Lesson 9

BIOLOGY E/M SUBJECT TEST

The Biology E/M Subject Test consists of 80 multiple-choice questions. In terms of the overall level of difficulty, the test is intended for students who have had a one-year introductory course in biology of the sort that is included in a college preparatory curriculum. Although there are two versions of the Biology Subject Test (E for ecology and M for molecular), your biology course probably prepared you adequately to take either version. Most of the questions are similar on the two versions with only about 20 questions making up the difference. If your course work emphasized topics such as DNA, then you might feel more comfortable with the M version; if your course work focused on topics such as biomes and populations, then you might feel more comfortable with the E version. Also, any additional work that you've done, such as an independent report or field research, might be a basis for choosing one version over the other.

The test presented in this book will give you questions that would be appropriate to both versions. And to make sure that you've had adequate practice, we've used 95 questions instead of just 80—though even 80 questions is a lot to answer in an hour. Still, the number of questions asked is not great when compared with the amount of information that is conveyed in a full-year course in biology. For this reason, everything you learned in biology cannot be the basis for a test question. Therefore, you may encounter some questions that test areas not emphasized in your course.

The following table summarizes the topics tested and the approximate number of questions for each:

Topics Tested	Approximate Percentage of Test
Cellular and Molecular Biology	12
Ecology	12
Classical Genetics	10
Organismal Biology	30
Evolution and Diversity	11
Ecology/Evolution Section (Biology–E Test) or Molecular/Evolution Section (Biology–M Test)	25

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The following are samples of the types of questions you will encounter on your exam:

EXAMPLE:

Ribosomes' function in a cell is controlled by the

(A) endoplasmic reticulum
(B) mitochondria
(C) golgi bodies
(D) ribosomal RNA
(E) gamete

The correct answer is (D). The RNA is the immediate determinant of the characteristic function of an organism.

EXAMPLE:

Which of the following are secretions of the pituitary gland?

I. Somatotropic hormone
II. Pitocin
III. Adrenalin

(A) I only
(B) II only
(C) I and II only
(D) I and III only
(E) I, II, and III

The correct answer is (C). Adrenalin is secreted by the adrenal cortex.

EXAMPLE:

The nutrients that supply an animal with its main source of energy are

(A) proteins
(B) carbohydrates
(C) lipids
(D) nucleic acids
(E) peptides

The correct answer is (B). Carbohydrates are the main source of energy for animals.

EXAMPLE:

How might echolocation enable insect-eating bats to avoid competing with birds for food?

(A) The bats can cover a greater territory than birds can.
(B) The bats can find more insects than birds can.
(C) The bats can fly faster than birds can.
(D) The bats can hunt at night while the birds are asleep.
(E) The bats roost in areas usually avoided by birds.

The correct answer is (D). Echolocation allows the bats to hunt insects at night while birds are asleep. None of the other choices relate to echolocation.

EXAMPLE:

A biologist viewing a cell under a microscope could tell that the cell was from a plant rather than an animal if the cell had

(A) a cell membrane and a nucleus
(B) a cell wall and chloroplasts
(C) a contractile vacuole and mitochondria
(D) a cell membrane and cilia
(E) a nucleus and cilia

The correct answer is (B). Only plant cells have a cell wall and chloroplasts.

EXAMPLE:

A leaf from a green-and-white variegated colleus that was placed in the sun for several hours was treated in the following manner: 1) placed in hot alcohol until colorless, 2) placed in a clean Petri dish and flooded with Lugol's iodine, 3) washed in distilled water, and 4) spread out on clean white paper. The same procedure was followed with the leaf from a green-and-white variegated plant that was stored without light for 12 hours. The following chart shows the results:

Treatment	**White Area of Leaf**		**Green Area of Leaf**	
	without light	with light	without light	with light
alcohol	white	white	white	white
Lugol's	brown	brown	brown	blue-black
water	no change	no change	no change	no change

EXAMPLE:

Which of the following statements best explains the observed results of the experiments?

(A) In green plants, light plus the green pigment chlorophyll results in the presence of starch.
(B) Plants must have chlorophyll in order to synthesize organic nutrients.
(C) Plants cannot grow without light.
(D) The green chlorophyll molecule uses light energy to split one molecule of water.
(E) In green plants, light plus starch produces water.

The correct answer is (A). During photosynthesis, glucose sugar is produced from carbon dioxide and water. Some of the sugar may be stored as starch, the presence of which can be tested. This experiment tests the effects of both the presence and absence of light and the presence and absence of chlorophyll. Only choice (A) relates to all of these factors.

BIOLOGY E/M SUBJECT TEST ANSWER SHEET

1	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	49	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
2	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	50	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
3	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	51	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
4	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	52	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
5	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	53	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
6	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	54	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
7	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	55	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
8	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	56	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
9	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	57	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
10	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	58	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
11	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	59	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
12	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	60	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
13	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	61	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
14	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	62	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
15	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	63	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
16	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	64	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
17	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	65	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
18	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	66	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
19	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	67	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
20	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	68	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
21	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	69	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
22	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	70	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
23	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	71	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
24	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	72	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
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26	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	74	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
27	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	75	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
28	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	76	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
29	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	77	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
30	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	78	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
31	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	79	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
32	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	80	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
33	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	81	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
34	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	82	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
35	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	83	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
36	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	84	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
37	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	85	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
38	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	86	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
39	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	87	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
40	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	88	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
41	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	89	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
42	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	90	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
43	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	91	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
44	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	92	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
45	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	93	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
46	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	94	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
47	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	95	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ
48	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ						

BIOLOGY E/M SUBJECT TEST

Part A

Directions: Each of the following questions or incomplete statements is followed by five possible answers or completions. Select the one choice that is best in each case and darken the corresponding circle on the answer sheet.

1. In the normal human circulatory system, the mean blood pressure is lowest in the

(A) aorta
(B) arteries
(C) arterioles
(D) capillaries
(E) inferior vena cava

2. Structural components common to plant cell walls but not part of bacterial cell walls include which of the following?

I. Peptidoglycan
II. Cellulose
III. Lignin

(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

3. In the bird egg, which of the following functions as a reservoir for wastes produced during development?

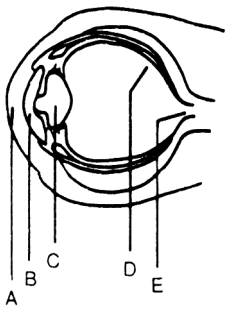
(A) Allantois
(B) Amnion
(C) Chorion
(D) Yolk sac
(E) Placenta

4. Food chains end with

(A) producers
(B) autotrophs
(C) decomposers
(D) primary consumers
(E) tertiary consumers

5. What would be the sequence of bases for the two anticodons that correspond to the codon base sequence of 5′–UGC–GGA–3′?

(A) 5′–TCC–GCA–3′
(B) TCG–CCT
(C) 5′–UCC–GCA–3′
(D) TGG–CCU
(E) ACC–GGU



6. In the diagram above, which part of the eye causes the blind spot?

(A) A
(B) B
(C) C
(D) D
(E) E

7. Which of the following occurs during anaphase I of meiosis?

(A) Formation of tetrads
(B) Separation of homologous chromosomes
(C) Crossing over
(D) Separation of sister chromatids, with one chromatid pulled toward each pole
(E) Assembly of chromosomes along the equatorial plane

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8. The wings of sparrows and flies are said to represent

(A) homologous structures
(B) analogous structures
(C) vestigial structures
(D) mutualism
(E) mimicry

9. Oxygen transport from the water to the bloodstream in the gills of fish occurs by diffusion. However, the efficiency of oxygen extraction by the blood is higher than would be predicted. This is because

(A) water flow and blood flow are parallel
(B) diffusion of oxygen is much greater in water than in air
(C) oxygen has a very high solubility in water
(D) blood flows opposite to the direction of water movement
(E) multiple layers of cells separate the bloodstream from the water

10. Which of the following participates in the glycosylation of proteins?

I. Endoplasmic reticulum
II. Histones
III. Golgi apparatus

(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

11. Each of the following statements about cellular bioenergetics is true EXCEPT

(A) fermentation may yield lactic acid
(B) fermentation may yield ethyl alcohol
(C) glycolysis occurs within the mitochondria
(D) oxidative phosphorylation (electron transport chain) occurs within the mitochondria
(E) the Krebs cycle occurs within the mitochondria

12. Each of the following is a characteristic of imprinting EXCEPT

(A) it is a conditioned response
(B) it is a learned behavior
(C) it typically occurs very early in an animal's life
(D) it occurs only during the critical, or sensitive, phase
(E) once imprinting occurs, the young animal cannot be imprinted on another animal or object

13. Stimulation of the parasympathetic nervous system causes each of the following EXCEPT

(A) release of bile
(B) acceleration of the heart rate
(C) constriction of bronchi
(D) pupillary constriction
(E) increased peristalsis in the gastrointestinal tract

14. The euglena possesses an organelle that synthesizes a polysaccharide for storage. This organelle is the

(A) stigma
(B) pyrenoid
(C) eyespot
(D) cytopharynx
(E) oral groove

15. The structure of a flowering plant that produces pollen is which of the following?

(A) Stigma
(B) Style
(C) Filament
(D) Anther
(E) Sepal

16. Severe vitamin K deficiency may cause

(A) scurvy
(B) pernicious anemia
(C) pellagra
(D) bleeding
(E) rickets

17. Which of the following best describes the sapwood of a woody dicot?
(A) Cork cambium
(B) Peripheral, more recent rings of xylem
(C) Central area of pith
(D) Area filled with pigments, gums, and resins
(E) Inner, older rings of xylem

18. Impulses carried from the central nervous system to the effector organs are conducted via the
(A) Schwann cells
(B) dendrites
(C) axon
(D) cerebrospinal fluid
(E) myelin sheath

19. The biome dominated by conifers, such as spruces and firs, is the
(A) chaparral
(B) deciduous forest
(C) tropical rain forest
(D) tundra
(E) taiga

20. Inheritance of color in a certain plant is known to follow simple Mendelian rules. Green leaf color is dominant and yellow leaf color is recessive to green. If a homozygous green-leafed plant is mated with a homozygous yellow-leafed plant, what proportion of offspring (F_1 generation) would be expected to possess yellow leaves?
(A) 0%
(B) 25%
(C) 50%
(D) 75%
(E) 100%

21. Archaeopteryx is important to the study of evolution because
(A) it is believed to represent the evolutionary link between the kingdom Plantae and the kingdom Fungi
(B) it is believed to represent the evolutionary link between the class Reptilia and the class Aves
(C) it is believed to represent the evolutionary link between the sponges and the molluscs
(D) it represents the last known evidence of the dinosaurs
(E) it represents the first known terrestrial animal

22. Enzymes accomplish each of the following EXCEPT
(A) increase the rate of the forward reaction
(B) increase the rate of the reverse reaction
(C) decrease the activation energy of the reaction
(D) increase the activation energy of the reaction
(E) allow reactions to occur more readily

23. High energy molecules involved in the dark reactions of photosynthesis include which of the following?
I. ATP
II. NADH
III. NADPH
(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

24. The "all-or-none response" refers to which of the following?
(A) Flocking defense scheme utilized by various birds
(B) Nondisjunction
(C) Fitness of an animal
(D) Expressivity of a phenotype
(E) Transmission of neural impulses

25. Bile, a complex fluid that assists in the digestion of fatty substances, is produced by the
(A) gallbladder
(B) small intestine
(C) pancreas
(D) stomach
(E) liver

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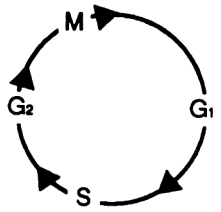
26. A dominant gene that shows X-linked inheritance is being studied by a biologist. If an affected male is mated with an unaffected female, which of the following most likely represents an accurate description of their immediate offspring?

(A) 100% affected males, 0% affected females
(B) 0% affected males, 100% affected females
(C) 50% affected males, 25% affected females, 100% carrier females
(D) 50% affected males, 50% affected females, 100% carrier females
(E) 25% affected males, 25% affected females, 25% carrier females

27. The diagram below depicts the cell cycle for an asynchronously growing cell population (cells at each stage are present at any given time). If the cell population is briefly exposed to $_3$H-thymidine, cells at which phase would immediately demonstrate incorporation of the radiolabeled thymidine?



(A) M
(B) G_1
(C) S
(D) G_2
(E) S and M

28. Energy dependent processes for cellular transport include each of the following EXCEPT

(A) cytoplasmic streaming in algae
(B) Na^+– K^+ ATPase
(C) osmosis
(D) axonal transport
(E) active transport

29. Which of the following is not a direct function of the vertebrate liver?

(A) Synthesis of plasma proteins
(B) Carbohydrate metabolism
(C) Deamination
(D) Reabsorption of water
(E) Detoxification

30. Which of the following pairs of organisms are the least related?

(A) Squid – Octopus
(B) Crayfish – Shrimp
(C) Shark – Ray
(D) Sea lily – Iris
(E) Lemur – Monkey

31. Which of the following would be expected to have the most stable ecosystem?

(A) Ocean floor beneath Antartic polar ice
(B) Pacific shore along California
(C) Subtropical forests of Africa
(D) Coniferous forest of North America
(E) Grasslands of Southwestern United States

32. Sperm stored in the epididymis flow into what immediate structure during copulation?

(A) Ureter
(B) Urethra
(C) Seminal vesicle
(D) Vas deferens
(E) Prostate

33. Carolus Linnaeus classified organisms according to their

(A) evolutionary trends
(B) morphologic similarities
(C) ability to mate
(D) ability to produce viable offspring
(E) ecological interrelationships

34. Which of the following represents the most likely succession of man?

(A) Homo erectus Australopithecus → Homo habilis → Homo sapiens
(B) Australopithecus Homo erectus → Homo habilis →Homo sapiens
(C) Homo sapiens → Australopithecus → Homo erectus → Homo habilis
(D) Australopithecus → Homo habilis → Homo erectus → Homo sapiens
(E) Homo habilis → Homo erectus → Australopithecus → Homo sapiens

35. Hemoglobin is a protein that functions in the transport of oxygen contained within red blood cells. Hemoglobin has been shown to consist of four independent polypeptide chains. The manner in which these four chains interact to form functional molecules is a characteristic of hemoglobin's

(A) secondary structure
(B) tertiary structure
(C) quaternary structure
(D) denaturation
(E) melting point

36. In humans, which of the following allow efficient absorption of digested foodstuffs to occur?

I. Microvilli
II. Large surface area
III. Presence of certain viruses

(A) I only
(B) II only
(C) I and II only
(D) I and III only
(E) I, II, and III

37. Each of the following methods of reproduction occurs without genetic recombination EXCEPT

(A) binary fission
(B) conjugation
(C) budding
(D) production of gemmae
(E) cloning

38. The ruminants–animals such as deer and cows–are able to digest cellulose. Each of the following contributes to the special digestive abilities of the ruminant EXCEPT

(A) multichambered gastrointestinal tract
(B) bacteria within digestive tract
(C) protozoa within digestive tract
(D) ability to convert β-glucose to ∝-glucose
(E) mutualism

39. A cell is removed from its normal environment and placed into another medium. It is then noted that the cell appears to shrink. Which term best describes the *medium* relative to the cell?

(A) Hypertonic
(B) Hypotonic
(C) Isotonic
(D) Osmotic
(E) Pinocytosis

40. Organic molecules, such as vitamin C and vitamin B_{12}, are required for specific enzymes to function. Such organic molecules are called

(A) substrates
(B) coenzymes
(C) allosteric modulators
(D) active sites
(E) competitive inhibitors

41. The corpus luteum secretes a hormone that prepares the uterus for implantation. This hormone is most likely

(A) a luteinizing hormone
(B) a follicle-stimulating hormone
(C) estrogen
(D) progesterone
(E) chorionic gonadotropin

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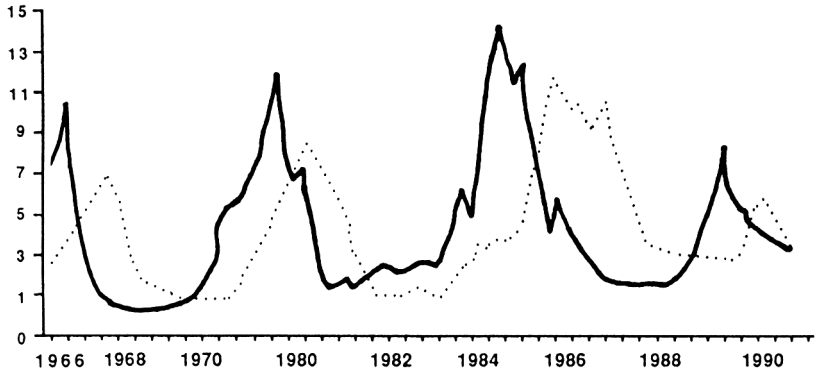
42. The graph below depicts the population trend in a predator-prey system. Assuming this is a stable system (free from outside influences), which of the following statements is most likely true?



(A) The solid line most likely represents the predator population trend.
(B) The populations of predator and prey reach peak levels concomitantly.
(C) Four years after the population of predator begins to decrease, there is a dramatic decrease in the population of prey.
(D) One year after the population of prey increases, there is a parallel rise in the population of predator.
(E) No correlation between predator and prey populations is observed.

43. According to the Hardy-Weinberg law, genetic equilibrium within a gene pool is contingent upon several factors. Which of the following is one of the requirements?

(A) Population size must be small.
(B) Genetic drift occurs.
(C) There is an absence of gene flow.
(D) Mutations are frequent and not balanced.
(E) There is an absence of random reproduction.

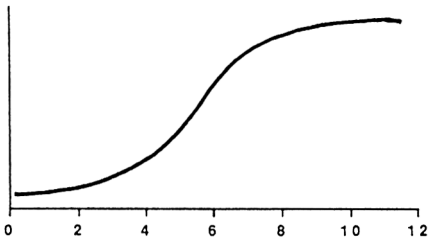
44. Several general characteristics of the angiosperms allow for the separation of this class of plants into two subclasses. Properties that differentiate these subclasses include each of the following EXCEPT

(A) the number of seed leaves
(B) arrangement of vascular tissue in the stem
(C) petal arrangement
(D) color scheme of petals
(E) vein structure of leaves

45. Which of the following hormones is NOT correctly matched with a known function of that hormone?

(A) Insulin – Glucose metabolism
(B) Calcitonin – Calcium metabolism
(C) Parathyroid hormone – Calcium metabolism
(D) Aldosterone – Electrolyte balance
(E) Erythropoietin – White blood cell regulation

46. The diagram below illustrates the growth curve of a certain bacteria in a controlled environment. Which time period represents the maximal growth acceleration of the bacterial population?



(A) Between hours 2 and 4
(B) Between hours 4 and 6
(C) Between hours 6 and 8
(D) Between hours 8 and 10
(E) Between hours 10 and 12

47. In the early stages of certain diseases, pooled immunoglobulin may be administered. Often, the disease process will be significantly less severe as a result of this treatment. The pooled immunoglobulin contains antibodies that are specific for the infectious agent. This treatment is an example of

(A) active immunity
(B) passive immunity
(C) colostrum
(D) vaccination
(E) autoimmunity

48. Which of the following is derived from the ectodermal germ layer?

(A) Mammary glands
(B) Thyroid gland
(C) Liver
(D) Eustachian tube
(E) Adrenal cortex

49. The first dinosaurs probably inhabited the earth during which era?

(A) Cenozoic
(B) Paleozoic
(C) Mesozoic
(D) Precambrian
(E) Silurian

50. The main reservoir of carbon for the carbon cycle is which of the following?

(A) Hydrocarbons contained in coal and oil
(B) Calcium carbonate contained in limestone
(C) Carbon contained in diamonds
(D) Carbon dioxide contained in air and dissolved in water
(E) Carbon contained in living organisms

51. Each of the following is a characteristic of mammals EXCEPT

(A) four-chambered heart
(B) homothermy
(C) only one bone in the middle ear
(D) ventral orientation of the limbs
(E) only one bone comprising the lower jaw

52. Which of the following is NOT a characteristic of procaryotes?

(A) Few, if any, organelles
(B) Synthesis of protein and RNA occurs within the same compartment
(C) Contain DNA within the cytoplasm
(D) Transcription and translation are closely coupled events
(E) Occurrence of introns within the primary RNA transcript

GO ON TO THE NEXT PAGE

Part B

Directions: Each set of lettered answer choices below refers to the numbered statements following it. Select the one lettered answer choice that best fits each statement and darken the corresponding circle on the answer sheet. An answer choice may be used once, more than once, or not at all in a given set.

Questions 53–57

(A) Stomata
(B) Guard cells
(C) Mesophyll
(D) Companion cells
(E) Petiole

53. Regulate the exchange of gases between the leaf and the environment

54. Stalk of a leaf

55. Region between the upper and lower epidermis of a leaf

56. Openings in the epidermis that allow transpiration to occur

57. Adjacent to sieve tube

Questions 58–61

(A) Ribosome
(B) Mitochondrion
(C) Centriole
(D) Nucleolus
(E) Peroxisome

58. Membrane-bound vesicle that contains the enzyme catalase

59. Possesses its own genetic material and self-replicates

60. Interacts with the endoplasmic reticulum during protein synthesis

61. Composed of microtubules and functions in cytoskeletal organization

Questions 62–65

(A) Contractile vacuole
(B) Flame-cell
(C) Nephridial system
(D) Malpighian tubules
(E) Nephron

62. Excretory system of insects

63. Excretory system of the earthworm

64. Excretory organelle present in some protozoans

65. Functional unit of the vertebrate kidney

Questions 66–69

The shape and character of pea seeds produced from mating heterozygous yellow, wrinkled-shaped peas are being studied. It is known that the yellow color and the rounded shape are dominant traits, while the green color and the wrinkled shape are recessive traits. The parent seeds are dihybrids. Furthermore, it has been determined that the genes for these traits are inherited independently. The lettered answer choices below represent the expected proportions of the various first-generation offspring from this mating experiment (dihybrid cross).

(A) 1/16
(B) 3/16
(C) 4/16
(D) 9/16
(E) 12/16

66. Yellow, rounded

67. Green, wrinkled

68. Green, rounded

69. Wrinkled

Questions 70–72

(A) Cerebellum
(B) Olfactory bulb
(C) Medulla
(D) Hypothalamus
(E) Thalamus

70. Involved in processing odors

71. Integrates sensory information from somatic receptors

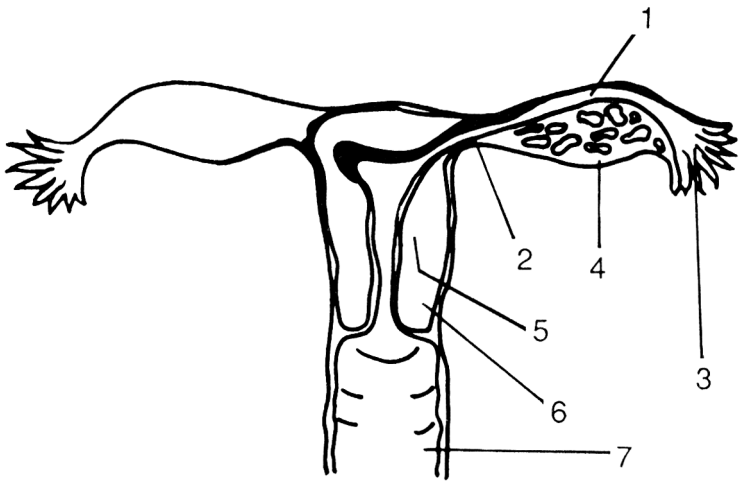
72. Contains centers responsible for control of blood pressure and respiration

Part C

Directions: The following questions refer to the diagram containing specific parts labeled with numbers. Each question is followed by five suggested labels as possible answers. For each question, select the one best answer and darken the corresponding circle on the answer sheet.

Questions 73-77

Female Reproductive System



73. Fertilization normally occurs in

(A) 1
(B) 2
(C) 3
(D) 6
(E) 7

74. Implantation normally occurs in

(A) 1
(B) 4
(C) 5
(D) 6
(E) 7

75. Gametes are produced in

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

76. Synthesis of sex hormones occurs in

(A) 3
(B) 4
(C) 5
(D) 6
(E) 7

77. The diaphragm, a birth control device, covers

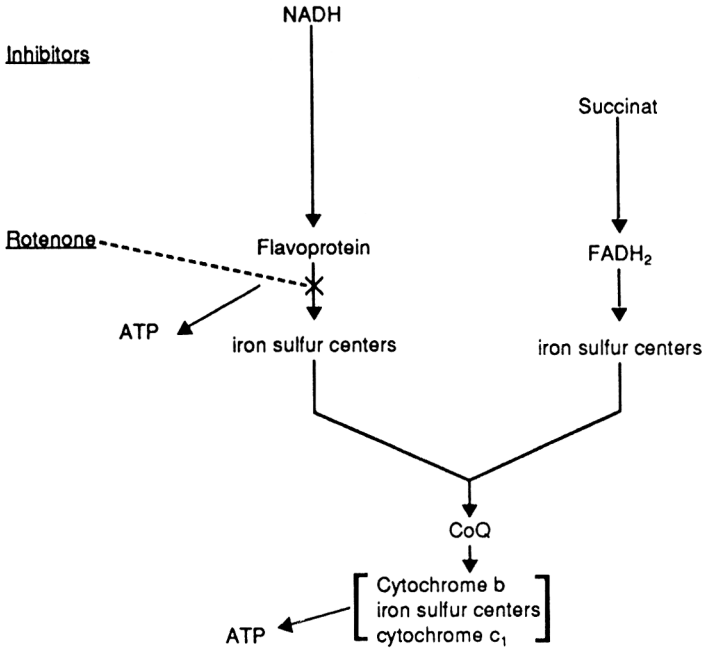
(A) 1
(B) 2
(C) 5
(D) 6
(E) 7

GO ON TO THE NEXT PAGE

Part D

Directions: Each group of questions below concerns a laboratory or experimental situation. In each case, study the description of the situation. Then, for each question following it select the one best answer and darken the corresponding circle on the answer sheet.

Questions 78–80 pertain to the electron transport chain. The reaction sequence below illustrates some of the components of the electron transport chain and the sites where ATP is generated. Also shown are various inhibitors and the steps where these chemicals exert their effects. In addition, the diagram depicts the sites of entry for several substrates of the electron transport chain.



78. According to the diagram, how many ATP would succinate be expected to yield under normal circumstances?

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

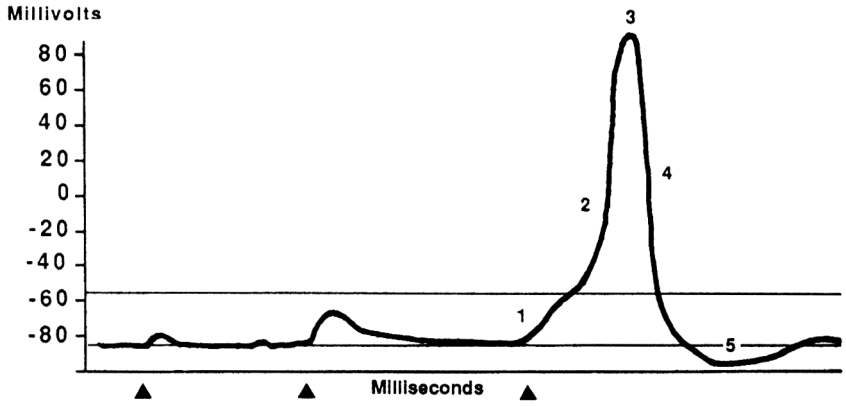
79. If the inhibitor rotenone is present, how many ATP would succinate be expected to yield?

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

80. Antimycin A blocks the transfer of electrons at the site shown in the diagram. Which of the following occurs if Antimycin A is present?

(A) Electron transfer proceeds normally.
(B) Electron carriers before the inhibition site become more oxidized.
(C) Oxidation of succinate occurs completely.
(D) Electron carriers after the inhibition site become more oxidized.
(E) Succinate would yield only 1 ATP, while ascorbate would yield 2 ATP.

Questions 81–84 refer to the action potential of a nerve fiber. The diagram below demonstrates the effect of several stimuli on the membrane potential of a neuron. Each triangle indicates the time at which a stimulus is applied to the nerve.



81. The interrupted line at –90 millivolts most likely represents the

(A) resting membrane potential
(B) threshold potential
(C) inhibitory potential
(D) refractory period
(E) hyperpolarization potential

82. The threshold potential for this nerve is most likely

(A) +80 millivolts
(B) +20 millivolts
(C) –56 millivolts
(D) –70 millivolts
(E) –90 millivolts

83. Rapid depolarization of the membrane, as occurs in the area labeled 2, is due to which of the following?

(A) Influx of K^+ ions
(B) Efflux of Ca^{2+} ions
(C) Influx of SO_4^{2-}
(D) Efflux of ATP
(E) Influx of Na^+ ions

84. Which of the following most likely explains repolarization?

(A) Na^+–K^+–ATPase ceases to function
(B) Rapid influx of Na^+ ions
(C) Rapid efflux of K^+ ions
(D) Rapid influx of Cl^- ions
(E) Rapid efflux of Cl^- ions

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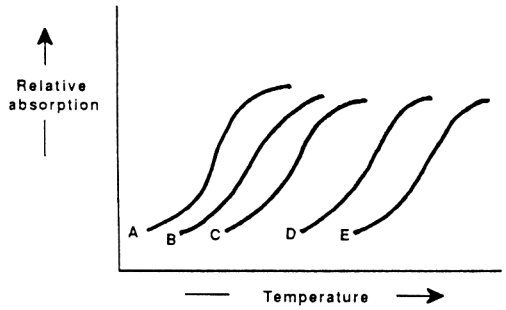
Questions 85–87

Experiments have demonstrated that DNA is a very well organized, cooperative structure. The two strands of the DNA double helix are joined by hydrogen bonds between the paired bases. Adenine and thymine are held together by two hydrogen bonds, while three hydrogen bonds will form between and join the bases cytosine and guanine. Five DNA melting curves, labeled A, B, C, D, and E, are illustrated below. The melting point of a given DNA molecule is described as being the temperature at which half the double helix is unwound. Absorption, as measured by the spectrophotometer, increases as the DNA melts. Once completely melted, the curve levels.



85. Which species of DNA melts at the lowest temperature?

(A) A
(B) B
(C) C
(D) D
(E) E

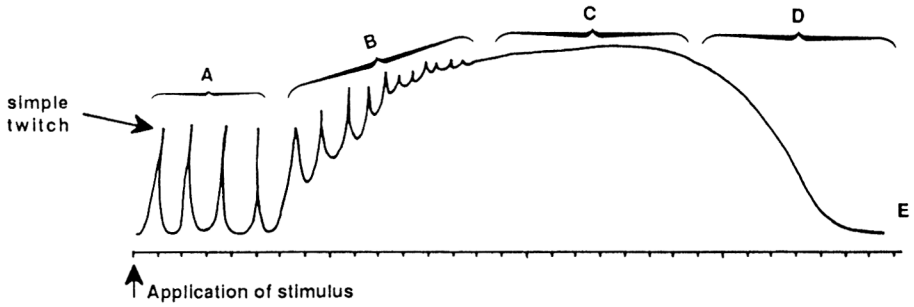
86. Which species of DNA possesses the greatest content of adenine-thymine base pairs?

(A) A
(B) B
(C) C
(D) D
(E) E

87. If a solution containing denatured DNA (assume only one species of DNA) is cooled to 25°C below its melting temperature, which of the following would be expected to occur?

(A) Phosphate groups would leave the individual bases.
(B) Annealing
(C) Adenine-thymine base pairs would again form three intermolecular hydrogen bonds.
(D) The individual strands composing the double helices will remain isolated and irreversibly altered.
(E) Adenine will reliably base pair with guanine and with thymine.

Questions 88–90 concern the physiology of muscle contraction. The diagram below represents a tracing from a kymograph. The contraction pattern of a frog's leg muscle is being studied. Under appropriate experimental conditions, the muscle is repeatedly stimulated. Note the frequency of stimulation varies throughout the first portion of the tracing.



88. The portion of the kymograph labeled D probably represents which of the following?

(A) Simple twitch
(B) Tetanus
(C) Latent period
(D) Relaxation period
(E) Fatigue

89. In part A of the kymograph, it is noted that muscle movement does not occur immediately with the application of the stimulus. Rather, there exists a finite time period between the application of the stimulus and the resultant muscle contraction. This time period is known as the

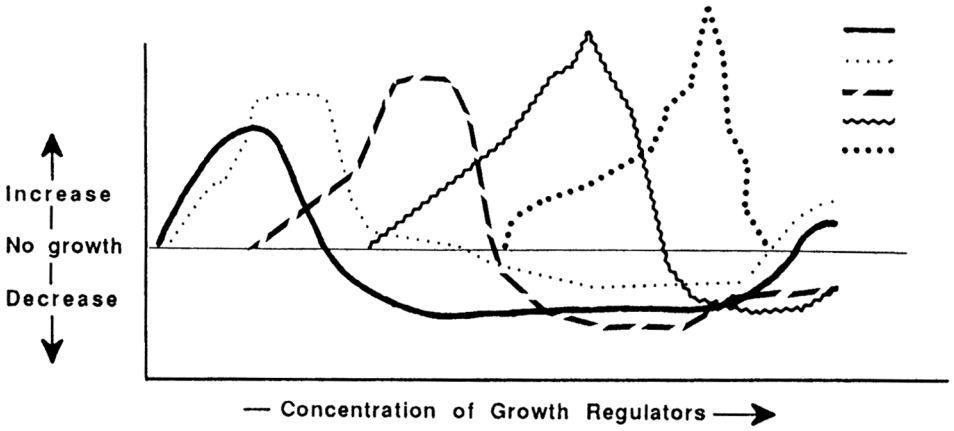
(A) simple twitch period
(B) latent period
(C) contraction period
(D) relative refractory period
(E) absolute refractory period

90. The energy for muscular contraction may come from each of the following EXCEPT

(A) ATP
(B) creatine phosphate
(C) glycolysis
(D) complete oxidation of glucose
(E) urea

Questions 91–92

It has been demonstrated that hormones within plants can exert influences on plant growth. The chart below depicts the differential sensitivity of various parts of a certain plant to changing levels of plant growth regulators. These results are based on laboratory studies and have not been confirmed on plants growing freely in nature.



91. Which of the following will grow with the least amount of plant growth regulators relative to the other plant parts?

(A) primary root
(B) lateral root
(C) buds
(D) stem
(E) fruit

92. The terminal bud of a stem is known to produce apical dominance in this plant. Which of the following best describes this condition?

(A) As the fruit of the plant grows larger, stem elongation occurs.
(B) As the fruit of the plant stops growing, stem elongation occurs.
(C) Primary root growth precedes lateral root growth.
(D) As stem elongation occurs, lateral bud growth is inhibited.
(E) As stem growth decreases, terminal bud growth increases.

Questions 93–94

Interactions between mesoderm and its overlying epidermis can have profound effects. Several experiments using the embryonic chicken demonstrate the results of such interactions. In the first experiment, mesoderm from a feathered region of the chick is combined with ectoderm from a nonfeathered region. As a result, the ectoderm produces feathers. In a second experiment, mesoderm from a scaled area is combined with ectoderm from a feather-producing area. The result is ectoderm, which produces scales.

93. Differentiation of cells as a result of location is best termed

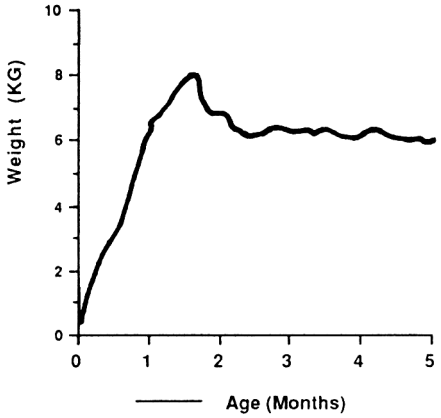
(A) integration
(B) ingression
(C) restriction
(D) induction
(E) morphogenesis

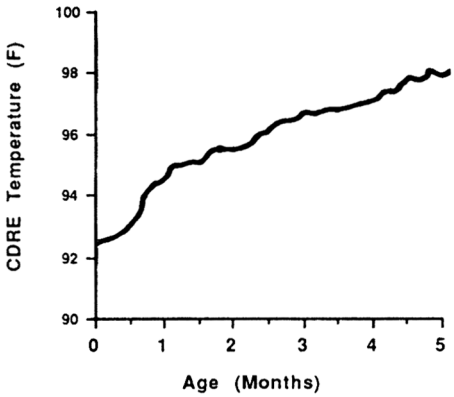
94. If ectoderm from the wing area is supplanted for the ectoderm covering leg mesoderm, which of the following is most likely to occur? Use the above experiments as a guide.

(A) Ectoderm will produce scales.
(B) Ectoderm will produce wing feathers.
(C) Ectoderm will produce leg feathers.
(D) Ectoderm will produce no feathers.
(E) Ectoderm will produce both scales and wing feathers.

Question 95

The curves below illustrate the early development of a young mammal. The normal fully developed adult of this species weighs 8 kilograms and maintains a core temperature of 99°F.





95. Based on the data presented for this animal, which of the following is a reasonable conclusion?

(A) Temperature regulation occurs as the animal's activity level increases.
(B) Weight increases linearly over the first three months of development.
(C) Maximum weight is attained after adult temperature regulation is achieved.
(D) Adult weight is attained prior to adult temperature regulation.
(E) Core temperature and body weight are inversely related over the first three months of development.

STOP

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS TEST ONLY. DO NOT WORK ON ANY OTHER TEST IN THIS BOOK.

ANSWER KEY

1. E	**20.** A	**39.** A	**58.** E	**77.** D
2. D	**21.** B	**40.** B	**59.** B	**78.** C
3. A	**22.** D	**41.** D	**60.** A	**79.** C
4. C	**23.** C	**42.** D	**61.** C	**80.** D
5. C	**24.** E	**43.** C	**62.** D	**81.** A
6. E	**25.** E	**44.** D	**63.** C	**82.** C
7. B	**26.** B	**45.** E	**64.** A	**83.** E
8. B	**27.** C	**46.** B	**65.** E	**84.** C
9. D	**28.** C	**47.** B	**66.** D	**85.** A
10. C	**29.** D	**48.** A	**67.** A	**86.** A
11. C	**30.** D	**49.** C	**68.** B	**87.** B
12. A	**31.** A	**50.** D	**69.** C	**88.** E
13. B	**32.** D	**51.** C	**70.** B	**89.** B
14. B	**33.** B	**52.** E	**71.** E	**90.** E
15. D	**34.** D	**53.** B	**72.** C	**91.** A
16. D	**35.** C	**54.** E	**73.** A	**92.** D
17. B	**36.** C	**55.** C	**74.** C	**93.** D
18. C	**37.** B	**56.** A	**75.** D	**94.** C
19. E	**38.** D	**57.** D	**76.** B	**95.** D

EXPLANATORY ANSWERS

1. **The correct answer is (E).** The contraction of the left ventricle provides the force necessary to propel blood through the circulatory system. Accordingly, as blood flows further from the heart, the mean blood pressure decreases. This is the result of the progressive dissipation of energy by frictional forces. Thus, the mean blood pressure would be lowest in the inferior vena cava. Recall the sequence of blood flow:

   Left ventricle → aorta → arteries → arterioles → capillaries → venules → veins → inferior/superior vena cava → right atrium

2. **The correct answer is (D).** Cellulose and lignin are structural components unique to plant cells. These materials serve supportive functions. Peptidoglycan, also called murein, is a complex structure consisting of polysaccharide chains connected by short sequences of amino acids. This substance composes part of the bacterial cell wall, but it is not present in plant cells.

3. **The correct answer is (A).** The allantois functions as the reservoir for wastes produced during development. The amnion encloses the embryo in a fluid-filled cavity. The chorion is an outer membrane that permits the exchange of gases. The yolk sac encloses the yolk. The placenta is not present in the chick egg.

4. **The correct answer is (C).** Food chains begin with the producers (autotrophs) and end with the decomposers. The pathway between the beginning and the end of a food chain is variable and may involve primary consumers, secondary consumers, tertiary consumers, etc.

5. **The correct answer is (C).** The anticodon base sequence is complementary to the codon base sequence. The codon is a triplet of bases on messenger RNA that specifies for a single amino acid. The anticodon is a triplet of bases on transfer RNA that is complementary to the codon sequence. Transfer RNA is

responsible for the transport of a specific amino acid during the process of protein synthesis. In this question, since the codon and anticodon are parts of RNA molecules, the bases present will be A, C, G, and U. Recall that T is present in DNA and not RNA. Remembering the base pairing rules (A:U, C:G) then, the correct anticodon sequence is determined.

6. **The correct answer is (E).** The blind spot is the point on the retina where the nerve fibers converge to form the optic nerve. At this location, the retina is devoid of visual receptors. The other labelled parts of the diagram are the cornea (A), pupil (B), lens (C), and the fovea (D).

7. **The correct answer is (B).** During anaphase I, homologous chromosomes separate. This is in contrast to the separation of sister chromatids, which occurs during anaphase II (and in anaphase of mitosis). Choices (A) and (C) occur during prophase I, and choice (E) describes metaphase.

8. **The correct answer is (B).** Structures that serve similar functions but arose along different evolutionary lines are referred to as analogous. Similarities between species that are the result of common ancestry represent homologous structures. Vestigial structures are homologous organs that have no known function in some species. Mutualism refers to a type of symbiotic relationship, and mimicry is a type of protective adaptation.

9. **The correct answer is (D).** The gills of fish are able to efficiently extract oxygen from water by utilizing a countercurrent exchange mechanism. In this system, the flow of blood is in the opposite direction to the flow of water. Such an arrangement allows for a continuous oxygen gradient between water and blood, which favors the passive flow of oxygen to the bloodstream.

10. **The correct answer is (C).** Glycosylation (the addition of oligosaccharides) is initiated in the endoplasmic reticulum. The Golgi apparatus then modifies the oligosaccharide structures. Histones are proteins involved in the organization of DNA into chromosomes.

11. **The correct answer is (C).** Glycolysis is the initial reaction sequence involved in the breakdown of glucose. The set of reactions occurs in the cytoplasm of the cell and not within the mitochondria.

12. **The correct answer is (A).** Imprinting is not a conditioned response. The famous experiments of Pavlov demonstrate conditioning. The other answer choices describe characteristics of imprinting.

13. **The correct answer is (B).** The parasympathetic nervous system would slow the heart rate. The sympathetic nervous system, which readies the body for emergencies ("fight-or-flight"), would cause acceleration of the heart rate.

14. **The correct answer is (B).** The pyrenoid is the organelle described in this question. The stigma–or eyespot–functions as a light detector for the euglenoids. The cytopharynx and the oral groove are structures of the paramecium.

15. **The correct answer is (D).** The anther is at the distal end of a filament and is responsible for producing pollen. The filament and its terminal anther comprise the structure known as the stamen. The style is part of the pistil. Sepals are specialized leaves of the flowering plant and serve a protective function.

16. **The correct answer is (D).** Vitamin K is necessary for the proper synthesis of some clotting factors. Thus, with a severe deficiency, spontaneous hemorrhage may occur. The other answer choices represent the results of other vitamin deficiencies: scurvy (vitamin C), pernicious anemia (vitamin B_{12}), pellagra (nicotinamide), and rickets (vitamin D).

17. **The correct answer is (B).** The outer rings of xylem in trees provide support as well as assist in transport. Such outer, more recent rings compose the sapwood. The older, innermost rings no longer serve transport functions and are called the heartwood. Vessels of the inner xylem become clogged with various pigments, resins, and gums.

18. **The correct answer is (C).** The axon is responsible for impulse transmission to the effector organ. Dendrites typically receive some sort of stimulation and conduct such information to the cell body. The Schwann cell and its myelin sheath serve to envelop the peripheral nerve and thereby act as an insulator.

19. **The correct answer is (E).** Dominated by the presence of conifers is the taiga. This biome is south of the tundra. Moose, bears, and birds are a few of the characteristic animals in the taiga.

20. **The correct answer is (A).** The offspring of a homozygous dominant-homozygous recessive cross will demonstrate the dominant phenotype. This result can quickly be ascertained from a Punnett square:

    G = dominant, green leaf color

    g = recessive, yellow leaf color

    GG × gg

	g	g
G	Gg	Gg
G	Gg	Gg

    Thus, it is observed that 100% of the offspring will be heterozygous for leaf color. However, since green leaf color is dominant, the phenotype will accordingly be green.

21. **The correct answer is (B).** Archaeopteryx is the oldest known fossil of the class Aves (birds). This animal possessed characteristics of both reptiles and birds. Hence, it is believed to represent the evolutionary link between the classes Reptilia and Aves. Although Archeopteryx had a long tail and teeth, it also had wings, leading systematists to classify this animal as a bird.

22. **The correct answer is (D).** Enzymes do not affect the equilibrium constant for a given reaction. Instead, enzymatic catalysis simply allows equilibrium to be reached more quickly than would occur in the non-catalyzed reaction. Enzymes accomplish such a task by allowing reactions to occur more readily; reactive portions of substrates are brought into close approximation. Consequently, the activation energy is lowered, and the forward and reverse reactions will occur more readily.

23. **The correct answer is (C).** Carbon fixation occurs in the dark reactions. In these reactions, CO_2 is used to synthesize carbohydrates. The energy sources for this set of reactions are ATP and NADPH. The ATP and NADPH are products of the light-dependent reactions.

24. **The correct answer is (E).** The all-or-none response is a property of neurons. This concept refers to the response of a neuron to a given stimulus. If a stimulus is of threshold intensity (or greater), then the neuron will "fire." However, if the stimulus is of subthreshold intensity, the neuron will not propagate a signal.

25. **The correct answer is (E).** Bile is produced by the liver. The gallbladder functions as a reservoir for bile and also concentrates this complex fluid by absorbing water. In response to hormonal stimulation the walls of the gallbladder contract, and bile is released into the small intestine. In the gastrointestinal tract, bile emulsifies fats and allows for more efficient digestion of these substances.

26. The correct answer is (B). An X-linked gene signifies that such a gene is sex-linked and occupies a locus on the X sex chromosome. Furthermore, since the gene in question is dominant, one "dose" of this gene will allow its full expression. (This is in contrast to a recessive gene, which requires the absence of the dominant gene in order for it to be expressed.) If X* is allowed to represent the particular dominant, X-linked gene in question, the mating can be described as

XX x X*Y

unaffected female affected male

Note that the female has to be XX and cannot be X*X or X*X*. Why? Realize that X*X or X*X* would signify an affected female–the X* is dominant! Hence, an unaffected female could not possess this gene. In addition, if it is assumed that the carrier state represents an individual who possesses the gene in question but is not affected, there can be no carriers for this gene. That is, each offspring who possesses the X* gene will be affected. Arranging a Punnett square for the cross that occurs in this problem, then:

	x*	y
x	xx*	xy
x	xx*	xy

So, 100% of the female offspring will inherit the X* chromosome. However, the X chromosome of the male offspring will be one of the unaffected X chromosomes from the unaffected female parent. Hence, none of the males will be affected.

27. The correct answer is (C). Thymidine is one of the nucleotides found in DNA. The various phases of the cell cycle are mitosis (M), gap 1 (G_1), replication or synthesis of DNA (S), and gap 2 (G_2). During the gap phases, the cell synthesizes the various cellular products that are necessary. Note that only during the S phase is DNA being synthesized. Thus, thymidine will be utilized during this phase, and radio-labeled thymidine will be incorporated.

28. The correct answer is (C). Active transport is an energy-dependent process for cellular transport. Specific types of active transport include the $Na^+ - K^+$ ATPase and axonal transport. Active transport allows for the movement of a particle against its concentration gradient. This is in contrast to diffusion and osmosis, which are passive processes: movement of a particle occurs down its concentration gradient (from higher to lower concentrations). Cytoplasmic streaming has been well-Characterized in algae. This process involves the movement of cellular contents by microfilaments and utilizes energy.

29. The correct answer is (D). Reabsorption of water is not a direct function of the vertebrate liver. The vertebrate digestive tract (intestines) absorbs water and the kidney functions to maintain salt and water balance. The other answer choices represent several of the functions served by the liver.

30. The correct answer is (D). Recall the classification hierarchy employed by taxonomists:

Kingdom, Phylum, Class, Order, Family, Genus, Species

The more closely related two organisms are, the more common their classification (i.e., same kingdom, phylum, class, order, etc.) In examining the answer choices, one choice clearly depicts disparate organisms. The sea lily is a member of the kingdom Animalia, while the iris belongs to the kingdom Plantae. Do not be misled by their names. The iris is a monocot *flower*, while the sea lily is a primitive marine animal. The other answer choices are related as follows: squid-octopus, same class; crayfish-shrimp, same class; shark-ray, same class; and lemur-monkey, same order. Note that it necessarily follows that organisms of the same class belong to the same phylum and kingdom.

31. **The correct answer is (A).** The term ecosystem describes a community of living organisms, the surrounding environment, and the interactions between the members of the community. The most stable ecosystem would have the least amount of change among its living organisms and physical environment. The ocean floor beneath the Antarctic is the most stable of the ecosystems listed. Meteorological factors are negligible. A very cold, dark state exists. Tides do not have much effect. The living population, though not static, is relatively unchanging in comparison to the other ecosystems given.

32. **The correct answer is (D).** Sperm are produced within the seminiferous tubules of the testis. The epididymis serves as the reservoir for sperm until they are released. Upon ejaculation, sperm in the epididymis enter the vas deferens. The vas deferens is connected to the urethra, and it is though the urethra that the sperm reach the outside.

33. **The correct answer is (B).** Carolus Linnaeus devised a classification scheme based upon the morphologic similarities of organisms.

34. **The correct answer is (D).** The first, primitive human is said to belong to the genus Australopithecus. A species within this genus is believed to have given rise to the genus Homo. Homo habilis may represent one of the earliest members of Homo. Homo erectus, also called Java man, is recognized as a later representative of this genus and probably is the precursor of modern man, Homo sapiens.

35. **The correct answer is (C).** The interaction of the four distinct polypeptide chains that compose hemoglobin is referred to as its quaternary structure. Primary structure refers to the amino acid sequence of a protein. Secondary structure refers to the interactions of amino acids with their nearest neighbors. Examples of secondary structure include the alpha helix, the β-turn, and the pleated sheet. Tertiary structure refers to the three-dimensional shape of the protein.

36. **The correct answer is (C).** In humans, the bulk of digestion and absorption occurs within the small intestine. The intestines are quite long and present a large surface area for digestion. To enhance the surface available for digestion and absorption, small projections called villi protrude from the lumen wall. Furthermore, the entire surface of the lumen is lined with microvilli. Although colonic bacteria can form vitamin K, vitamin B_{12}, and various gases, viruses play no known role in absorption of digested foodstuffs.

37. **The correct answer is (B).** Conjugation is a reproductive process used by some bacteria. During conjugation, two bacteria are connected by a cytoplasmic bridge. Via this connection, genetic material may be passed from one bacterial cell to the other. The other answer choices represent asexual methods of reproduction that occur without genetic recombination.

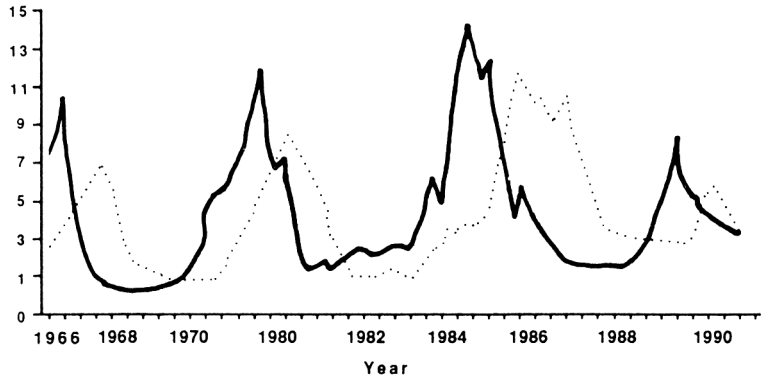
38. **The correct answer is (D).** Glucose occurs as both α-glucose and β-glucose. β-glucose is the form found in cellulose and composes the majority of the plant cell wall. Humans and ruminants do not possess the ability to directly digest β-glucose. However, the ruminants do have bacteria and protozoa within their digestive tracts that are able to digest β-glucose. β-glucose is not converted to α-glucose. Since the microorganisms and the ruminants each benefit, this situation is an example of mutualism. Ruminants also have a multichambered gastrointestinal tract to aid in digestion.

39. **The correct answer is (A).** Osmosis is the diffusion of a solvent through a semipermeable membrane. The solvent involved is usually water. In this question, the cell is placed in a medium and the cell shrinks. This occurs because the medium contains more osmotically active particles than the cell (hypertonic). Thus, water will flow down its concentration gradient: water moves from the cell interior to the external medium.

40. **The correct answer is (B).** A coenzyme is an organic molecule that is required for an enzyme to accomplish its function.

41. **The correct answer is (D).** The hormone mainly responsible for preparing the uterus for implantation is progesterone. The corpus luteum does secrete this hormone for a period.

42. **The correct answer is (D).** The graph depicts the classic relationship between predator and prey. The solid line represents the prey population, while the interrupted line represents the predator population. Note that the population curves are approximately parallel, but there is a time lag between the two. In the stable predator-prey system, as the population of prey increases, there will be more food for the predator. Hence, the predator population will increase. However, as more and more of the prey are killed, there will be less food for the growing predator population. Consequently, the predator population will not have an appropriate food supply and the population will decrease. Once fewer predators exist, the prey population will again increase as fewer of their members are being killed.



43. **The correct answer is (C).** According to the Hardy-Weinberg law, genetic equilibrium may exist if the following occur: (1) the population is sufficiently large, (2) there is a net absence of mutations, (3) no gene migration occurs, and (4) reproduction is random within the species. Gene migration may also be referred to as gene flow, so answer choice **(C)** is the only requirement listed.

44. **The correct answer is (D).** The two subclasses of the angiosperms are the Monocotyledoneae (monocots) and the Dicotyledoneae (dicots). Distinguishing characteristics include each of the answer choices given, except **(D)** petal color.

45. **The correct answer is (E).** Erythropoietin is a hormone formed in the kidney. This hormone stimulates red blood cell production (red blood cells are also called erythrocytes). Erythropoietin does not regulate the white blood cell population.

46. **The correct answer is (B).** Maximal growth acceleration occurs between the fourth and sixth hours. The diagram depicts the familiar "S-shaped" growth curve. At a low population density, the bacteria initially multiply rapidly, then reproduction slows until a steady state is reached. Growth acceleration occurs between hours 0–6, with maximal acceleration between the fourth and sixth hours. Between the sixth and tenth hours, deceleration is actually occurring. The steady state is reached between the tenth and twelfth hours.

47. **The correct answer is (B).** Passive immunity is the term used to describe the injection of preformed antibodies. That is, the antibodies are synthesized elsewhere (laboratory synthesis, pooled antiserum) but are given to the patient so an immediate immune response can be obtained. Active immunity occurs when an individual mounts an immune response, synthesizes antibodies, reacts to a foreign stimulus (the antigen). Active immunity occurs as a result of being infected or by receiving a vaccine.

48. The correct answer is (A). The mammary glands are ectodermal derivatives. The thyroid gland, the liver, and the Eustachian tube are derived from endoderm. Mesodermal derivatives include the heart, the kidneys, and the adrenal cortex.

49. The correct answer is (C). The first dinosaurs inhabited the earth during the Mesozoic era. The age of mammals is classified as early Cenozoic. Fish, amphibians, and reptiles each have origins tracing back to the Paleozoic era. Precambrian life consisted of primitive marine organisms. Within the Paleozoic era is the Silurian period (i.e., Silurian is a period, not an era).

50. The correct answer is (D). The carbon dioxide that is contained in the earth's atmosphere and that dissolved in the earth's bodies of water form the major supply of carbon for the carbon cycle.

51. The correct answer is (C). Mammals have three bones in the middle ear, while reptiles and birds have only one bone in the middle ear.

52. The correct answer is (E). Procaryotes are typically small and mainly unicellular. Composed of a single compartment, they possess few, if any, organelles. DNA, RNA, and protein synthesis occur within this compartment, the groundwork substance of which is called the cytoplasm. Hence, transcription and translation may be both temporally and spatially related events. However, unlike eucaryotes, the RNA transcript is not composed of exons and introns. That is, the primary transcript of a procaryote does not undergo extensive modification prior to translation.

53. The correct answer is (B). Guard cells are specialized epidermal cells. Two of these cells lie adjacent to one another and regulate the opening and closing of the stoma. Hence, although the actual exchange of gases occurs via the stoma, it is the guard cells that regulate this opening.

54. The correct answer is (E). The stalk of a typical dicot leaf is also called the petiole.

55. The correct answer is (C). The region between the upper and lower epidermis is the mesophyll. This part of the leaf consists of cells densely laden with chloroplasts. Indeed, most of the photosynthesis of a plant occurs in this region.

56. The correct answer is (A). Stomata allow gases to be exchanged between the plant and the environment. The evaporation of water at the stoma is called transpiration.

57. The correct answer is (D). Companion cells are integral components of phloem. These elongate cells serve a supportive function, helping to maintain the sieve elements.

58. The correct answer is (E). Peroxisomes are intracellular vesicles that are similar to lysosomes. All peroxisomes contain the enzyme catalase, which catalyzes the degradation of hydrogen peroxide to a less toxic molecule.

59. The correct answer is (B). Mitochondria are the so-called "powerhouses" of the cell, producing the ATP necessary for cellular processes. Mitochondria also reproduce by dividing in two and contain DNA.

60. The correct answer is (A). Ribosomes are composed of protein and RNA. Protein synthesis is catalyzed by this complex structural unit.

61. The correct answer is (C). Centrioles are organizing centers that are composed of a cylindrical array of microtubules.

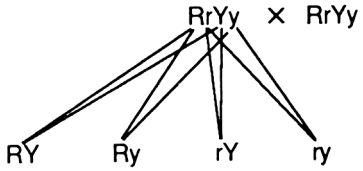
62. The correct answer is (D). Malpighian tubules lie in the hemocoel of insects, where the tubules are bathed in blood. Fluid is absorbed into the tubules and water and salts are reabsorbed. Waste materials then pass into the hindgut.

63. The correct answer is (C). Nephridia filter the extracellular fluid of the earthworm and reclaim valuable materials.

64. The correct answer is (A). Contractile vacuoles are responsible for maintaining water balance. These structures are present in some protozoans.

65. The correct answer is (E). The functional unit of the vertebrate kidney is called the nephron. The nephron consists of Bowman's capsule and a long tubule. The tubule is divided into several, well-characterized segments.

66. The correct answer is (D). Questions 66–69 refer to a dihybrid cross that follows simple Mendelian laws. The results of this mating can be demonstrated through the use of a Punnett square. Round (R) and yellow (Y) are dominant traits, while wrinkled (r) and green (y) are recessive traits. Thus, the parents' genotypes may be represented as RrYy. The cross is then:



The Punnett square, then, is as illustrated:

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	RrYy	rryy

Thus, the combination R and Y—yellow, rounded—is present in 9/16 of the offspring. This number represents the expected proportion of offspring from the dihybrid cross that are yellow and rounded.

67. The correct answer is (A). Green, wrinkled peas are characterized by the genotype rryy. Both the green color and the wrinkled shape are recessive traits. Therefore, for the recessive phenotype to be manifest, the genotype must be homozygous recessive: rryy (refer to the Punnett square provided in the answer to question 66).

68. The correct answer is (B). Green, rounded peas are characterized by the following genotypes: RRyy and Rryy (refer to the Punnett square provided in the answer to question 66).

69. The correct answer is (C). Wrinkled peas must have the homozygous recessive genotype: rr. The color of the pea is irrelevant (refer to the Punnett square provided in the answer to question 66).

70. The correct answer is (B). The sense of smell is also referred to as olfaction. The olfactory bulb, located within the central nervous system, is involved in the processing of various odors.

71. The correct answer is (E). All somatosensory information that enters the cerebrum is relayed through the thalamus. From the thalamus, such information may be directed to appropriate cortical areas.

72. The correct answer is (C). The medulla contains centers that are responsible for maintaining vital functions.

73. The correct answer is (A). Fertilization normally occurs in the ampulla of the uterine tube (1). The remainder of the labeled parts are: (2) ovarian ligament, (3) fimbriae, (4) ovary, (5) uterus, (6) cervix, and (7) vagina.

74. The correct answer is (C). Implantation normally occurs in the wall of the uterus.

75. The correct answer is (D). The ovaries have the dual functions of producing female gametes and synthesizing sex hormones.

76. The correct answer is (B). The ovary is a gland that produces eggs and sex hormones.

77. The correct answer is (D). The cervix is a muscular ring of tissue at the end of the uterus. When in position, the diaphragm covers the cervix and functions as a barrier. Thus, sperm are prevented from entering the uterus.

78. The correct answer is (C). According to the diagram, succinate yields 2 ATP.

79. The correct answer is (C). Rotenone inhibits the transfer of electrons from NADH to CoQ. Rotenone does not affect the transfer of electrons from succinate to CoQ; therefore succinate yields 2 ATP.

80. The correct answer is (D). Reducing equivalents are "shuttled" down to cytochromes of the electron transport chain. If these electrons cannot pass, the carrier before the block will become more reduced. Furthermore, the carriers after the block will not receive any of the reducing equivalents and will become more oxidized.

81. The correct answer is (A). The resting membrane potential for the nerve fiber being studied is approximately -90 millivolts. This value signifies that the internal milieu of the cell is at -90 millivolts relative to the cell exterior.

82. The correct answer is (C). The threshold potential for this nerve is most likely -56 millivolts. If a stimulus is of sufficient intensity to cause the cell interior to reach the threshold potential, then the nerve will "fire," and the action potential illustrated in the diagram is the result. Note the first two stimuli of the diagram raised the potential of the cell's interior to approximately -80 millivolts and -70 millivolts, respectively. However, since the threshold potential was not attained, the nerve did not fire.

83. The correct answer is (E). Rapid depolarization is due to rapid influx of sodium ions (Na^+). Recall that the external environment of the cell has a high concentration of sodium ions relative to the intracellular compartment.

84. The correct answer is (C). Repolarization occurs as potassium ions (K^+) rapidly flow from the inside of the cell to the cell's exterior. In addition, sodium ions no longer flow into the cell. The Na^+–K^+–ATPase can then function to restore the cell to its normal intracellular concentration of Na^+ and K^+

85. The correct answer is (A). The DNA labeled A melts at the lowest temperature.

86. The correct answer is (A). Adenine-thymine base pairs are held together by only two hydrogen bonds. Therefore, it will take less heat to disrupt adenine-thymine base pairs as compared to guanine-cytosine base pairs (contain three hydrogen bonds). Thus, the DNA labeled A, which melts at the lowest temperature, possesses the greatest content of adenine-thymine base pairs. The DNA labeled E melts at the highest temperature. This species of DNA thus has the greatest content of guanine-cytosine base pairs.

87. The correct answer is (B). DNA will return to its normal configuration. That is, the double helix will be re-formed. This process is called annealing or re-annealing or renaturation.

88. The correct answer is (E). In part D of the kymograph tracing, muscle contraction diminishes despite repeated stimuli. This is known as fatigue. Part C of the tracing represents tetanus.

89. The correct answer is (B). The time period defined in the question is the latent period.

90. The correct answer is (E). Urea is a nitrogenous waste product and does not serve as an energy source for muscular contraction. ATP, formed by glycolysis and the complete oxidation of glucose, serves as the immediate source of energy. Creatine phosphate serves to reform ATP within the muscle by transferring the high energy phosphate group to ADP.

91. The correct answer is (A). The primary root demonstrates the greatest sensitivity to low amounts of growth regulators.

92. The correct answer is (D). Apical dominance exists when the terminal bud of a stem inhibits lateral bud growth during stem elongation.

93. The correct answer is (D). Induction is said to occur when the differentiation of cells is the result of location. In these experiments, the mesoderm induces the overlying ectoderm to produce a certain type of ectodermal derivative.

94. The correct answer is (C). As outlined in the experiments, the mesoderm determines the type of growth the ectoderm will produce. Thus, the leg mesoderm would be expected to cause the overlying ectoderm to produce leg feathers.

95. The correct answer is (D). Choice (D) represents the only reasonable conclusion that can be drawn from the data supplied. Choices (B), (C), and (E) are not in agreement with the data. Activity level is not discussed, so choice (A) cannot represent a reasonable conclusion of the data.