Questions 1-4 refer to the following plant cell types.

(A) Tracheids and vessel elements  
(B) Guard cells  
(C) Parenchyma cells  
(D) Sieve tube members and companion cells  
(E) Sclerenchyma cells

1. Chains of these nonliving cells form continuous tubes for the transport of water in vascular plants.
2. These cells take up potassium ions and water when sunlight and low concentrations of carbon dioxide are present, which causes them to become rigid.
3. These versatile cells serve as storage sites for sugars and starches in stems and roots.
4. These cells form a living tissue which transports sugar from one part of a vascular plant to another.

Questions 5-6 refer to the following.

(A) 2 
(B) 4 
(C) 16 
(D) 25 
(E) 50

5. The expected percentage of offspring with the recessive phenotype from a cross between two individuals heterozygous for a particular trait
6. The number of different phenotypes possible for the progeny of the cross \( \text{AaBb} \times \text{AaBb} \), where \( A \) and \( B \) exhibit simple dominance

Questions 7-10

(A) Monera  
(B) Protista  
(C) Fungi  
(D) Plantae  
(E) Animalia

7. Contains all the protozoa and most of the algae  
8. Contains multicellular heterotrophic organisms that reproduce asexually by spores  
9. Contains organisms without membrane-bound organelles such as nuclei  
10. Contains autotrophic organisms with cells that are organized into tissues and organs
Questions 11-14 refer to the following illustration of protein synthesis in a mammalian cell.

11. A strand of mRNA being translated
12. A polypeptide being synthesized
13. A barrier to diffusion of large proteins from nucleus to cytoplasm
14. A structure that contains a lipid bilayer
Questions 15-17

(A) Insulin
(B) Growth hormone
(C) Progesterone
(D) Thyroxin
(E) Secretin

15. It is secreted by the pituitary gland.

16. It directly controls metabolic rate.

17. Its concentration in the blood rises when the corpus luteum develops.
Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Some questions pertain to a set that refers to a laboratory or experimental situation. For each question, select the one choice that is the best answer to the question and then fill in the corresponding circle on the answer sheet.

18. The ribosomes of a cell are of primary importance for
   (A) DNA replication
   (B) transcription
   (C) translation
   (D) translocation
   (E) repression

19. If a couple has two boys and one girl, what is the probability that the next child born to this couple will be a girl?
   (A) $\frac{1}{4}$
   (B) $\frac{1}{3}$
   (C) $\frac{1}{2}$
   (D) $\frac{2}{3}$
   (E) $\frac{3}{4}$

20. Eggs fertilized by two sperm instead of one sometimes form a mitotic spindle with three poles. After mitosis the daughter cells will probably
   (A) be indistinguishable from normal cells
   (B) eliminate the chromosomes contributed by the second sperm
   (C) eliminate the chromosomes contributed by the egg
   (D) display an abnormal number of chromosomes
   (E) stop protein synthesis immediately

21. In higher plant cells, a pigment important in the manufacture of carbohydrates from CO$_2$ and H$_2$O is contained in the
   (A) nucleus
   (B) vacuole
   (C) cytoplasm
   (D) chloroplast
   (E) centrosome
23. Which of the following statements is true for red blood cells that have been added to a flask of saturated NaCl solution?

(A) The cells will undergo mitosis.
(B) The cells will increase in volume.
(C) The cells will lose water.
(D) The cells are hypertonic relative to the surrounding medium.
(E) The concentration of NaCl is lower outside the cells than inside.

24. Today's worldwide human population can best be described as

(A) oscillating
(B) declining
(C) fluctuating near equilibrium
(D) growing arithmetically
(E) growing exponentially

25. The base of the food web of the open ocean is provided by

(A) phytoplankton
(B) zooplankton
(C) kelp
(D) fish
(E) whales

26. Nitrogen fixation is the conversion of atmospheric nitrogen into

(A) ammonia
(B) protein
(C) urea
(D) carbon dioxide
(E) DNA

22. In the diagram of the human skeleton above, which of the following is a ball-and-socket joint?

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5
27. In the fruit fly, the allele for normal wings (W) is dominant over the allele for vestigial wings (w). A cross of two normal-winged flies produced 76 normal-winged and 23 vestigial-winged offspring. It can be concluded that the genotypes of the two parent flies were which of the following?

(A) WW and ww
(B) WW and Ww
(C) Ww and ww
(D) Ww and Ww
(E) WW and WW

28. Factors that have been known to result in the elimination of a species in a particular area include which of the following?

I. Use of insecticides
II. Hunting of the species' prey
III. Habitat destruction

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

29. According to the partial karyotype of a mammal shown above, which of the following must be true?

(A) The organism has a single gene defect.
(B) The organism is a male.
(C) The organism is a homozygote.
(D) The organism is a human.
(E) The alleles on both chromosomes labeled 3 are identical.

30. An organism is examined and is found to be multicellular and heterotrophic and to have cell walls made of a substance other than cellulose. The organism belongs to which of the following kingdoms?

(A) Monera
(B) Protista
(C) Fungi
(D) Plantae
(E) Animalia
31. Which of the following statements is correct?
   (A) Heritable variation allows for evolution.
   (B) Adaptive radiation allows for mutation.
   (C) Crossing-over allows for mitosis.
   (D) Translocation allows for DNA replication.
   (E) Cellular differentiation allows for meiosis.

32. Behavior that remains unaffected by environmental changes is most likely
   (A) territorial
   (B) learned
   (C) innate
   (D) stereotyped
   (E) conditioned

33. A man who has hemophilia and a woman who does not have hemophilia have a daughter who has hemophilia. Hemophilia is a recessive condition, and the gene is located on the X chromosome. Which of the following can be concluded?
   (A) The mother is a carrier for hemophilia.
   (B) Hemophilia is not a sex-linked trait.
   (C) Crossing-over has occurred.
   (D) All subsequent daughters of this couple will have hemophilia.
   (E) All sons of this couple will have hemophilia.

34. All of the following are measures useful in describing a given population's growth rate EXCEPT
   (A) fertility
   (B) mortality
   (C) survivorship
   (D) age structure
   (E) habitat

35. Which of the following is LEAST consistent with the fossil record?
   (A) Bony fish evolved from amphibians.
   (B) Mammals evolved from reptiles.
   (C) Birds evolved from reptiles.
   (D) Reptiles evolved from amphibians.
   (E) Cartilaginous fish evolved from jawless fish.

36. Which of the following is NOT true of enzymes?
   (A) Enzyme activity is affected by changes in temperature.
   (B) Enzymes change the rate at which biochemical reactions proceed.
   (C) Enzyme activity is affected by large shifts in pH.
   (D) Enzymes often require the presence of cofactors or coenzymes to become active.
   (E) Enzymes are assembled from vitamin subunits.

37. The gene for a particular trait that is passed only from fathers to sons is most likely
   (A) autosomal recessive
   (B) autosomal dominant
   (C) codominant
   (D) Y-linked
   (E) X-linked
38. The diagram above illustrates a proposed phylogeny for horses. Which of the following genera is currently represented by live animals?

(A) Epihippus  
(B) Equus  
(C) Hippidion  
(D) Hyracotherium  
(E) Nannippus
39. Which of the following organelles in human sperm provides the energy needed by the sperm?
   (A) Flagellum
   (B) Mitochondrion
   (C) Y chromosome
   (D) Centriole
   (E) Nucleus

40. Which of the following organs secretes the hormone responsible for the “fight-or-flight” reaction in mammals?
   (A) Liver
   (B) Kidney
   (C) Pancreas
   (D) Cowper’s gland
   (E) Adrenal gland

41. Most replication of DNA takes place during which of the following stages of the cell cycle?
   (A) I
   (B) II and III
   (C) IV only
   (D) IV and V
   (E) VI
42. Which of the following is a biotic factor that can make a major contribution to the regulation of a population in a given community?
(A) The annual pattern of rainfall
(B) The average ratio of \( \text{O}_2 \) to \( \text{CO}_2 \)
(C) The annual pattern of daily temperature ranges
(D) The rate of weathering of rocks into soil
(E) The number of predators and competitors

43. Characteristics of adult echinoderms such as sea stars (starfish) include which of the following?
I. Tube feet
II. Bilateral symmetry
III. Water vascular system
(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

44. If in an adult organism the genes \( A \) and \( B \) occur on one chromosome and their alleles \( a \) and \( b \) occur on its homologue, which of the following explains a combination of \( Ab \) or \( aB \) occurring in the gametes?
(A) Sex-linkage
(B) Lack of dominance
(C) Nondisjunction
(D) Crossing-over
(E) Blending

45. Which of the following is NOT a major function of the mammalian kidney?
(A) Elimination of urea and other nitrogenous wastes
(B) Maintenance of water balance
(C) Manufacture of antibodies
(D) Regulation of salt excretion
(E) Formation of urine from glomerular filtrate

46. An ecologically sound reason for conserving tropical rain forests is that they:
(A) supply most of the oxygen that humans breathe
(B) occupy four-fifths of Earth's surface
(C) are the major producers of atmospheric nitrogen
(D) are crucial to migratory ungulates like bison and wildebeest
(E) are an important reservoir of biodiversity
Questions 47-48

A population study of plants was done in an abandoned field. Each year for 3 years the vegetation was sampled. The chart below indicates the results of the study.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sandspur</th>
<th>Ragweed</th>
<th>Timothy Grass</th>
<th>Goldenrod</th>
<th>Wire Grass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3,800</td>
<td>4,900</td>
<td>600</td>
<td>0</td>
<td>412</td>
</tr>
<tr>
<td>2</td>
<td>1,500</td>
<td>2,209</td>
<td>1,185</td>
<td>75</td>
<td>796</td>
</tr>
<tr>
<td>3</td>
<td>752</td>
<td>180</td>
<td>2,234</td>
<td>790</td>
<td>1,643</td>
</tr>
</tbody>
</table>

47. According to the data, which of the following are initially most successful in the succession taking place in the field described above?

(A) Sandspur and ragweed
(B) Sandspur and timothy grass
(C) Ragweed and timothy grass
(D) Ragweed and wire grass
(E) Sandspur and goldenrod

48. The data above suggest that

(A) fires cause the changes in the populations
(B) floods cause the changes in the populations
(C) the plants in the population have similar life spans
(D) plant populations are replacing one another
(E) the reproductive capacity of plants changes with time
Questions 49-51

The figure below represents the increase in prevalence of both keratoses (thickened pigmented patches on the skin) and skin cancers in males of Irish descent in several geographic areas.

50. Which of the following can be inferred from these data?
(A) Skin cancers develop from keratoses.
(B) Keratoses develop from skin cancers.
(C) The majority of males with keratoses also have skin cancer.
(D) The environment in Australia is more likely to cause keratoses than is the environment in Ireland.
(E) The intensity of sunlight is the primary factor causing the development of skin cancers.

51. If the study were conducted as a function of the age of the female population in the same geographic areas, which of the following results would be most likely?
(A) The data would show a higher percentage of females with the diseases at all ages.
(B) The data would show a lower incidence of the diseases, because females have higher levels of estrogen.
(C) The data would be the same as for males in Australia and Ireland, but no predictions can be made for Texas.
(D) The data would be the same as for males with regard to keratoses but not for skin cancers.
(E) No accurate predictions can be made from the data because the sample populations would be different.
NO TEST MATERIAL ON THIS PAGE
Questions 52-55

Charles Darwin and his son Francis performed a series of experiments on phototropism (growth toward light) of the coleoptile (the cap that covers the first leaves of new seedlings of grass). The treatments they used are described below:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Growth Toward Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: Coleoptile untreated.</td>
<td>Allowed</td>
</tr>
<tr>
<td>II: Tip of coleoptile cut off.</td>
<td>Prevented</td>
</tr>
<tr>
<td>III: Opaque cap placed over coleoptile tip.</td>
<td>Prevented</td>
</tr>
<tr>
<td>IV: Coleoptile cut halfway through.</td>
<td>Allowed</td>
</tr>
<tr>
<td>V: Transparent cap placed over coleoptile tip.</td>
<td>Allowed</td>
</tr>
<tr>
<td>VI: Opaque sleeve placed over base of coleoptile.</td>
<td>Allowed</td>
</tr>
</tbody>
</table>

52. Comparison of treatments I and II shows which of the following?

(A) Growth is promoted by cutting off the tip.
(B) The tip is the site of sensing light.
(C) The tip is the site of auxin synthesis.
(D) The tip is necessary for the response to light.
(E) There is a range of response to a single treatment.

53. The fact that the effect of cutting off the tip (treatment II) is not simply due to wounding of the plant is demonstrated by comparison of which of the following treatments?

(A) IV and V
(B) I, II, and III
(C) I, II, and IV
(D) II, III, and IV
(E) IV, V, and VI
54. Comparison of treatments III, V, and VI shows that
(A) the tip plays a role in sensing the light
(B) the base plays a role in sensing the light
(C) confinement of the tip inhibits the response to light
(D) confinement of the base facilitates the response to light
(E) confinement reverses the response to light

55. To test the hypothesis that the response to light involves differential cell elongation, an experimenter could
(A) measure the distance between marks made on the seedling after it has bent
(B) count the number of cells visible in a cross section of the coleoptile
(C) compare the length of cells on the sides of the stem toward and away from the light
(D) determine whether mitosis is affected by light
(E) repeat the experiment using light of a different wavelength
During normal development of the sea urchin, the egg divides once to give two cells. Each of these cells divides again. The cells continue to divide and, eventually, a sea-urchin larva is formed. It is possible to separate the cells of a young sea-urchin embryo and allow them to develop independently. The results of several such experiments are shown below.

56. Experiment I suggests that
- (A) sea urchins would be better adapted if they had smaller eggs
- (B) embryo cells are committed to different developmental fates
- (C) different cells of an embryo can have equal potential for development
- (D) a particular cell of an embryo always develops into the same structure
- (E) cell division ensures that both cells will develop identically

57. Experiments I and II suggest that
- (A) sea-urchin embryos often grow to full-size adults
- (B) larva size is determined by the amount of material in the embryo
- (C) development must always occur the same way in every embryo
- (D) embryo cells do not interact with each other
- (E) natural selection favors the formation of small larvae
58. Experiments III and IV together suggest that
(A) there is a difference between separating cells along the vertical axis and the horizontal axis of an eight-cell embryo
(B) embryo cells cannot be separated without damaging development
(C) material at the top of the embryo is the same as material at the bottom
(D) cells divide correctly only when they are vertical
(E) embryo cells do not differ until gastrulation

59. The different results in experiments III and IV probably are caused by
(A) failure of mitosis to occur normally at the third cell division
(B) loss of chromosomes by the top four cells
(C) fertilization of the top and bottom of the egg by two different sperm
(D) different genes being expressed in the top four cells than in the bottom four cells
(E) some genes in the left half of the embryo that are different from those in the right half of the embryo

60. Which of the following questions is NOT addressed by this series of experiments?
(A) When do the cells of an embryo become different from each other?
(B) Can cells of an embryo survive when separated from each other?
(C) Can smaller larvae be produced by experimental manipulation?
(D) When are components in the fertilized egg activated?
(E) Can the cells of an embryo be made to develop abnormally?
61. Stream and river ecosystems differ from other aquatic ecosystems because streams and rivers
(A) move continuously in one direction and have a nutrient content that is dependent on location
(B) support a greater diversity of aquatic plants
(C) have highly variable salinity
(D) include the greatest biodiversity of all ecosystems because of the fluctuating water levels
(E) support the largest stationary plankton communities

62. A trophic level within an ecosystem is best characterized by the
(A) size of food eaten at that level
(B) nutrient source of the organisms in each level
(C) stages in ecological succession
(D) habitats of the organisms within that level
(E) elevation above sea level

63. According to most scientific theories of the origin of life, the first organisms were
(A) eukaryotic
(B) parasitic
(C) symbiotic
(D) anaerobic
(E) pathogenic

64. The global cycles of nitrogen and phosphorus differ in that
(A) nitrogen is recycled whereas phosphorus is not
(B) animals get most of their nitrogen from the water they drink whereas they get their phosphorus from the food they eat
(C) nitrogen occurs primarily in deep sediments whereas phosphorus occurs primarily in the atmosphere
(D) nitrogen is lost to the oceans whereas phosphorus is not
(E) nitrogen has a gaseous phase whereas phosphorus does not
67. The term “adaptive radiation” refers to the
(A) ability of one species to adapt to only one
    niche
(B) ability of a species to adapt itself to rapidly
    changing conditions
(C) evolution from a single ancestral species
    into several species adapted to various
    environments
(D) ability of a species to adjust its temperature
    by radiating heat
(E) advantages of radial symmetry to a stationary
    species

68. Which of the following does NOT refer primarily
to a relationship between members of different
species?
(A) Mutualism
(B) Hibernation
(C) Parasitism
(D) Commensalism
(E) Predation

69. Plant seeds can be dispersed by which of the
following?
   I. Wind
   II. Water
   III. Birds

(A) I only
(B) III only
(C) I and II only
(D) I and III only
(E) I, II, and III
Questions 70 - 72

Both types of Barnacles, Balanus and Chthamalus, grow on rocks that are exposed during low tide; when immersed at high tide, they feed on organic particles suspended in the water.

(A)  
(B) 3 months after removal of Balanus  
(C) 12 months after removal of Balanus

⊙: Chthamalus  
☑: Balanus
70. Since both species of barnacles have free-swimming larvae that settle on hard surfaces, the change in the distribution of Chthamalus observed 3 months after removal of the larger Balanus individuals could best be explained by which of the following?

(A) Balanus feeds on Chthamalus larvae.
(B) Balanus does not reproduce as quickly as Chthamalus.
(C) Balanus has less tolerance for wet conditions.
(D) Balanus adults are mobile.
(E) Balanus is less susceptible to predators.

71. The distribution of the two species at 3 and 12 months suggests all of the following EXCEPT:

(A) Balanus sometimes dominates over the smaller Chthamalus.
(B) Chthamalus can tolerate more drying than Balanus.
(C) Balanus adults are swept away more often than Chthamalus.
(D) Balanus and Chthamalus larvae can settle in the same area.
(E) Balanus is larger and thus needs more feeding time in the water.

72. Based on this study, on rocks with tops below the midtide line, it can be predicted that

(A) more of the rock surface would be covered by Chthamalus
(B) the two barnacle populations would be equal
(C) there would be few, if any, Balanus
(D) there would be few, if any, Chthamalus
(E) Balanus individuals would become smaller
Questions 73-75 refer to the following experiment in which an agar petri dish was prepared as shown below. Using aseptic techniques, an experimenter spread *E. coli* bacteria on the agar uniformly throughout the dish. The dish was then incubated at 37°C for 24 hours.

73. Which of the following distributions of bacterial colonies is most likely to be observed on completion of the experiment? (Dots represent bacterial colonies.)

(A) ![Diagram A]

(B) ![Diagram B]

(C) ![Diagram C]

(D) ![Diagram D]

(E) ![Diagram E]
74. The cells that survived exposure to penicillin were most likely able to do so because they
(A) mutated as a result of the exposure
(B) had a more rapid metabolism than the other cells
(C) lacked cell walls
(D) already possessed penicillin resistance
(E) formed spores

75. In the experiment, penicillin causes a stress that, in an ecosystem, would promote
(A) natural selection
(B) Lamarckian evolution
(C) competition
(D) mutation
(E) parasitism
BIOLOGY-E TEST—Continued

Questions 76-80

A scientist studied a field that had been burned in a brushfire ten years before. She identified seven different species and produced the table below.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Gross Form</th>
<th>Microscopic Form</th>
<th>Stem Form</th>
<th>Color</th>
<th>Reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Platismatia glauca</em></td>
<td>sheetlike</td>
<td>eukaryotic and prokaryotic filaments</td>
<td>not applicable</td>
<td>green on top white below</td>
<td>none evident</td>
</tr>
<tr>
<td><em>Funaria americana</em></td>
<td>cushionlike</td>
<td>eukaryotic multicellular</td>
<td>not applicable</td>
<td>green throughout</td>
<td>spore-producing structures on stalks</td>
</tr>
<tr>
<td><em>Dryopteris spinulosa</em></td>
<td>roots, underground stems, compound leaves</td>
<td>eukaryotic multicellular</td>
<td>fleshy</td>
<td>green leaves, white stem and roots</td>
<td>spores on underside of leaves</td>
</tr>
<tr>
<td><em>Picea rubens</em></td>
<td>roots, stems, needlelike leaves</td>
<td>eukaryotic multicellular</td>
<td>erect, woody</td>
<td>green leaves, brown stem and roots</td>
<td>cones</td>
</tr>
<tr>
<td><em>Smilax herbacea</em></td>
<td>roots, vine, broad leaves</td>
<td>eukaryotic multicellular</td>
<td>erect, herbaceous</td>
<td>green leaves and stem, white roots</td>
<td>flowers</td>
</tr>
<tr>
<td><em>Smilax rotundifolia</em></td>
<td>roots, woody vine, broad leaves</td>
<td>eukaryotic multicellular</td>
<td>erect</td>
<td>green leaves, brown stem and roots</td>
<td>none evident</td>
</tr>
<tr>
<td><em>Monotropa uniflora</em></td>
<td>roots, stems, broad leaves</td>
<td>eukaryotic multicellular</td>
<td>erect</td>
<td>white throughout</td>
<td>fruits</td>
</tr>
</tbody>
</table>

76. The organism that evolutionarily is most closely related to *Smilax herbacea* is

(A) *Platismatia glauca*  
(B) *Dryopteris spinulosa*  
(C) *Picea rubens*  
(D) *Smilax rotundifolia*  
(E) *Monotropa uniflora*

77. Symbiosis is best illustrated by which of the following organisms?

(A) *Platismatia glauca*  
(B) *Dryopteris spinulosa*  
(C) *Picea rubens*  
(D) *Smilax herbacea*  
(E) *Smilax rotundifolia*
78. Which of the following shows the simplest level of physical organization?
(A) Funaria americana  
(B) Monotropa uniflora  
(C) Dryopteris spinulosa  
(D) Picea rubens  
(E) Smilax rotundifolia

79. Which of the following is most likely a flowering plant?
(A) Platismatia glauca  
(B) Funaria americana  
(C) Dryopteris spinulosa  
(D) Picea rubens  
(E) Monotropa uniflora

80. The appearance of these plants in the burned area is an example of what biological process?
(A) Evolution by natural selection  
(B) Succession  
(C) Mutation  
(D) Eutrophication  
(E) Recombination

STOP

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THE ENTIRE BIOLOGY-E TEST.
81. Which of the following is correct about the phospholipid shown above?

(A) Only I would be found in the middle of the lipid bilayer.
(B) Only II would be found in the middle of the lipid bilayer.
(C) Both I and II would be found in the middle of the lipid bilayer.
(D) II is hydrophilic.
(E) I and II are hydrophobic.
82. Products of the light reactions of photosynthesis that later participate in the dark reactions of photosynthesis include which of the following?

I. Reduced NADP (NADPH)
II. ATP
III. O₂

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

83. The way in which an enzyme and its specific substrate interact is best described by the

(A) fluid-mosaic model
(B) induced-fit model
(C) Oparin hypothesis
(D) Lyon hypothesis
(E) competitive-exclusion principle

84. If a somatic cell in a diploid organism contains ten pairs of chromosomes, what is the total number of chromatids that are present in the cell after the DNA has replicated but before mitosis has taken place?

(A) 10
(B) 20
(C) 30
(D) 40
(E) 80

85. Which of the following atmospheric gases shows a net release during photosynthesis in plants?

(A) Carbon dioxide
(B) Oxygen
(C) Methane
(D) Hydrogen
(E) Nitrogen

86. Which of the following are the final products of fermentation?

(A) Carbon and oxygen
(B) Glucose and alcohol
(C) Carbon dioxide and oxygen
(D) Carbon dioxide and alcohol
(E) Oxygen and water

87. A function of transfer RNA is to

(A) receive the genetic information from nuclear DNA
(B) store the genetic information in the nucleus
(C) store RNA in the ribosomes
(D) transfer the genetic information from the nucleus to the cytoplasm
(E) position amino acids for protein synthesis by pairing with codons in messenger RNA
88. Which of the following statements most accurately describes a basic difference between mitosis and meiosis?

(A) Homologous chromosomes form tetrads in mitosis but not in meiosis.
(B) Homologous chromosomes form tetrads in meiosis but not in mitosis.
(C) The nuclear membrane disappears in mitosis but not in meiosis.
(D) A spindle forms in mitosis but not in meiosis.
(E) A spindle forms in meiosis but not in mitosis.

89. The Bt protein produced in the bacterium, Bacillus thuringiensis, kills corn earworms that ingest the Bacillus. If the Bt gene were transferred to corn so that corn could express the Bt protein, which of the following would be expected to occur when corn earworms eat the corn?

I. Corn earworms that eat the Bt corn would be killed.
II. Bacillus bacteria that infect the Bt corn would be killed.
III. The corn earworms would incorporate the Bt gene into their chromosomes.

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

90. The wavelengths of light absorbed by chlorophyll are similar to the wavelengths of light that are associated with the greatest amount of oxygen release by plants. Based on these observations which of the following is a reasonable hypothesis about the function of chlorophyll?

(A) It plays a role in cell respiration.
(B) It plays a role in the light reactions of photosynthesis.
(C) It takes part in \( H_2O \) release.
(D) It takes part in \( CO_2 \) fixation.
(E) It generates energy.

91. Cellular respiration shares which of the following characteristics with the light-dependent reactions of photosynthesis?

(A) Production of ATP
(B) Production of AMP
(C) Production of GTP
(D) Production of oxygen
(E) Use of carbon dioxide in synthetic reactions

92. The position of a mutation in a gene and the location of an altered amino acid sequence in the corresponding protein are

(A) not related
(B) inversely related
(C) related in bacteria but not in mammals
(D) species-dependent
(E) in the same relative position

93. In order for an animal that was cloned from its mother to grow and develop normally, it must have received

(A) half of its mother's DNA sequences
(B) half of its father's RNA sequences
(C) all of its mother's RNA sequences
(D) all of its father's DNA sequences
(E) all of its mother's DNA sequences
Questions 94-97

Bowls 1 and 7 — water only
Bowls 2 and 8 — water + 20 water plants
Bowls 3 and 9 — water + 40 water plants
Bowls 4 and 10 — water + 2 goldfish
Bowls 5 and 11 — water + 4 goldfish
Bowls 6 and 12 — water + 20 water plants + 2 goldfish

A biologist set up 12 bowls as described above. She exposed bowls 1 to 6 to light for 24 hours and placed bowls 7 to 12 in the dark for 24 hours. She determined the CO₂ content of the water in micromoles per liter for each bowl at the end of the 24 hours. The results are indicated below.

<table>
<thead>
<tr>
<th>Bowls</th>
<th>CO₂ in light (μmol/L)</th>
<th>Bowls</th>
<th>CO₂ in dark (μmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.0</td>
<td>7</td>
<td>10.2</td>
</tr>
<tr>
<td>2</td>
<td>4.3</td>
<td>8</td>
<td>13.7</td>
</tr>
<tr>
<td>3</td>
<td>2.1</td>
<td>9</td>
<td>16.9</td>
</tr>
<tr>
<td>4</td>
<td>14.9</td>
<td>10</td>
<td>14.1</td>
</tr>
<tr>
<td>5</td>
<td>18.3</td>
<td>11</td>
<td>17.9</td>
</tr>
<tr>
<td>6</td>
<td>10.2</td>
<td>12</td>
<td>19.2</td>
</tr>
</tbody>
</table>

94. The process responsible for the relatively low concentrations of CO₂ in bowls 2 and 3 is

(A) respiration
(B) fermentation
(C) photosynthesis
(D) photoperiodism
(E) transpiration

95. The main controls for bowl 4 are

(A) 1 and 3
(B) 1 and 6
(C) 1 and 10
(D) 2 and 5
(E) 2 and 8

96. The difference in CO₂ concentrations for bowls 2 and 6 can best be explained by

(A) photosynthesis carried out by water plants
(B) respiration carried out by water plants
(C) respiration carried out by goldfish
(D) competition between water plants and goldfish
(E) experimental error

97. Which of the following is the best explanation for the fact that the CO₂ concentration of bowl 4 is almost the same as that of bowl 10 and the CO₂ concentration of bowl 5 is almost the same as that of bowl 11?

(A) Photosynthesis does not occur in the light.
(B) Photosynthesis does not occur in the dark.
(C) Respiration and photosynthesis occur at the same rate in the light.
(D) Respiration is not affected by either light or dark.
(E) Goldfish are more active in the absence than in the presence of plants.
98. In the electrophoresis experiment described, the distance moved by a fragment within the electric field is influenced by which of the following?

I. The number of amino acids in the fragment
II. The amount of electric current used in the apparatus
III. The porosity of the gel matrix

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

99. Which of the following techniques could have been used as an alternative to electrophoresis to separate the products of digestion with enzyme Z?

I. Translation
II. Chromatography
III. Serial dilution

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

100. Of the two fragments resulting from the digestion of the protein with enzyme Z, one is larger and the other is smaller than either of the fragments resulting from the digestion with enzyme Y. The most logical explanation for this is that

(A) the protein fragments produced by enzyme Y have the same molecular weights as those produced by enzyme Z
(B) proteins are produced by ribosomes
(C) enzymes Y and Z have different amino acid sequences
(D) electric current is divided into discrete units
(E) the protein is cut at different amino acid sequences by enzymes Y and Z

STOP

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THE ENTIRE BIOLOGY-M TEST.
Questions 98-100 refer to the following experimental procedure.

A protein is purified from a frog embryo. The protein sample is divided into five fractions. One fraction is not treated. The other fractions are partially digested by using enzymes that act on specific amino acid sequences. In every case, the digestions are carried out at the appropriate temperature and pH. The samples are then separated by electrophoresis as shown below.

<table>
<thead>
<tr>
<th>Unaltered Protein</th>
<th>Protein Digested by Enzyme X</th>
<th>Protein Digested by Enzyme Y</th>
<th>Protein Digested by Enzyme Z</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>