W. M. Bayliss
b. Marcello Malpighi	k. Antoine Lavoisier
c. Ernest Starling	l. Otto Loewi
d. Claude Bernard	m. C. S. Sherrington
e. William Beaumont	n. F. C. Banting
f. J. J. R. Macleod	o. C. H. Best
g. Emil Kocher	p. David Marine
h. Konrad Lorenz	q. Ivan Pavlov
i. H. E. Huxley	r. Albert Szent-Gyorgi

2. Research reports investigating specific experiments performed by any of the above scientists.

3. Analogous and/or homologous structures in the animal kingdom.

4. Select one animal structure or organ and trace its evolution through the animal kingdom.

5. Show how the malfunctioning of a single organ or organ system affects the overall homeostasis of the organism.

6. Relate the concept of homeostasis in a single organism to the concept of homeostasis in a population, society, community or ecosystem.

RELATED PROBLEMS

1. How does an increase in size affect any physiological system?

2. How can physical laws be related to the operation of a biological system?

3. What roles does electricity play in a biological system?

4. How can radioactive materials be used in animal physiology studies?

5. How can the concept of homeostasis be illustrated in non-biological terms?

FILMS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

1. Nine Basic Functional Systems of the Human Body
   AV#1-05535, 11' BW

2. Circulation
   AV#1-12977, 16' C

3. Circulation (AIBS)
   AV#1-30424, 28' C, BW

4. Circulation of the Blood
   AV#1-03102, 9' C

5. Circulation: Why and How
   AV#1-03089, 10' C

6. Heart and Circulation
   AV#1-03093, 10' BW

7. Heart Disease (Its Major Causes)
   AV#1-03421, 11' BW

8. Heart, The: How it Works
   AV#1-03097, 12' BW

9. Hemo the Magnificent (Part 1)
   AV#1-40027, 35' C

10. Hemo the Magnificent (Part 2)
    AV#1-40032, 35' C

11. Human Body, The: Circulatory System
    AV#1-11226, 14' C

12. Our Wonderful Body: The Heart and its Work
    AV#1-05761, 11' C

13. Phagocytes: The Body's Defenders
AV#1-03103, 10' C

14. Story of the Bloodstream (Heart and Circulatory System)
AV#1-30714, 29' C

15. Story of the Bloodstream (The Red Blood Cell)
AV#1-30715, 24' C

16. Work of the Blood
AV#1-11231, 13' C

17. Alimentary Tract
AV#1-03113, 11' BW

18. Digestion: Chemical
AV#1-11235, 18' BW

19. Digestion of Foods
AV#1-03115, 10' BW

20. Foods and Nutrition
AV#1-03128, 11' BW

21. Human Body: Chemistry of Digestion
AV#1-13800, 16' C

22. Human Body: The Digestive System
AV#1-11240, 13' C

23. Human Body: Nutrition and Metabolism
AV#1-11244, 14' C

24. Ingestion and Digestion (AIBS)
AV#1-30439, 28' C, BW

25. Cell Respiration (AIBS)
AV#1-30499, 30' C, BW

26. Human Body, The: Respiratory System
AV#1-11211, 13' C

27. Mechanisms of Breathing
AV#1-03109, 11' BW

28. Nose, The (Structure and Function)
AV#1-03112, 11' BW

29. Our Wonderful Body: How We Breathe
AV#1-05760, 11' C

30. Respiration (AIBS)
AV#1-30434, 28' C, BW

31. Excretion (AIBS)
AV#1-30444, 28' C, BW

32. Human Body, The: Excretory System
AV#1-11214, 13' C

33. Kidneys, Ureters and Bladder
AV#1-03052, 11' BW

34. Work of the Kidneys
AV#1-03449, 11' BW

35. Ears and Hearing
AV#1-03067, 10' BW

36. Exploring the Human Nervous System
AV#1-30720, 23' C

37. Fundamentals of the Nervous System
AV#1-11276, 16' C

38. Gateways to the Mind (Part 1)
AV#1-30718, 30' C

39. Gateways to the Mind (Part 2)
AV#1-30719, 30' C

40. How the Ear Functions
AV#1-03076, 11' BW

41. How the Eye Functions
AV#1-03148, 11' BW

42. Human Body, The: Nervous System
AV#1-11277, 14' C

43. Human Body, The: The Brain
AV#1-13808, 16' C

44. Human Brain, The
AV#1-03060, 11' BW

45. Nervous System
AV#1-03152, 11' BW

46. Nervous System, The (AIBS)
AV#1-30681, 28' C, BW

47. Our Senses: What They Do For Us
AV#1-03158, 11' C

48. Miracle of Vision
AV#1-13730, 16' C

49. Senses, The (AIBS)
AV#1-30413, 28' C

50. Senses of Man, The
AV#1-13713, 18' C

51. Endocrine Glands
AV#1-03441, 11' BW

52. Endocrine Glands: How They Affect You
AV#1-11367, 15' BW

53. Hormones (AIBS)
AV#1-30479, 28' C, BW

54. Principles of Endocrine Activity
AV#1-11213, 16' C

55. Human Body, The: Skeleton
AV#1-03050, 10' BW

56. Muscles (AIBS)
AV#1-30677, 28' C, BW

57. Human Body, The: Muscular System
AV#1-11273, 14' BW

58. Our Wonderful Body: How it Moves
AV#1-05758, 11' C

59. Behavior (AIBS)
AV#1-30692, 28' C, BW

60. Behavior in Animals and Plants
AV#1-02415, 11' C

61. Life Science: Response in a Simple Animal
AV#1-02732, 11' C

62. Amoeba, The
AV#1-02717, 10' BW

63. Earthworms
AV#1-02735, 10' BW

64. Earthworms
AV#1-02734, 10' C

65. Frog Anatomy
AV#1-11182, 17' C

66. Frog, The
AV#1-02845, 10' BW

TRANSPARENCIES AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

1.	Anatomy: Circulatory System	AV#2-30034
2.	Circulatory System: Heart-Pumping Cycle	AV#2-00207
3.	Circulatory System - Man (No. 1)	AV#2-00062
4.	Circulatory System - Man (No. 2)	AV#2-00070
5.	Human Circulatory System	AV#2-00029
6.	Structure of the Human Heart	AV#2-00171
7.	Structure of the Human Heart	AV#2-00046
8.	Digestive System - Man (No. 1)	AV#2-00060
9.	Digestive System - Man (No. 2)	AV#2-00072
10.	Human Digestive System	AV#2-00042
11.	Human Mouth and Nasal Cavities	AV#2-00035
12.	Human Teeth	AV#2-00040
13.	Structure of a Tooth	AV#2-00146
14.	Respiratory System	AV#2-00155
15.	Respiratory System - Man	AV#2-00061
16.	Excretory System - Man	AV#2-00064
17.	Nervous System - Man	AV#2-00065
18.	Skeletal and Nervous System - Man	AV#2-00068
19.	Structure of the Eye (No. 1)	AV#2-00123
20.	Structure of the Eye (No. 2)	AV#2-00124
21.	Structure of the Human Eye	AV#2-00049
22.	Eye	AV#2-00089
23.	Structure of the Human Ear	AV#2-00169
24.	Structure of the Human Ear	AV#2-00052
25.	The Endocrine Glands	AV#2-00045
26.	Endocrine Glands - Man	AV#2-00063
27.	Anatomy: Muscles, Skeleton	AV#2-30031
28.	Human Muscular System	AV#2-00038
29.	Human Skeleton	AV#2-00055
30.	Muscles - Man	AV#2-00059
31.	Muscular System - Man	AV#2-00069
32.	Skeletal System - Man	AV#2-00058
33.	Skeletons of Man and Frog	AV#2-00032
34.	Front Body Wall Removed - Man	AV#2-00071
35.	Frog Anatomy	AV#2-00020

MODELS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

1.	Heart model with holder	AV#6-00175
2.	Human heart model	AV#6-00071
3.	Human heart model	AV#6-00135
4.	Human heart model	AV#6-00009
5.	Human kidney model	AV#6-00074
6.	Human brain (4 p.)	AV#6-00074
7.	Human brain and cranial cavity model	AV#6-00137
8.	Human brain (2 p.)	AV#6-00070
9.	Ear model	AV#6-00130
10.	Human ear: external, middle, inner	AV#6-00058
11.	Human ear model	AV#6-00073
12.	Human eye model	AV#6-00007
13.	Human eyeball model	AV#6-00059
14.	Human eyeball model	AV#6-00132
15.	Human head model: sagittal section	AV#6-00072
16.	Human skeleton model	AV#6-00049
17.	Human skeleton model	AV#6-00134
18.	Human skeleton model	AV#6-00068
19.	Human torso: miniature model	AV#6-00069
20.	Human torso model with head	AV#6-00047

SUGGESTED DISCUSSION QUESTIONS

1. Why is a transport system more important for a land animal than an aquatic animal?

2. How do the structures of arteries and veins fit with their respective functions?

3. How does the lymphatic system complement the vascular system?

4. How does oxygen consumption vary with organism size, weight, activity and habitat?

5. What affect does high altitude have on blood physiology, gas transport and breathing?

6. What factors control the secretions of digestive juices?

7. What is the evolutionary significance of extracellular digestion?

8. How does nephron structure vary among freshwater fish, saltwater fish and land animals?

9. Why are kidneys important to homeostasis?

10. What events occur in the passage of a nerve impulse?

11. What evidence is there to support the claim that the pituitary gland is the "master gland"?

12. How do glands exercise self-regulatory control?

13. What relationship exists between the size of an organism and the presence or absence of a skeleton?

14. How is muscle activity related to biochemical activity?

15. How is behavior involved in the evolution of organisms?

ADDITIONAL ACTIVITIES

1. Use Micro-Slide-Viewers, Microslides and Texts numbers: 21, 52, 67, 68, 69, 70, 71, 72, 73, and 76. Materials available from: National Teaching Aids, Inc., 120 Fulton Ave., Garden City Park, N. Y. 11040.

2. Use the following Life Reprint Articles as either introductory activities, enrichment activities or summation activities:

World Within	#88
Food to Fuel	#34
Circuits of Senses	#35
Chemical Balance	#57
Marvel of Motion	#58
Control of the Brain	#30
What Will the New Man Be Like?	#32

3. Use the heart model produced by Merck Sharp & Dohme. Models come with explanatory booklet and ditto master. Models are inexpensive and are most effective when each student has an individual model and diagram while listening to a tape recording of instructions and explanations.

REFERENCES

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2. Asimov, Isaac. The Human Brain. Boston: Houghton Mifflin Company, 1964.*

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9. Gordon, Albert S. Blood Cell Physiology (B. S. C. S. Pamphlet #8). Boston: D. C. Heath and Company, 1963.*

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MASTER SHEET - ANIMAL STRUCTURES AND FUNCTIONS

Objective #	Laboratory Investigations	Student Text References	Supplementary References	Films	Film Loops	Demonstrations	Models	Transparencies	Discussions	Additional Activities
1		#1 Ch. 3 #3 Ch. 14 #4 Ch. 2 #6 Ch. 1	10,24,25,26	1						2
2		#1 Ch. 18 #2 Ch. 18, #3 Ch. 1 14,22 #4 Ch. 5 #5 Ch. 19 #6 Ch. 13								
3 4 5	4,13,15,39,40, 62,63,64,65, 66,67	#1 Ch. 21 #2 Ch. 18 #3 Ch. 14 #4 Ch. 27-38, 42 #5 Ch. 16 #6 Ch. 12	1,3,7,10,23, 24,25,26	2,3,5, 62,63, 64,65,66		1			1	1
6	1,33,50,51	#1 Ch. 21 #2 Ch. 18 #3 Ch. 14 #4 Ch. 42 #5 Ch. 16 #6 Ch. 12	9,11,16,20,21, 27	2,3,4,9, 10,13, 15,16		3,4			3	
7	3,14,15,38,40, 62,63,64,65,66, 67	#1 Ch. 21 #2 Ch. 18 #3 Ch. 14 #4 Ch. 27-38,42 #5 Ch. 16 #6 Ch. 13	7,10,23,24,25, 26	3,6,7,8, 63,64, 65,66		1	1,2,3, 4	6		
8 9	2,3,4,13,14,15, 34,40,41,52	#1 Ch. 21 #2 Ch. 18 #3 Ch. 14 #4 Ch. 42 #5 Ch. 16 #6 Ch. 13	1,3,10,11,12, 16,18,20,21,24, 25,26	3,4,5,6, 7,8,11, 12,14		2,5,6	1-4	1-7		3
10 11	5,16,42,43,53	#1 Ch. 20 #2 Ch. 20 #3 Ch. 14 #4 Ch. 41 #5 Ch. 15 #6 Ch. 11	16,20,21,24,25, 26	18,19, 20,23,24		7			7	2
12	5,6,16,17,35, 43,53	#1 Ch. 20 #2 Ch. 20 #3 Ch. 14 #4 Ch. 41 #5 Ch. 15 #6 Ch. 11	17,20,21,24, 25,26	17,18, 19,21 23,24					6,7	2
13	6,16,17	#1 Ch. 20 #2 Ch. 20 #3 Ch. 14 #4 Ch. 41 #5 Ch. 15 #6 Ch. 11	1,3,4,7,10,11, 12,16,18,20, 21,24,25,26	17,22,24				8-13	6,7	2
14	44	#1 Ch. 22 #2 Ch. 19 #3 Ch. 14 #4 Ch. 43 #5 Ch. 18 #6 Ch. 13	1,3,10,11,12, 16,18,20,21, 24,25,26	26,27, 28,29,30		8,9,10, 11		14,15	5	
15	62,63,64,65, 66,67	#1 Ch. 22 #2 Ch. 19 #3 Ch. 14 #4 Ch. 27-38 #5 Ch. 18 #6 Ch. 13	7,10,23,24, 25,26	26,27,28, 29,30		9,12		14,15		1
16	7,8,9,10,18, 19,44,54	#1 Ch. 22 #2 Ch. 19 #3 Ch. 14 #4 Ch. 43 #5 Ch. 18 #6 Ch. 13	7,10,23,24, 25,26	25,26,30		3,8,11			4,5	

MASTER SHEET - ANIMAL STRUCTURES AND FUNCTIONS - continued

Objective #	Laboratory Investigations	Student Text References	Supplementary References	Films	Film Loops	Demonstrations	Models	Transparencies	Discussions	Additional Activities
17 18	20,21,45,46	#1 Ch. 23 #2 Ch. 21 #3 Ch. 14 #4 Ch. 27-38, 42 #5 Ch. 19 #6 Ch. 13	7,10,14,22,23, 24,25,26	31,32, 33,34		13	5	16	8	1
19		#1 Ch. 23 #2 Ch. 21 #3 Ch. 14 #4 Ch. 42 #5 Ch. 19 #6 Ch. 13	1,3,7,10,11, 12,16,20,21,24, 25,26	31,32 33,34		13	5	16	9	1
20 21	22,47,56,62,63, 64,65,66,67	#1 Ch. 24 #2 Ch. 23 #3 Ch. 14 #4 Ch. 27-38, 44 #5 Ch. 21, 26 #6 Ch. 15	7,8,10,23,24, 25,26	36,37, 42,43, 44,45, 46,47, 49,50			6,7,8	17,18		1,2
22 23	11,47,55	#1 Ch. 24 #2 Ch. 23 #3 Ch 14 #4 Ch 44 #5 Ch. 21, 26 #6 Ch. 15	7,8,10,23,24, 25,26	36,37, 42,45, 46		14,15			10	2
24	23,24,36,47,56, 57,58	#1 Ch. 24 #2 Ch. 23 #3 Ch. 14 #4 Ch. 44 #5 Ch. 21, 26 #6 Ch. 15	1,2,3,8,10,11, 12,16,18,20,21, 24,25,26	36,37, 38,39, 40,41, 42,43, 44,45, 46,47, 48,49, 50		14,15, 16	6,7,8, 9,10, 11,12, 13,14	17,18, 19,20, 21,22, 23,24		2
25	25,26,59	#1 Ch. 24 #2 Ch. 22 #3 Ch. 14 #4 Ch. 46 #5 Ch. 20 #6 Ch. 14	1,3,10,11,12, 14,18,20,21, 22,24,25,26	51,52, 53,54		17		25,26	11,12	1,2
26	25,26,59	#1 Ch. 24 #2 Ch. 22 #3 Ch. 14 #4 Ch. 46 #5 Ch. 20 #6 Ch. 14	1,3,10,11,12, 14,18,20,21, 22,24,25,26	51,52, 53,54		17		25,26	11,12	1,2
27	37,60,63,64, 65,67	#1 Ch. 25 #2 Ch. 24 #3 Ch. 14 #4 Ch. 27-38,40 #5 Ch. 18	1,3,6,7,10, 15,25,26	55, 58			16,17, 18	27,29, 32,33	13	2
28 29	12,27,28,29, 48,49,61	#1 Ch. 25 #2 Ch. 24 #3 Ch. 14 #4 Ch. 40 #5 Ch. 18	1,3,6,7,8, 10,15,25,26	56,57, 58				27,28, 30,31	14	1,2
30	All previous activities apply									
31 32 33	30,31,32	#1 Ch. 35 #2 Ch. 25 #3 Ch. 15 #4 Ch. 33 #5 Ch. 28 #6 Ch 16	5	59,60, 61						15