

# AP<sup>®</sup> Biology Exam

## SECTION I: Multiple-Choice Questions

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.**

### At a Glance

**Total Time**

1 hour and 30 minutes

**Number of Questions**

69

**Writing Instrument**

Pencil required

### Instructions

Section I of this examination contains 69 multiple-choice questions. These are broken down into Part A (63 multiple-choice questions) and Part B (6 grid-in questions).

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. After you have decided which of the suggested answers is best, completely fill in the corresponding oval on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

### Sample Question

Chicago is a

- (A) state
- (B) city
- (C) country
- (D) continent

### Sample Answer

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

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all the multiple-choice questions.

### About Guessing

Many candidates wonder whether or not to guess the answers to questions about which they are not certain. Multiple choice scores are based on the number of questions answered correctly. Points are not deducted for incorrect answers, and no points are awarded for unanswered questions. Because points are not deducted for incorrect answers, you are encouraged to answer all multiple-choice questions. On any questions you do not know the answer to, you should eliminate as many choices as you can, and then select the best answer among the remaining choices.

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BIOLOGY  
SECTION I

Time—1 hour and 30 minutes

**Directions:** Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

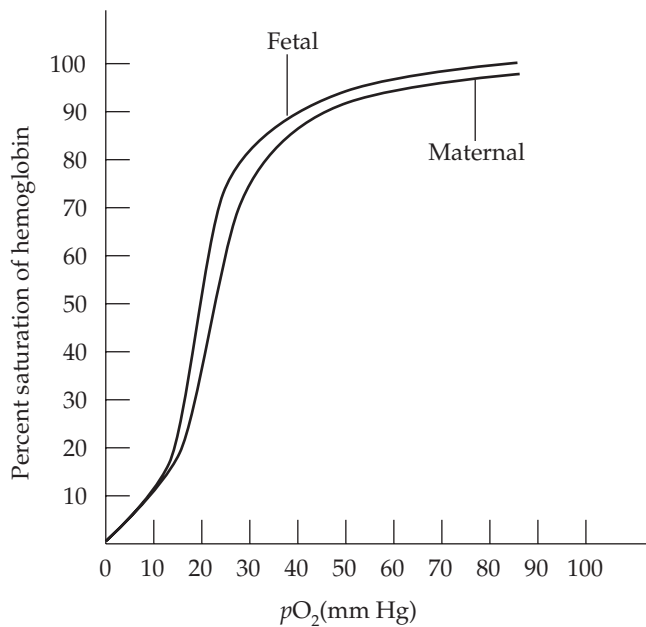
- In general, animal cells differ from plant cells in that animal cells have
  - a cell wall made of cellulose
  - lysosomes
  - large vacuoles that store water
  - centrioles within centrosomes
- A cell from the leaf of the aquatic plant *Elodea* was soaked in a 15 percent sugar solution, and its contents soon separated from the cell wall and formed a mass in the center of the cell. All of the following statements are true about this event EXCEPT:
  - The vacuole lost water and became smaller.
  - The space between the cell wall and the cell membrane expanded.
  - The large vacuole contained a solution with much lower osmotic pressure than that of the sugar solution.
  - The concentration of solutes in the extracellular environment is hypertonic with respect to the cell's interior.
- A chemical agent is found to denature all enzymes in the synaptic cleft. What effect will this agent have on acetylcholine?
  - Acetylcholine will not be released from the presynaptic membrane.
  - Acetylcholine will not bind to receptor proteins on the postsynaptic membrane.
  - Acetylcholine will not diffuse across the cleft to the postsynaptic membrane.
  - Acetylcholine will not be degraded in the synaptic cleft.
- The base composition of DNA varies from one species to another. Which of the following ratios would you expect to remain constant in the DNA?
  - Cytosine : Adenine
  - Pyrimidine : Purine
  - Adenine : Guanine
  - Guanine : Deoxyribose
- In reptile eggs, the extraembryonic membrane that functions in excretion and respiration is the
  - amnion
  - chorion
  - allantois
  - yolk sac
- Consider the following enzyme pathway:
 
$$A \xrightarrow{1} B \xrightarrow{2} C \xrightarrow{3} D \xrightarrow{4} E \xrightarrow{5} F$$

$$C \xrightarrow{6} X \xrightarrow{7} Y$$

An increase in substance F leads to the inhibition of enzyme 3. All of the following are results of the process EXCEPT

  - an increase in substance X
  - increased activity of enzyme 6
  - decreased activity of enzyme 4
  - increased activity of enzyme 5
- The liver is a vital organ that performs all of the following functions EXCEPT
  - storing amino acids that were absorbed in the capillaries of the small intestine
  - detoxifying harmful substances such as alcohol or certain drugs
  - synthesizing bile salts that emulsify lipids
  - breaking down peptides into amino acids

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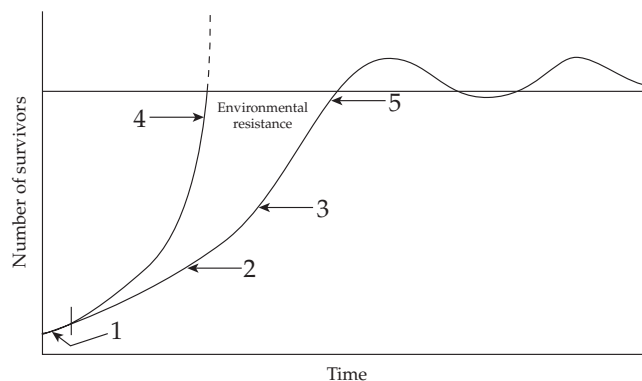
8. The graph above shows the oxygen dissociation curves of maternal hemoglobin and fetal hemoglobin. Based on the graph, it can be concluded that
- fetal hemoglobin surrenders  $O_2$  more readily than maternal hemoglobin
  - the dissociation curve of fetal hemoglobin is to the right of maternal hemoglobin
  - fetal hemoglobin has a higher affinity for  $O_2$  than does maternal hemoglobin
  - fetal and maternal hemoglobin differ in structure
9. In minks, the gene for brown fur (B) is dominant over the gene for silver fur (b). Which set of genotypes represents a cross that could produce offspring with silver fur from parents that both have brown fur?
- $BB \times BB$
  - $BB \times Bb$
  - $Bb \times Bb$
  - $Bb \times bb$
10. Hemoglobin is a molecule that binds to both  $O_2$  and  $CO_2$ . There is an allosteric relationship between the concentrations of  $O_2$  and  $CO_2$ . Hemoglobin's affinity for  $O_2$
- decreases as blood pH decreases
  - increases as  $H^+$  concentration increases
  - increases in exercising muscle tissue
  - decreases as  $CO_2$  concentration decreases
11. All viruses contain at least these two principal components:
- DNA and proteins
  - nucleic acid and a capsid
  - DNA and cell membrane
  - RNA and cell wall
12. All of the following are differences between prokaryotes and eukaryotes EXCEPT
- eukaryotes have linear chromosomes, while prokaryotes have circular chromosomes
  - eukaryotes possess double stranded DNA, while prokaryotes possess single stranded DNA
  - eukaryotes process their mRNA, while in prokaryotes transcription and translation occur simultaneously
  - eukaryotes contain membrane-bound organelles, prokaryotes do not
13. In humans, fertilization normally occurs in the
- ovary
  - fallopian tube
  - uterus
  - placenta
14. The development of an egg without fertilization is known as
- meiosis
  - parthenogenesis
  - embryogenesis
  - vegetative propagation

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15. All of the following are examples of hydrolysis EXCEPT
- (A) conversion of fats to fatty acids and glycerol
  - (B) conversion of proteins to amino acids
  - (C) conversion of starch to simple sugars
  - (D) conversion of pyruvic acid to acetyl CoA
16. In cells, which of the following can catalyze reactions involving hydrogen peroxide, provide cellular energy, and make proteins, in that order?
- (A) Peroxisomes, mitochondria, and ribosomes
  - (B) Peroxisomes, mitochondria, and lysosomes
  - (C) Peroxisomes, mitochondria, and Golgi apparatus
  - (D) Lysosomes, chloroplasts, and ribosomes
17. All of the following play an important role in regulating respiration in humans EXCEPT
- (A) an increase in the amount of  $\text{CO}_2$  in the blood
  - (B) a decrease in the amount of  $\text{O}_2$  in the blood
  - (C) a decrease in the plasma pH level
  - (D) strenuous exercise
18. The primary site of glucose reabsorption is the
- (A) glomerulus
  - (B) proximal convoluted tubule
  - (C) loop of Henle
  - (D) collecting duct

Questions 19 and 20 refer to the graph.

The graph below shows the growth curve of a bacterial culture.



19. Which of the following represents the carrying capacity of the environment?
- (A) 2
  - (B) 3
  - (C) 4
  - (D) 5
20. Which of the following shows the exponential growth curve of the population?
- (A) 1
  - (B) 2
  - (C) 3
  - (D) 4

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21. All of the following statements are true EXCEPT:
- (A) Thyroxine increases the rate of metabolism.
  - (B) Insulin decreases storage of glycogen.
  - (C) Vasopressin stimulates water reabsorption in the kidney.
  - (D) Epinephrine increases blood sugar levels and heart rate.
22. Metafemale syndrome, a disorder in which a female has an extra X chromosome, is the result of nondisjunction. The failure in oogenesis that could produce this would occur in
- (A) metaphase I
  - (B) metaphase II
  - (C) telophase I
  - (D) anaphase II
23. In plants, the tendency of climbing vines to twine their tendrils around a trellis is called
- (A) thigmotropism
  - (B) hydrotropism
  - (C) phototropism
  - (D) geotropism
24. Females with Turner's syndrome have a high incidence of hemophilia, a recessive, X-linked trait. Based on this information, it can be inferred that females with this condition
- (A) have an extra X chromosome
  - (B) have an extra Y chromosome
  - (C) lack an X chromosome
  - (D) have red blood cells that clump
25. When a retrovirus inserted its DNA into the middle of a bacterial gene, it altered the normal reading frame by one base pair. This type of mutation is called
- (A) duplication
  - (B) translocation
  - (C) inversion
  - (D) frameshift mutation
26. High levels of estrogen from maturing follicles inhibit the release of gonadotropin releasing hormone (GnRH). Which of the following endocrine glands produces GnRH?
- (A) Anterior pituitary
  - (B) Posterior pituitary
  - (C) Hypothalamus
  - (D) Pineal gland
27. The principle inorganic compound found in living things is
- (A) carbon
  - (B) oxygen
  - (C) water
  - (D) glucose
28. Kangaroo rats are better able to concentrate urine than humans are. It would be expected that, compared to the nephrons of human kidneys, the nephrons of kangaroo-rat kidneys would have
- (A) thicker walls, which are impermeable to water
  - (B) shorter loops of Henle
  - (C) longer loops of Henle
  - (D) shorter collecting ducts

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29. All of the following are modes of asexual reproduction EXCEPT
- (A) sporulation
  - (B) fission
  - (C) budding
  - (D) meiosis
30. The moist skin of earthworms, spiracles of grasshoppers, and the mucus membranes lining alveoli are all associated with the process of
- (A) excretion
  - (B) respiration
  - (C) circulation
  - (D) digestion
31. Invertebrate immune systems possess which of the following?
- (A) Cytotoxic T lymphocytes
  - (B) Phagocytes
  - (C) B cells
  - (D) Helper T cells
32. All of the following are examples of connective tissue EXCEPT
- (A) ligaments
  - (B) muscle
  - (C) blood
  - (D) cartilage
33. Photosynthesis requires
- (A) glucose, light,  $\text{CO}_2$
  - (B) light,  $\text{CO}_2$ , water
  - (C) water, soil,  $\text{O}_2$
  - (D)  $\text{O}_2$ , water, light
34. If a forest of fir, birch, and white spruce trees was devastated by fire, which of the following would most likely happen?
- (A) Only animal life would continue to inhabit the region.
  - (B) Secondary succession would begin to occur.
  - (C) Only tough grasses would appear.
  - (D) The number of species would stabilize as the ecosystem matures.
35. Which of the following processes occur in the cytoplasm of an eukaryotic cell?
- I. DNA replication
  - II. Transcription
  - III. Translation
- (A) I only
  - (B) III only
  - (C) II and III only
  - (D) I, II, and III
36. Crossing-over during meiosis permits scientists to determine
- (A) the chance for variation in zygotes
  - (B) the rate of mutations
  - (C) the distance between genes on a chromosome
  - (D) which traits are dominant or recessive
37. An animal cell that is permeable to water but not salts has an internal NaCl concentration of 10%. If placed in freshwater the cell will
- (A) plasmolyze
  - (B) swell and eventually lyse
  - (C) endocytose water into a large central vacuole
  - (D) shrivel

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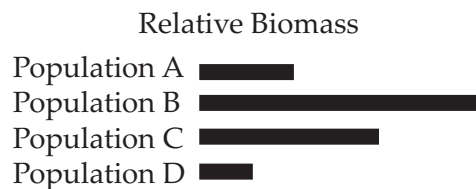
38. Three distinct bird species, flicker, woodpecker, and elf owl, all inhabit a large cactus, *Cereus giganteus*, in the desert of Arizona. Since competition among these birds rarely occurs, the most likely explanation for this phenomenon is that these birds
- (A) have a short supply of resources
  - (B) have different ecological niches
  - (C) do not live together long
  - (D) are unable to breed
39. Lampreys attach to the skin of lake trout and absorb nutrients from its body. This relationship is an example of
- (A) commensalism
  - (B) parasitism
  - (C) mutualism
  - (D) gravitropism
40. The nucleotide sequence of a DNA molecule is 5'-C-A-T-3'. A mRNA molecule with a complementary codon is transcribed from the DNA in the process of protein synthesis a tRNA pairs with a mRNA codon. What is the nucleotide sequence of the tRNA anticodon?
- (A) 5'-G-T-A-3'
  - (B) 5'-G-U-A-3'
  - (C) 5'-C-A-U-3'
  - (D) 5'-U-A-C-3'
41. Viruses are considered an exception to the cell theory because they
- (A) are not independent organisms
  - (B) have only a few genes
  - (C) move about via their tails
  - (D) have evolved from ancestral protists
42. All of the following organs in the digestive system secrete digestive enzymes EXCEPT the
- (A) mouth
  - (B) stomach
  - (C) gall bladder
  - (D) small intestine
43. Memory loss would most likely be due to a malfunction of which part of the brain?
- (A) Medulla
  - (B) Cerebellum
  - (C) Cerebrum
  - (D) Pons

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44. The sequence of amino acids in hemoglobin molecules of humans is more similar to the hemoglobin of chimpanzees than it is to the hemoglobin of dogs. This similarity suggests that
- (A) humans and dogs are more closely related than humans and chimpanzees
  - (B) humans and chimpanzees are more closely related than humans and dogs
  - (C) humans are related to chimpanzees but not to dogs
  - (D) humans and chimpanzees are closely analogous
45. According to the heterotroph hypothesis, which event had to occur before oxygen filled the atmosphere?
- (A) Heterotrophs had to remove carbon dioxide from the air.
  - (B) Autotrophs, which make their own food, had to evolve.
  - (C) Heterotrophs had to evolve.
  - (D) Autotrophs had to convert atmospheric nitrogen to nitrate.
46. Two individuals, one with type B blood and one with type AB blood have a child. The probability that the child has type O blood is
- (A) 0%
  - (B) 25%
  - (C) 50%
  - (D) 100%

Questions 47–48 refer to the bar graph, which shows the relative biomass of four different populations of a particular food pyramid.

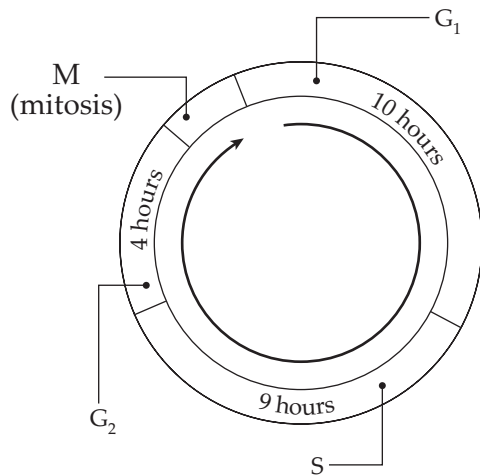


47. The largest amount of energy is available to
- (A) population A
  - (B) population B
  - (C) population C
  - (D) population D
48. Which of the following would be the most likely result if there was an increase in the number of organisms in population C?
- (A) The biomass of population D will remain the same.
  - (B) The biomass of population B will decrease.
  - (C) The biomass of population C will steadily increase.
  - (D) The food source available to population C would increase.

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Questions 49–52 refer to the following illustration and information.

The cell cycle is a series of events in the life of a dividing eukaryotic cell. It consists of four stages:  $G_1$ , S,  $G_2$ , and M. The duration of the cell cycle varies from one species to another, and from one cell type to another. The  $G_1$  phase varies the most. For example, embryonic cells can pass through the  $G_1$  phase so quickly that it hardly exists, whereas neurons are arrested in the cell cycle and do not divide.



49. During which phase do chromosomes replicate?

- (A)  $G_1$
- (B) S
- (C)  $G_2$
- (D) M

50. In mammalian cells, the first sign of prophase is the

- (A) appearance of chromosomes
- (B) separation of chromatids
- (C) disappearance of the nuclear membrane
- (D) replication of chromosomes

51. Mitosis occurs in all of the following types of cells EXCEPT

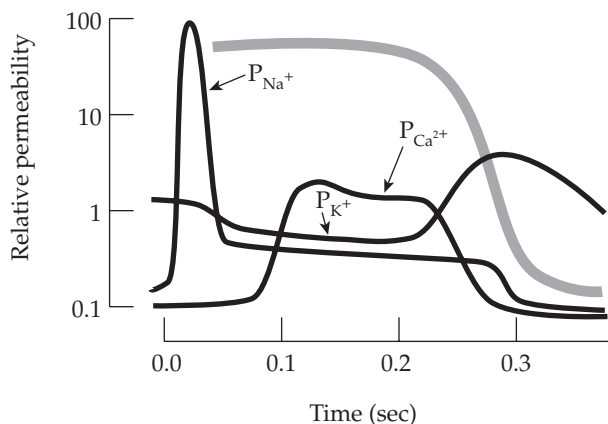
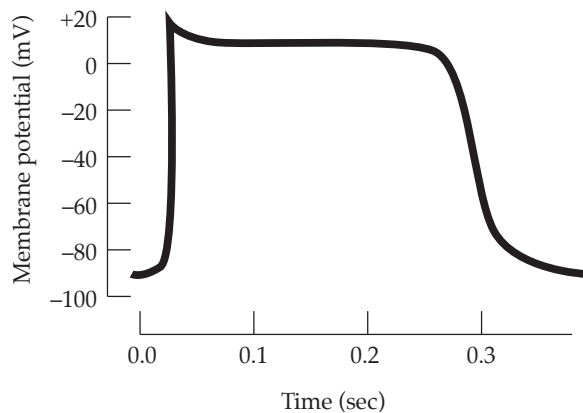
- (A) epidermal cells
- (B) hair cells
- (C) red blood cells
- (D) pancreatic cells

52. Since neurons are destined never to divide again, what conclusion can be made?

- (A) These cells will go through cell division.
- (B) These cells will be permanently arrested in the  $G_1$  phase.
- (C) These cells will be permanently arrested in the  $G_2$  phase.
- (D) These cells will quickly enter the S-phase.

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Questions 53–56 refer to the graphs, which show the permeability of ions during an action potential in a ventricular contractile cardiac fiber. The action potential of cardiac muscle fibers resembles that of skeletal muscles.



53. Based on the graph, the resting membrane potential of the muscle fibers is close to
- (A)  $-90$  mV  
 (B)  $-70$  mV  
 (C)  $0$  mV  
 (D)  $+70$  mV

54. Which of the following statements is true concerning the initial phase of depolarization?
- (A) Voltage-gated  $K^+$  channels open in the plasma membrane.  
 (B) The concentration of  $Ca^{2+}$  ions within the plasma membrane becomes more negative.  
 (C) The membrane potential stays close to  $-40$  mV.  
 (D) The permeability of the sarcolemma to  $Na^+$  ions increases.
55. In cardiac fibers, the duration of an action potential is approximately
- (A) 0.10 secs  
 (B) 0.20 secs  
 (C) 0.25 secs  
 (D) 0.30 secs
56. One major difference between the action potential of cardiac muscle fibers and the action potential of skeletal muscle fibers is that in cardiac muscle fibers
- (A) the membrane is permeable to  $Na^+$ , not  $K^+$   
 (B) voltage-gated  $K^+$  channels open during depolarization, not repolarization  
 (C) depolarization is prolonged compared to that in skeletal muscle fibers  
 (D) the refractory period is shorter than that of skeletal muscle fibers

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Questions 57–60 refer to the data below concerning the general animal body plan of five organisms.

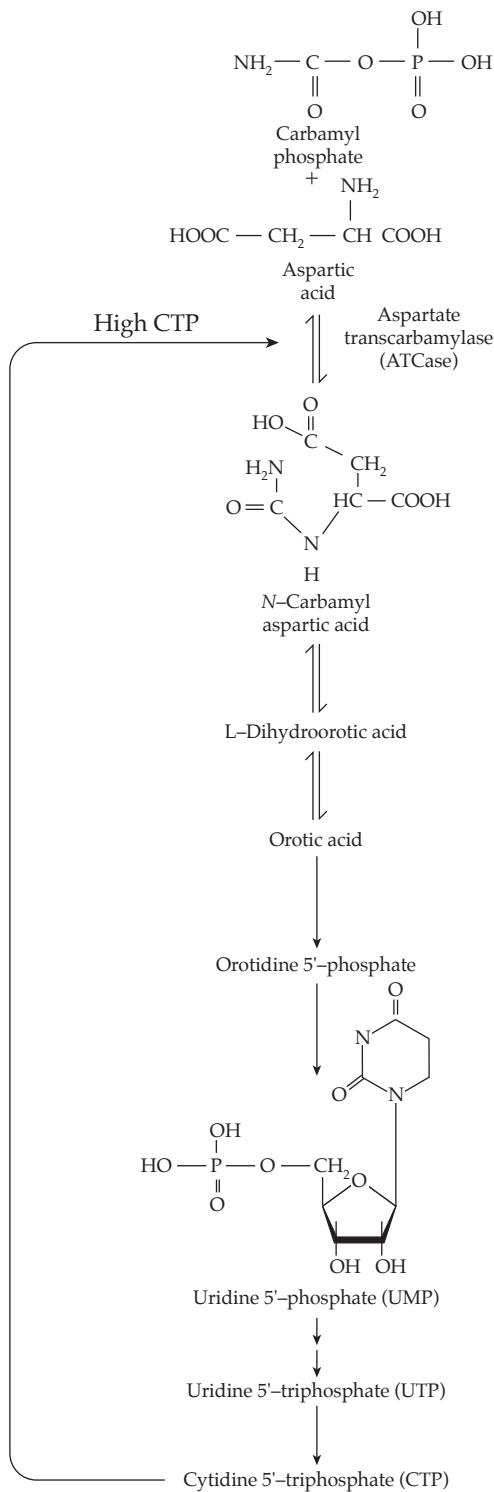
Characteristic	Sea anemone	Hagfish	Eel	Salamander
Vertebral column		+	+	+
Jaws	+		+	+
Walking legs				+

Note: + indicates a feature presence in an organism.

57. The two most closely related organisms are
- (A) sea anemone and hagfish
  - (B) eel and salamander
  - (C) hagfish and eel
  - (D) sea anemone and salamander
58. The correct order of evolution for the traits above is
- (A) jaws – vertebral column – walking legs
  - (B) walking legs - jaws – vertebral column
  - (C) jaws - walking legs – vertebral column
  - (D) vertebral column – jaws – walking legs
59. Pre and post-zygotic barriers exist that prevent two different species from producing viable offspring. All of the following are pre-zygotic barriers EXCEPT
- (A) anatomical differences preventing copulation
  - (B) different temporality of mating
  - (C) sterility of offspring
  - (D) incompatible mating songs
60. Birds and insects have both adapted wings to travel by flight. The wings of birds and insects are an example of
- (A) divergent evolution
  - (B) convergent evolution
  - (C) speciation
  - (D) mutation

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Questions 61–63 refer to the synthetic pathway of a pyrimidine, cytidine 5' triphosphate, CTP. This pathway begins with the condensation of two small molecules by the enzyme, aspartate transcarbamylase (ATCase).



*Regulation of CTP biosynthesis*

61. Which of the following is true when the level of CTP is low in a cell?
- (A) CTP is converted to ATCase  
 (B) The metabolic traffic down the pathway increases  
 (C) ATCase is inhibited, which slows down CTP synthesis  
 (D) The final product of the pathway is reduced
62. This enzymatic phenomenon is an example of
- (A) transcription  
 (B) feedback inhibition  
 (C) dehydration synthesis  
 (D) photosynthesis
63. The biosynthesis of cytidine 5'-triphosphate requires
- (A) a ribose sugar, a phosphate group, and a nitrogen base  
 (B) a deoxyribose sugar, a phosphate group, and a nitrogen base  
 (C) a ribose sugar, phosphate groups, and a nitrogen base  
 (D) a deoxyribose sugar, phosphate groups, and a nitrogen base

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Directions: This part B consists of questions requiring numeric answers. Calculate the correct answer for each question.

64. In a diploid organism with the genotype AaBbCCDDEE, how many genetically distinct kinds of gametes would be produced?

	/	/	/	
.	.	.	.	.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

65. Under favorable conditions, bacteria divide every 20 minutes. If a single bacterium replicated according to this condition, how many bacterial cells would one expect to find at the end of three hours?

	/	/	/	
.	.	.	.	.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

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66. In snapdragon plants that display intermediate dominance, the allele  $C^R$  produces red flowers and  $C^W$  produces white flowers. If a homozygous red-flowered snapdragon is crossed with a homozygous white-flowered snapdragon, what will the percentage of pink offspring be?

	/	/	/	
.	.	.	.	.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

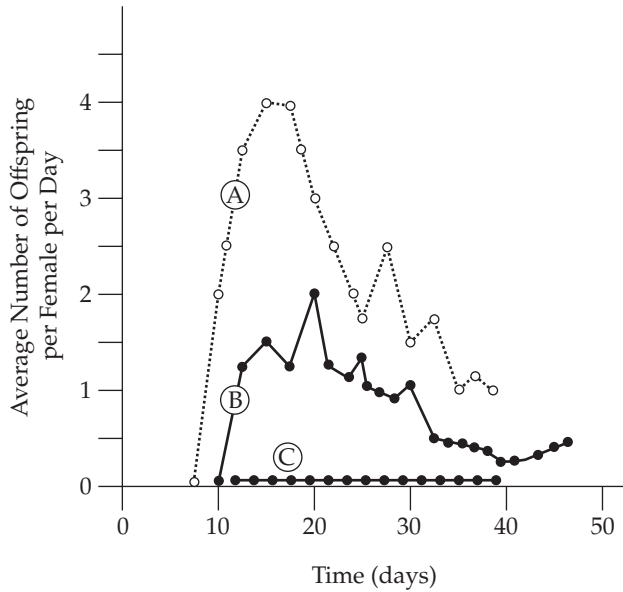
67. Translation is an energy-intensive process. Approximately how many ATPs are required to synthesize a protein containing 115 amino acids?

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0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

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Question 68 refers to the following experiment.

A group of 100 *Daphnia*, small crustaceans known as water fleas, were placed in one of three culture jars of different sizes to determine their reproductive rate. The graph below shows the average number of offspring produced per female each day in each jar of pond water.



- Key: (A) Water fleas in a 1-liter jar of pond water  
 (B) Water fleas in a 0.5-liter jar of pond water  
 (C) Water fleas in a 0.25-liter jar of pond water

68. What is the total number of offspring produced in the 0.5-liter jar on the twentieth day, assuming all survive?

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0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

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69. On average, there is a 90 percent reduction of productivity for each trophic level. Based on this information, 10,000 pounds of grass should be able to support how many pounds of crickets?

	/	/	/	
.	.	.	.	.
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

END OF SECTION I

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BIOLOGY  
SECTION II

Planning time—10 minutes

Writing time—1 hour and 30 minutes

**Directions:** Questions 1 and 2 are long-form essay questions that should require about 20 minutes each to answer. Questions 3 through 8 are short free-response questions that should require about 6 minutes each to answer. Read each question carefully and write your response. Answers must be written out. Outline form is not acceptable. It is important that you read each question completely before you begin to write.

1. Chlorophyll is one of a class of pigments that absorbs light energy in photosynthesis.
  - a. **Relate** the structure of chlorophyll to its function.
  - b. **Design** an experiment to investigate the influence of sunlight on the activity of chlorophyll.
  - c. **Describe** what information concerning the structure of chlorophyll could be inferred from your experiment.
2. Over the course of early evolution, organisms had to develop various methods to regulate internal fluids and excrete wastes. **Discuss** the problems faced by **three** organisms and how these problems were solved. In your discussion include structural adaptations and their functional significance.
3. **Describe** the chemical nature of genes. Name two types of gene mutations that could occur during replication.
4. Select **one** of the following three pairs of hormones and discuss the concept of negative feedback.
  - a. Thyroid-stimulating hormone (TSH) and thyroxine
  - b. Parathyroid hormone and calcitonin
  - c. ACTH and cortisol
5. **Describe** why fermentation is a less efficient way to produce energy than aerobic respiration.
6. **Define** analogous structures and give an example.
7. **Describe** symbiosis and give an example involving humans.
8. **Define** the role of ADH (anti-diuretic hormone) and aldosterone in the regulation of blood pressure.

**STOP****END OF EXAM**

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