

Bio League
Competition
2024 Phase
one

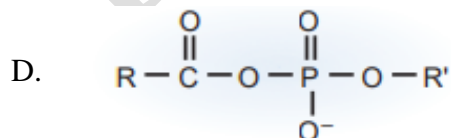
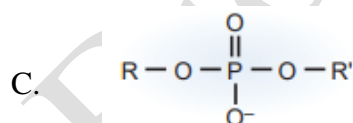
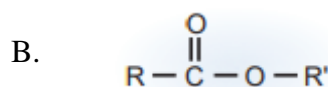
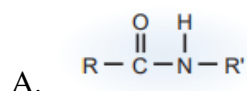
1_ Which of the following statements is TRUE regarding the self-assembly of the protein structure?

- A. The subunits shown must be completely identical for self-assembly to occur.
- B. ATP is always required for the self-assembly of this protein complex due to the decrease in system entropy.
- C. The process illustrated always requires catalysts or nucleating agents for the initial assembly stages.
- D. The protein self-assembly process shown occurs only in eukaryotic cells.
- E. The self-assembly of this protein complex can occur along a scaffold as depicted.

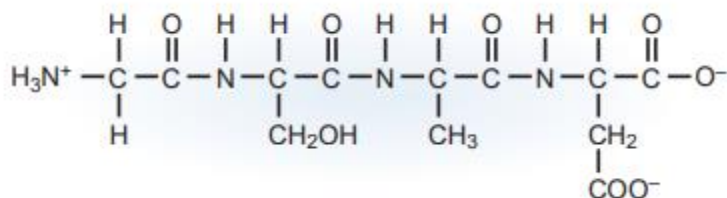
2_ Which of the following proteins act as molecular motors that move along microtubules of the cytoskeleton?

- A. Myosin.
- B. Dynein.
- C. Flagellin.
- D. Kinesin

3_ "Which of the following types of bonds is responsible for allowing nucleotides to form long polymers? (Select all that apply)



4_ Given the structure provided below, which of the following descriptions best characterizes it?

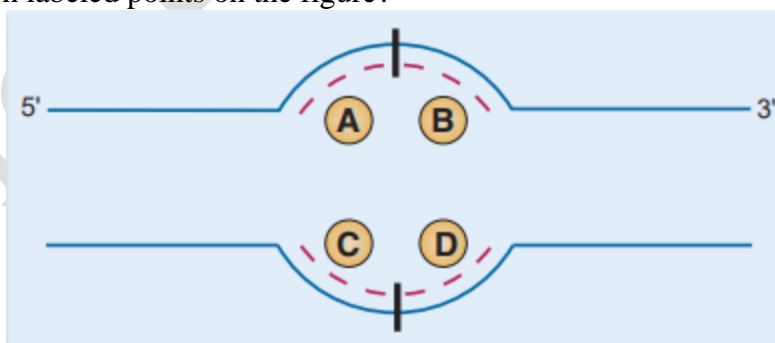


- A. An amino acid
- B. A tripeptide
- C. A tetrapeptide
- D. A lipid
- E. A carbohydrate

5_ The high mutation rate of the human immunodeficiency virus (HIV) is due in part to a property of which of the following host cell enzymes?

- A. DNA polymerase
- B. RNA polymerase
- C. DNA primase
- D. Telomerase
- E. DNA ligase

6_ Consider the DNA replication fork shown below. DNA ligase will be required to finish synthesis at which labeled points on the figure?

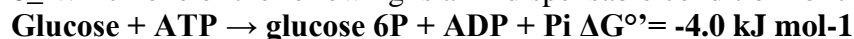


- A. A and B
- B. C and D
- C. A and C
- D. D and B
- E. B and C

7_ In an enzymatic reaction, a non-competitive inhibitor:

- A. diminishes K_M
- B. diminishes V_{max}
- C. diminishes K_M and V_{max}
- D. does not affect V_{max}
- E. augments K_M

8_ Which one of the following is an indispensable condition for the reaction to proceed?



- A. increase the concentration of ATP.
- B. increase the temperature.
- C. presence of hexokinase
- D. hydrolysis of ATP
- E. increase the concentration of glucose

9_ Which of the following statements is/are TRUE regarding secondary messengers?
(Select all that apply)

- A. Phospholipase C cleavage of a membrane phospholipid produces diacylglycerol and inositol triphosphate.
- B. Diacylglycerol binds to calcium channels to open the channels.
- C. Inositol triphosphate diffuses throughout the cell after being cleaved from the membrane phospholipid.
- D. cAMP is formed by phosphodiesterase-catalyzed cyclization of ATP.
- E. GTP is hydrolyzed to GDP by the G protein, which functions as a GTPase.

10_ Which of the following statements is/are TRUE regarding glycogen buildup and breakdown?
(Select all that apply)

- A. Glycogen phosphorylase builds up glycogen branches.
- B. Insulin release into the bloodstream and signaling leads to glycogen buildup.
- C. Glucagon release into the bloodstream and signaling leads to glycogen buildup.
- D. Phosphorylation of glycogen synthase inhibits its activity.
- E. Phosphorylation of glycogen phosphorylase inhibits its activity.

11_ Which of the following statements is FALSE regarding mechanisms of enzyme inhibition?

- A. Reversible inhibitors form only noncovalent bonds with the inhibited enzyme.
- B. Reversible inhibitors are often classified as poisons, whereas irreversible inhibitors are often used as medicines.
- C. Competitive inhibitors affect the K_M of the enzyme but not the V_{max} .
- D. Noncompetitive inhibitors can bind to the enzyme itself, as well as to the enzyme-substrate complex

12_ Select ALL that are FALSE regarding the ribosomes.

- A. The catalytic site is protein.
- B. Catalytic activity is still relatively functional after removing protein portions of ribosomes using proteases.
- C. Ribosome-catalyzed protein synthesis occurs in the N to C direction.
- D. The catalytic site is RNA and thus a ribozyme.
- E. Catalytic activity is still relatively functional after removing RNA portions of ribosomes using RNAases.

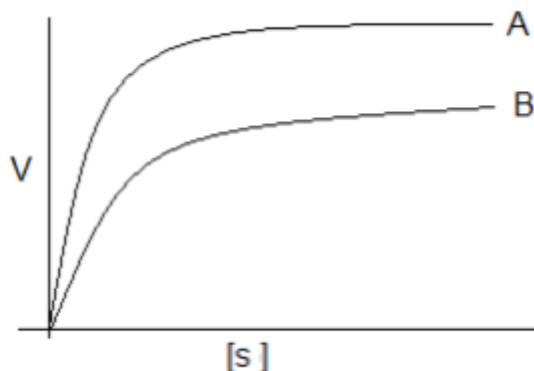
13_ Which of the following is not true of Rubisco?

- A. It is likely the most abundant protein on earth.
- B. It catalyzes carbon fixation in photosynthesis.
- C. Carbon atoms bond directly to it during photosynthesis.
- D. It is involved in the Calvin Cycle.
- E. It stands for ribulose bisphosphate carboxylase.

14_ What is the best reason why oxygen can bind to the heme group in myoglobin, despite the heme being deep in the protein?

- A. Rapid flexing of the amino acid side chains produces temporary cavities for the oxygen to enter.
- B. The side chains pass the oxygen to each other until it reaches the heme group.
- C. The myoglobin protein contains special alpha-helix domains that let the oxygen tunnel through.
- D. The myoglobin protein moves the heme group towards its surface through the rearrangement of its tertiary structure.
- E. High partial pressure of oxygen displaces carbon dioxide attached to the heme group.

15_ The following graph represents the kinetics of the transport of two substances through the membrane; its analysis leads to the conclusion that:



- A. the transport of A is more specific than that of B.
- B. the transport of A is active and that of B is passive.
- C. the transport of B is active and that of A passive.

- D. both transports can be saturated.
- E. both A and B are transported by a favorable gradient.

16_ Which of the following cell types would you expect to be abundant in ER and Golgi Bodies?

- I. Adipose cells
- II. Islet of Langerhans cells
- III. Plasma B cells
- IV. Red blood cells

- A. I only
- B. III only
- C. I and II only
- D. II and III only
- E. I, II, III, and IV

17_ Glucose enters the erythrocyte via a transport type characterized by being:

- A. simple diffusion
- B. stimulated by insulin
- C. facilitated by GLUT 1
- D. dependent on the supply of ATP
- E. facilitated by a sodium ion co-transporter

18_ Only a very small proportion of fatty acids is actually free in the body. The immense majority of them are linked to proteins, CoA, or ACP, depending on their location. This is a major advantage because it prevents:

- A. disorganized membranes on account of their detergent power
- B. being metabolized out of control
- C. leak out from cells and not be available for use
- D. inactivation of glycolysis by inhibition of phosphofructokinase
- E. unleash inflammatory reactions

19_ A 9-month-old child of strict vegan parents is brought to the pediatrician due to perceived muscle weakness. Due to their strict dietary beliefs, the child has not been given vitamin supplements. An image of the anterior of the knee reveals cupped and widened metaphysis. As the child is very fair-skinned, the parents always cover up the child when they go outside such that minimal skin is exposed to the sun. In order to correct these problems, the physician prescribes treatment with which of the following?

- A. Vitamin D
- B. Vitamin K
- C. Folic acid
- D. Vitamin B12
- E. Vitamin E

20_ Lipoprotein lipase (LPL) plays a role in the degradation of triacylglycerols located in:

- A. primary micelles
- B. secondary micelles
- C. extracellular space
- D. adipocytes
- E. the liver

21_ A protective role against gastrointestinal infections in the newborn has been attributed to lactoferrin in breast milk. It is believed that this is due to lactoferrin:

- A. supplies the iron necessary for the immune cells to attack pathogens
- B. promotes the synthesis of antibodies in the newborn
- C. can bind directly to the toxins secreted by gastrointestinal pathogens
- D. sequesters the iron that impairs bacterial growth
- E. supplies the iron for the generation of free radicals that damage bacteria

22_ A eukaryotic cell line contains an aberrant, temperature-sensitive ribonuclease that specifically cleaves the large rRNA molecule into many pieces, destroying its secondary structure and its ability to bind to ribosomal proteins. This cell line, at the nonpermissive temperature, has greatly reduced the rates of protein synthesis. This rate-limiting step is which of the following?

- A. Initiation
- B. Termination
- C. Elongation
- D. Peptide bond formation
- E. tRNA activation and charging

23_ The synthesis of one mole of glucose from two moles of lactate requires six moles of ATP. Which one of the following steps requires ATP in the gluconeogenic pathway?

- A. Pyruvate kinase
- B. Triosephosphate isomerase
- C. Glucose-6-phosphatase
- D. Fructose-1,6-bisphosphatase
- E. Phosphoglycerate kinase

24_ In an uncompensated diabetic patient, there is the inhibition of the Krebs Cycle in hepatic mitochondria because there is:

- A. An increase in the ratio of NADH/NAD due to increased beta-oxidation
- B. a decrease in oxaloacetate synthesis due to the inhibition of pyruvate carboxylase
- C. a decrease in the activity of pyruvate dehydrogenase
- D. an increase in utilization of Acetyl CoA for ketone body synthesis

25_ A person is infected by a bacterial pathogen. Which of the following would be the typical physiological response to that infection?

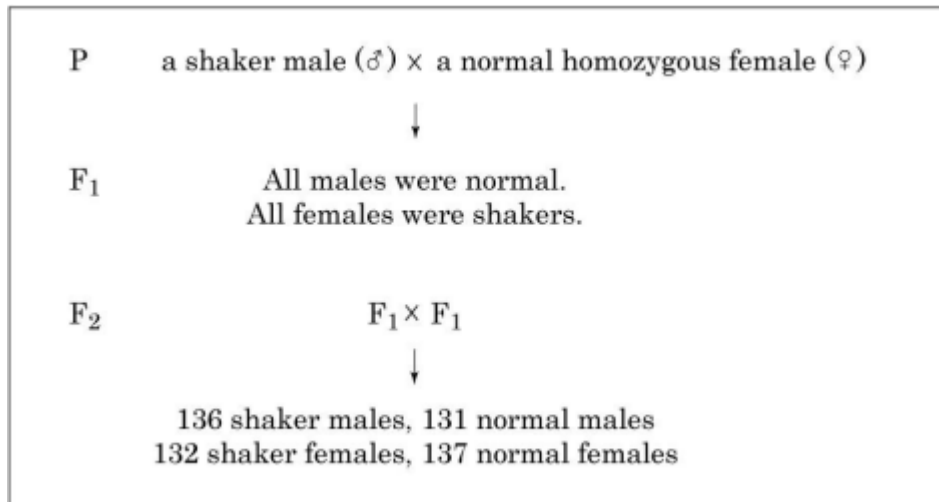
- A. B cell activation
- B. Cytotoxic T cell activation
- C. A decrease in body temperature
- D. Rapid mitotic division in cells in contact with the bacterium
- E. Release of interferon

Genetics and Evolution

1_ Which of the following is incorrect about operons?

- A. Operons can be switched off with a repressor.
- B. The lac operon is an inducible operon.
- C. In the presence of lactose and glucose, the lac operon will not be repressed.
- D. CAP is an activator of transcription when not bound to cAMP.
- E. A mutation in the operator of the trp operon can lead to the overproduction of tryptophan.

2_ An experimental cross is shown below:



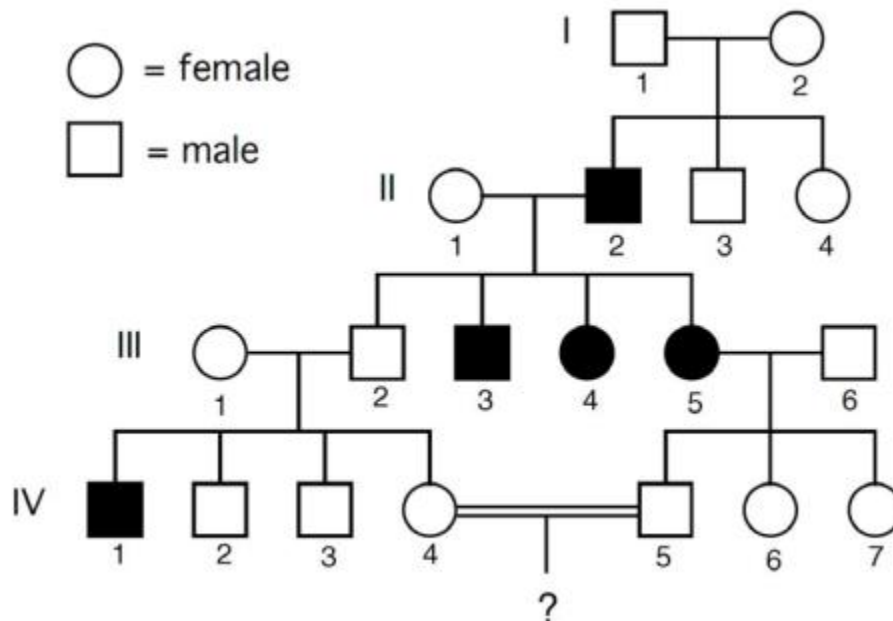
What kind of inheritance best explains the inheritance pattern for the Shaker gene?

- A. Somatic dominant.
- B. Somatic recessive.
- C. X-linked dominant.
- D. X-linked recessive.
- E. Y-linked dominant.

3_ Glucose-6-phosphate dehydrogenase (G6PDH) is encoded by a single X-linked gene in humans. There are multiple functional alleles for this gene, such as A1, A2, etc. G6PDH dimers are made in cells and secreted into blood. If a woman has both A1 and A2 alleles for G6PDH, what type(s) of dimers is/are found in her blood?

- A. Only A1A1
- B. Only A2A2
- C. Only A1A2
- D. Only A1A1 and A2A2
- E. A1A1, A2A2, and A1A2

4_ The image below depicts the inheritance of a rare skin disorder in four generations of a family; the disorder has 100% penetrance. Which of the following choices describes the most likely mode of inheritance of this skin disorder?



- A. Autosomal dominant.
- B. Autosomal recessive.
- C. Sex-linked dominant.
- D. Sex-linked recessive.
- E. Familial nondisjunction.

5_ All of the following are parts of the allopatric speciation by natural selection model, except:

- A. Geographically isolated populations evolve or change in response to novel environments.
- B. Reproductive isolation evolves as a by-product of changes in other traits associated with adapting to new resources or environments.
- C. Selection against hybridization leads to exaggeration of signals to facilitate recognizing conspecifics (individuals of the same species).
- D. Changes among or between populations occur while populations are geographically separated.
- E. All of the above are parts of the allopatric speciation by natural selection model.

6_ A pea plant X dihybrid for flower color and height is crossed with a pea plant Y true breeding for flower color and height. Pea plant X is tall and has purple flowers, while pea plant Y is short and has white flowers. Given that the genes are on separate chromosomes, tall is dominant to short, and purple is dominant to white, find the phenotypic ratios of the offspring.

- A. 1 tall purple: 1 short purple: 1 tall white: 1 short white.
- B. 9 tall purple: 3 short purple: 3 tall white: 1 short white.
- C. 9 tall purple: 3 short purple: 4 short white.
- D. 9 tall purple: 7 short white.
- E. 9 tall purple: 4 short white.

7_ In 1904, soon after Mendel's work was rediscovered, the French biologist Lucien Cuenot performed experiments with mice that did not appear to follow Mendel's laws. He found that when two yellow-colored mice were crossed, litters with both yellow- and gray-colored offspring were always produced. Over the years, he collected the following data.

Yellow x Yellow → 263 yellow-colored mice and 100 gray-colored mice.

In 1910, W.E. Castle confirmed Cuenot's results with similar experiments. Their combined data are shown in the table below.

Which of the following is the most likely explanation for yellow and gray coat colors in the mice?

	Yellow	Gray	Total	% Yellow
Cuenot	263	100	363	72.45
Castle	800	435	1235	64.77
Total	1063	535	1598	66.52

- A. Gray color is caused by a homozygous recessive condition in either or both of two separate genes that are interacting epistatically.
- B. Gray color is homozygous recessive, and yellow color can either be homozygous or heterozygous.
- C. Gray color is homozygous, the yellow color is heterozygous, and the yellow allele is lethal when homozygous.
- D. Yellow color is caused by the recessive allele of an X-linked gene.
- E. There are fewer gray-colored mice than expected due to double crossover.

8_ Sexual selection is a case of natural selection that describes evolution not due to variable survival rates due to fitness but rather due to variable reproductive rates stemming from characteristics that allow an individual to successfully attract a mate. These traits are called secondary sexual characters. Which answer is NOT a correct statement about secondary sexual characteristics?

- A. The peacock's tail is a secondary sexual character.
- B. Reproductive organs are secondary sexual characters.
- C. Birdsong can be used for mate attraction.
- D. The roaring of deer can be used for mate attraction.
- E. Sexual selection can select for traits that decrease individuals' likelihood of survival.

9_ The recognition sequence and cleavage pattern for the restriction enzyme BamH I (from *Bacillus amyloliquefaciens*) are shown below. Although the enzyme cleaves both strands of a double-stranded DNA, BamH I is said, by convention, to make one cut in the double-stranded recognition sequence.

↓ 5'-GGATCC-
CCTAGG-5' ↑

Predict the number of cuts and the number of fragments produced if the DNA sequence shown below is presented as a substrate for BamH I digestion.

5'-GACGCGTCCTAGGTGACCGGATCCATGGAATTCGCGGCCACTGGTTAAC 3'-
CTGCGCAGGATCCACTGGCCTAGGTACCTTAAGCACCGGTGACCAATTG

Number of cuts, number of fragments produced

- A. 0, 1
- B. 1, 1
- C. 1, 2
- D. 2, 2
- E. 2, 3

10_ Cells, when infected by a DNA virus, can transcribe both strands of the viral DNA and process it into ~21 nt single-stranded fragments that can be loaded into protein complexes that target viral protein-encoding transcripts for degradation. Which statement below correctly characterizes this process?

- A. This siRNA silencing results in a gene knockout.
- B. This siRNA silencing results in a gene knockdown.
- C. This miRNA silencing results in a gene knockout.
- D. This miRNA silencing results in a gene knockdown.
- E. This miRNA silencing results in reversible gene regulation.

11_ Which form of DNA damage is least likely to be encountered on a day-to-day basis?

- A. Double-strand breaks.
- B. Hydroxylation.
- C. Deamination.
- D. Pyrimidine dimers.
- E. Tautomerization.

12_ Sister chromatid is:

- A. The same thing as homologous chromosomes.
- B. A pair of chromosomes of the same kind.
- C. Identical copies of the same chromosome attached at the centromere.
- D. Always haploid.
- E. Always diploid.

13_ Place the following events of sexual reproduction in the correct order.

- I. Separation of homologous chromosomes.
- II. Separation of sister chromatids.
- III. Zygote mitosis.
- IV. Fusion of two gametes.
- V. Oocyte activation.

- A. II, I, V, III, IV.
- B. II, I, V, IV, III.
- C. I, II, V, IV, III.
- D. I, II, IV, V, III.
- E. V, I, II, III, IV.

14_ Which of the following is not a line of evidence whereby scientists try to determine genetic factors that influence the development of behavior?

- A. Isolation experiments.
- B. Comparison of relatives.
- C. Natural selection.
- D. Hybridization.
- E. Mutation (single gene/molecular genetic analysis).

15_ Huntington's disease is caused by an autosomal dominant mutation. The birth of an affected child to non-affected individuals with no family history of the disease is most likely due to:

- A. A mistake in replication
- B. A mistake in transcription
- C. A mistake in translation
- D. Incomplete penetrance
- E. Incomplete dominance

16_ Mule-foot (M) is dominant to the normal cloven-foot (m) in swine. The white coat is controlled by a dominant allele of another locus, B, and black by its recessive allele, b. A black mule-footed sow is mated with a white cloven-footed boar. They have multiple litters. All 36 offspring are white, but 17 have mule feet and 19 have cloven feet. What are the most likely genotypes of the parents?

- A. MmBb x mmBb
- B. Mmbb x mmBB
- C. Mmbb x mmBb
- D. MMbb x mmBB
- E. MMBb x mmBb

17_ In a chromosome with the genes E, F, G, and H, the crossing over frequencies are as follows:

E and F 11%

E and G 9%

E and H 3%

F and H 8%

What of the following are possible crossing over frequencies of genes G and H?

Select all that apply.

A. 6%

B. 8%

C. 12%

D. 17%

E. 19%

Questions 18 to 20. Jack and Diane marry and have a son, John. Four years later, they divorce amicably. Jack later marries Jill, and they have a son, Fletch. Diane remarries a man named Charles, and they have a daughter, Beth. Twenty-five years pass; Beth is married to Bob, and they have twins, Kate and William. Fletch is married to Ellen, and they have a son, Michael. The entire blended family reunites for John's wedding.

18_ Which of the following carries Diane's mitochondrial DNA, but not Jack's Y chromosome?

A. Bob

B. Charles.

C. Fletch.

D. John.

E. Michael.

F. William.

19_ Which of the following carries Diane's mitochondrial DNA and John's Y chromosome?

A. Fletch

B. John

C. Michael

D. William

20_ What is the coefficient of relatedness between John and Michael?

A. 1/16.

B. 1/8.

C. 1/4.

D. 3/8.

E. 1/2.

21_ Which of the following is NOT TRUE regarding translation in prokaryotes?

- A. tRNA synthetases couple amino acids to charged tRNAs.
- B. The peptidyl transferase reaction requires a charged tRNA bound at the P site.
- C. Polypeptide synthesis proceeds from the amino end to the carboxyl end, while mRNAs are translated in a 5'-to-3' direction.
- D. The positioning of the very first tRNA entering the P site is facilitated by the binding of mRNA to 16S RNA in the small subunit of the ribosome.

22_ Which of the following molecules would make good candidates for phylogenetic analysis (Select ALL that apply)?

- A. tRNA genes.
- B. The gene for 23S rRNA.
- C. The genes for ribosomal proteins.
- D. The gene for a subunit of DNA polymerase.
- E. The gene for a critical step in the synthesis of an amino acid.

23_ . All known organisms transcribe genetic information to protein molecules via the same genetic code. This finding strongly supports the hypothesis that:

- A. There is only one possible way to encode information in a macromolecule.
- B. the earliest macromolecules probably arose when lightning struck an oxygen-free atmosphere.
- C. all organisms are descended from a single common ancestor.
- D. the genetic code will never be broken.
- E. Life arose at many different times in many different ways.

24_ The coloration of tortoiseshell and calico cats is a visible manifestation of X-inactivation. The black and orange alleles of a fur coloration gene reside on the X chromosome. For any given patch of fur, the inactivation of an X chromosome that carries one gene results in the fur color of the other, active gene. Inactivation of one X chromosome in female mammals is an example of

- A. Epigenetics
- B. Sex-linked inheritance
- C. Autosomal dominance
- D. Autosomal dominance
- E. Autosomal recessiveness

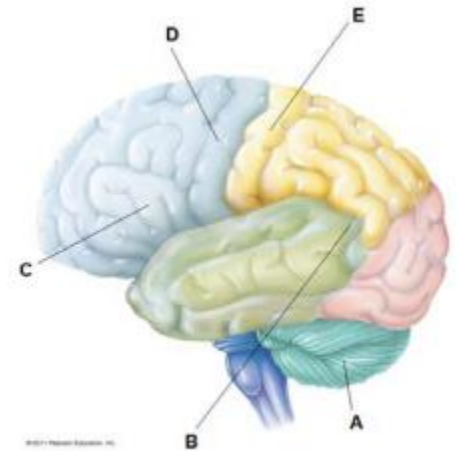
25_ While researching a genetic disease, an aberrant molecule was found that leads to improper protein production. This molecule is found in the nucleus but rarely in the cytoplasm and binds to the middle of the freshly transcribed mRNA molecule. By what mechanism might this molecule impair protein production?

- A. Blocking of the intron splice site and misrecognition of the spliceosome leading to improper exon sequence.
- B. Early termination of translation due to blocked codon.
- C. Alternate anti-codon recognition at the site leading to wrong amino acid placement.
- D. Disruption of the 5' cap or poly A tail leading to early degradation of the mRNA molecule.
- E. Retention of the mRNA molecule in the nucleus.

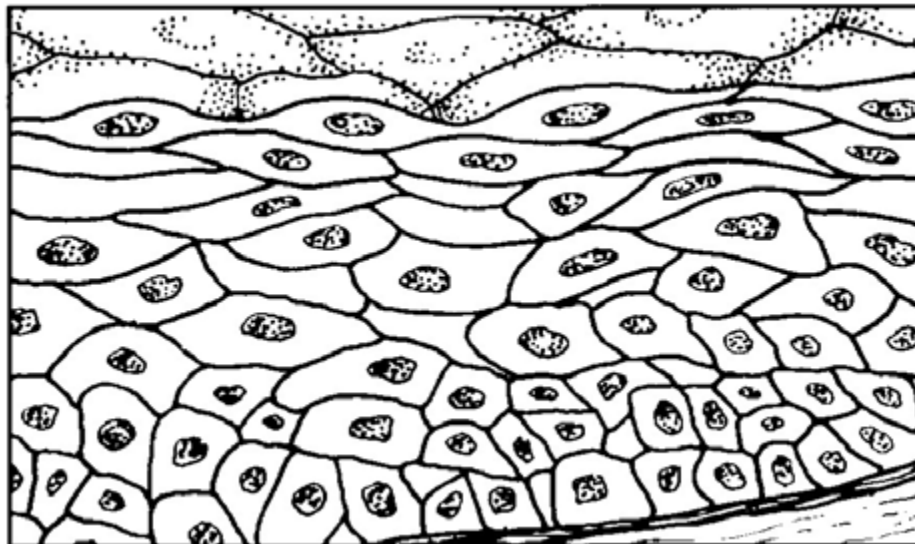
Anatomy and physiology

1_ A figure shown below is the human cerebral cortex. Which of the following is incorrectly paired with its function and indicated structure?

- A- coordination of balance and movement
- B- comprehending language
- C- forming speech
- D- decision-making and planning
- E- sense of touch



2_ The tissue shown in the Figure below is most likely:



- A) transmits electrochemical impulses
- B) stores fat
- C) covers and lines body surfaces
- D) contracts to produce movement
- E) contains a matrix

3_ The respiratory center_____

- A. Is in the hypothalamus.
- B. Sends impulses to inspiratory muscles during quiet breathing.
- C. Sends impulses to expiratory muscles during quiet breathing.
- D. Is involved in the swallowing reflex.
- E. Is involved in the vomiting reflex

4_ As people age, there is usually a decrease in their

- A. Ratio of lung residual volume to vital capacity.
- B. Percentage of vital capacity expelled in one second.
- C. Lung volume level at which small airways start to close during expiration.
- D. Lung elasticity.
- E. Resting arterial blood PO₂.

5_ Cerebrospinal fluid

- A. Is formed in the arachnoid granulations.
- B. Provides the brain with most of its nutrition.
- C. Protects the brain from injury when the head is moved.
- D. Has a lower pressure than that in the cerebral venous sinuses.
- E. Flow around the adult brain is around half a liter per day.

6_ In which one of the following sensory systems does stimulation cause the receptor cell to hyperpolarize?

- A. Vision
- B. Hearing
- C. Taste
- D. Touch
- E. Smell

7_ Which statement below is NOT true of lymphatic systems and lymph nodes?

- A. Naïve lymphocytes frequent lymph nodes.
- B. New lymphocytes enter circulation via the blood.
- C. Most lymphocytes in tissues get back into circulation via lymphatic vessels.
- D. From circulation, lymphocytes enter secondary or tertiary lymphoid tissues via veins.
- E. Lymph nodes provide a place for the antigens and mature lymphocytes to interact and initiate the adaptive immune response.

8_ During the cardiac cycle, the atrioventricular valves close because

- A. Pressure in the atria exceeds pressure in the ventricles due to atrial contraction.
- B. Pressure in the ventricles exceeds pressure in the atria due to atrial contraction.
- C. Pressure in the atria exceeds pressure in the ventricles due to ventricular contraction.
- D. Pressure in the ventricles exceeds pressure in the atria due to ventricular contraction.
- E. They're stimulated by the sympathetic nervous system.

9_ A 1973 Washington Post quote about a gun shooting follows: “The most serious wound, which at the onset many thought would cost the victim his life, was just above the beltline on the left side. It affected the pancreas, colon, and portal vein, which supplies blood to the stomach. The vein was almost severed in two.”

There is a biological error in this excerpt. Select the error from the responses below:

- A. The colon is nowhere near the indicated wound site.
- B. The pancreas is on the left side of the body.
- C. The portal vein does not supply blood to the stomach.
- D. A single bullet could not have hit both the pancreas and the colon.
- E. The listed wounds were not serious enough to endanger life.

10_ At the venule end of the capillary bed

- A. The hydrostatic blood pressure is greater than the osmotic pressure of the blood.
- B. The hydrostatic blood pressure is higher than it is at the arteriole end.
- C. The hydrostatic blood pressure and the osmotic pressure are equal.
- D. The osmotic pressure of the blood is greater than the hydrostatic blood pressure.
- E. Water and dissolved materials leave the capillary.

11_ In the responses below are hormones matched with functions. Which one is False?

- A. Melatonin—inhibits gonadotropin secretion.
- B. Parathyroid hormone—regulates calcium phosphate balance.
- C. ACTH—stimulates the adrenal cortex.
- D. Oxytocin—stimulates water reabsorption by the kidneys.
- E. Prolactin—stimulates milk production by the mammary glands.

12_ Which of the following changes, by itself, would tend to make lymph form more slowly?

- A. An increase in capillary blood pressure.
- B. An increase in the osmotic concentration of the interstitial fluid.
- C. An increase in the osmotic concentration of the blood plasma.
- D. Two of the above could both make lymph form more slowly.
- E. All of the above could make lymph form more slowly.

13_ Which of the following statements is TRUE?

- A. Oxygen moves from the atmosphere into the alveoli by diffusion and from the alveoli into the blood by bulk flow.
- B. Oxygen moves from the atmosphere into the alveoli by bulk flow and from the alveoli into the blood by diffusion.
- C. Oxygen moves from the atmosphere into the alveoli and from the alveoli into the blood by diffusion.
- D. Oxygen moves from the atmosphere into the alveoli and from the alveoli into the blood by bulk flow.
- E. Oxygen does not move from the atmosphere to the blood.

14_ Which of the following statements about capillaries is FALSE?

- A. They are the blood vessel type with the thinnest walls.
- B. They are the vessels with the narrowest diameter.
- C. Blood moves through the capillaries at a lower velocity than other vessels.
- D. More blood moves through the combined capillaries each minute than through the combined arteries.
- E. All of these are true.

15_ Imagine a neuron with a relatively long axon covered in myelin but lacking any nodes of Ranvier. Which of the following best describes the action potential results?

- A. The axon would have better cable properties than if it lacked myelin, and an action potential would be able to propagate the length of the axon.
- B. The axon would have better cable properties than if it lacked myelin, but an action potential would not be able to propagate the length of the axon.
- C. The axon would have worse cable properties than if it lacked myelin, but an action potential would still be able to propagate the length of the axon.
- D. The axon would have worse cable properties than if it lacked myelin, and an action potential would not be able to propagate the length of the axon.

16_ The second line of defense for the body is the innate immune system. Which of the following is a receptor associated with the process of innate immunity?

- A. Immunoglobulin receptor.
- B. Toll-like receptors.
- C. Major Histocompatibility Complex-I.
- D. T-cell receptor.
- E. NMDA receptor.

17_ Some of the axons of spinal motor nerves may be up to a yard in length. Suppose you stimulated an axon about halfway along its length. What is NOT going to occur?

- A. Chloride ions will pass from inside the axon to the outside.
- B. Depolarization will be propagated toward and away from the cell body.
- C. The sodium-potassium pump will be activated.
- D. Sodium ions will pass from outside the axon to its interior.
- E. Potassium ions will pass from inside the axon to the outside.

18_ What is the route of large fatty acids and cholesterol as they enter the bloodstream?

- A. Active transport into mucosal cells, enzymatic degradation to simpler compounds, secretion into villi capillaries.
- B. Simple diffusion into mucosal cells, enzymatic degradation to simpler components, secretion into villi capillaries.
- C. Simple diffusion into mucosal cells, packaging into transport forms, secretion into lymph vessels, emptying of lymph into the bloodstream.
- D. Active transport into mucosal cells, packaging into transport forms, secretion into villi capillaries.
- E. Facilitated diffusion into mucosal cells, secretion into lymph vessels. Emptying of lymph into the bloodstream.

19_ A major league baseball player takes human growth hormone to increase his performance. Which of the following is true regarding human growth hormone?

- A. Secretion is stimulated by somatostatin and inhibited by ghrelin.
- B. It has a long half-life.
- C. It inhibits protein synthesis.
- D. It decreases lipolysis.
- E. It stimulates production of somatomedins (insulin-like growth factors I and II) by the liver, cartilage, and other tissues.

20_ Radiation treatment for a pituitary tumor in an 8-year-old boy results in the complete loss of pituitary function. As a result, the child is likely to experience which of the following symptoms?

- A. Hypothyroidism and goiter.
- B. Absent sexual maturation.
- C. Accelerated growth spurts.
- D. Increased ACTH.
- E. Increased TSH levels.

21_ If a substance appears in the renal artery but not in the renal vein, which of the following is true?

- A. It must be filtered by the kidney.
- B. It must be reabsorbed by the kidney.
- C. Its clearance is equal to the glomerular filtration rate.
- D. Its clearance is equal to the renal plasma flow.
- E. Its urinary concentration must be higher than its plasma concentration.

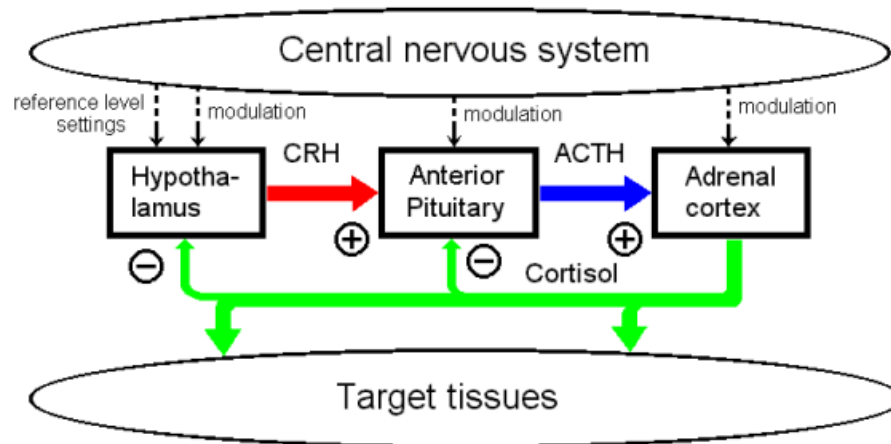
22_ A patient complaining of an irregular heart beat is referred for a cardiac electrophysiological (EP) study. Propagation of the action potential through the heart is fastest in which of the following?

- A. SA node
- B. Atrial muscle
- C. AV node
- D. Purkinje fibers
- E. Ventricular muscle

23_ All of the following are stimulated by the sympathetic nervous system EXCEPT:

- A. increased heart rate.
- B. increase secretion of the sweat glands.
- C. dilation of the pupil.
- D. constriction of blood vessels
- E. increased peristalsis in the gastrointestinal tract.

Questions 24 and 25 refer to the diagram shown below. The diagram illustrates feedback loops. Increased or decreased stimulation is indicated by + or —.



24_ Which of the following would lead to a DECREASE in activity of the anterior pituitary gland?

- A. A lack of receptors for cortisol on the hypothalamus
- B. A lack of receptors for cortisol on the anterior pituitary
- C. An intravenous injection of a large amount of ACTH
- D. A tumor in the hypothalamus causing it to secrete excess corticotropin-releasing hormone
- E. An increased sensitivity of the anterior pituitary to corticotropin-releasing hormone

25_ What would happen if the adrenal cortex was artificially stimulated to produce large amounts of cortisol?

- A. Less corticotropin-releasing hormone would be released.
- B. More ACTH would be released.
- C. The activity of the hypothalamus would increase.
- D. The activity of the anterior pituitary would increase.
- E. The hypothalamus would become insensitive to cortisol.

Ecology and ethology

1_ Why is it disadvantageous to grow deciduous trees in Oregon?

- A. There is not enough water available in winter to meet the tree's water requirements.
- B. There is insufficient light to support photosynthesis in the winter.
- C. There is insufficient moisture in summer to support photosynthesis.
- D. The soil is too shallow for their roots to support the weight of the tree.
- E. The absence of leaves the trees with no protection during the very bitter winters.

2_ If you traveled from northern Canada to the southernmost tip of Florida, what order I to IV would you cross?

- I. Deciduous forest.
- II. Taiga.
- III. Tundra.
- IV. Tropical rainforest.

- A. III, II, I, IV
- B. III, IV, II, I
- C. IV, I, II, III
- D. IV, III, I, II
- E. IV, III, II, I

3_ Mating of *Recurvirostra avosetta*, a wading bird, is preceded by some peculiar movements. Both male and female clean their feathers nervously. After some time, the female takes a horizontal position, and this triggers the male to copulate. The horizontal position of the female corresponds to:

- A. a conditioned reflex.
- B. a displacement activity.
- C. an innate response.
- D. a sign stimulus.
- E. the supernormal releaser.

4_ Which of the following statements are correct?

- I. The amount of nitrogen in living organisms is very small compared to the total quantity in the atmosphere.
- II. Less than 30% of the nitrogen available for plants comes from nitrogen-fixing bacteria or algae.
- III. The gaseous nitrogen cycle is global because it implies an exchange between the ecosystem and the atmosphere.
- IV. The input mechanisms of nutrients to an ecosystem are different from the output ones.
- V. The nutrient cycles can be studied introducing radioactive markers in natural or artificial ecosystems.

- A. I; II; and IV.
- B. II; III; and V.
- C. I; III; and V.
- D. III; IV; and V.
- E. II; IV; and V

5_ A snail crawling across a board will withdraw into its shell when you drop a marble on the board. Repetition of dropping marble will lead to a weaker withdrawal action, and in the end the snail will ignore the marble dropping. Which of the following terms do apply for the disappearance of the withdrawal action?

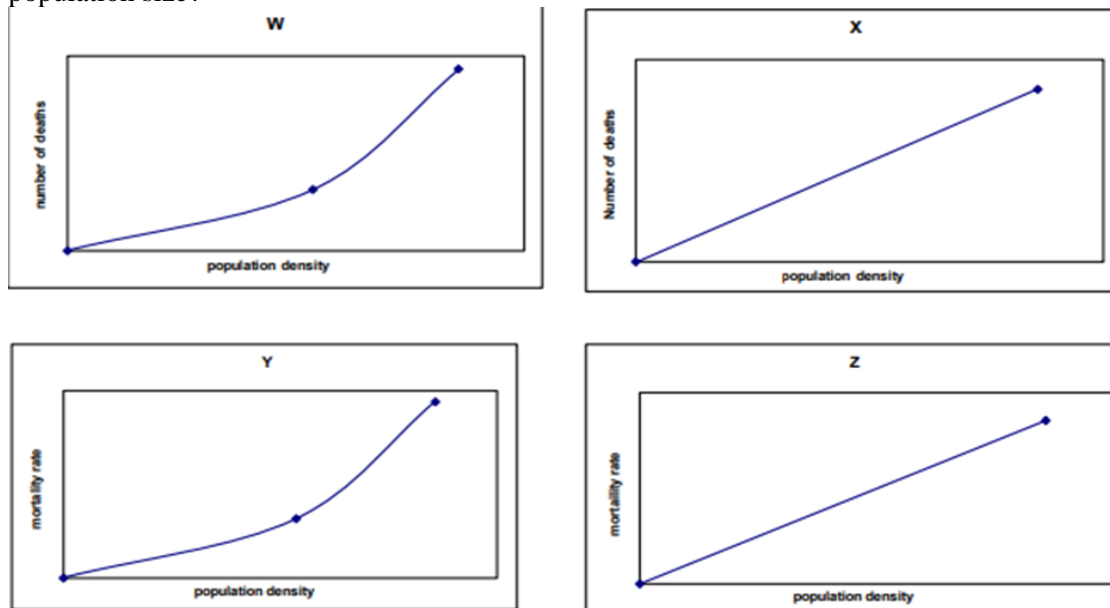
- (1) adaptation
- (2) conditioning
- (3) habituation
- (4) imprinting
- (5) insight
- (6) learned behavior

- A. 1, 3
- B. 2, 4
- C. 3, 6
- D. 4, 5
- E. 5, 6

6_ Why do territorial birds, which are territory owners, tend to win when they meet intruder birds?

- A. They are more aggressive and better fighters.
- B. They have more to gain from a fight, and so they are prepared to fight harder. The higher the benefit associated with territory, the harder they fight for it.
- C. Ownership is simply a conventional settlement.
- D. Owners always have a larger body size.
- E. Both A and D are correct answers.

7_ Which of the figures below show density-dependent mortality that could play a role in the regulation of population size?



- A. W, X, Y and Z
- B. Y and Z
- C. W and X
- D. Only Y
- E. W, Y and Z

8_ In a Latvian pond, a random sample of carp fish consisted of 120 individuals. All individuals were permanently marked and released without injuring them. On the next day, 150 individuals were captured, of which 50 were marked. Assuming no change in the total population size between the two days, what is the size of the population in the pond?

- A. 3600
- B. 6000
- C. 170
- D. 360
- E. 50

9_ Which of the combinations of sentences below are correct?

1. all autotrophic organisms are also phototrophic.
2. of the total light energy reaching the atmosphere, only about 1% is utilized in photosynthesis.
3. light intensity and quality change vertically through a forest canopy.
4. light intensity and quality change vertically through a water column.

- A. 1, 3, 4.
- B. 2, 3, 4.
- C. 3,4.
- D. 1,2,3,4.

10_ Which of the following roles have humans NOT traditionally taken in the process of domesticating animals?

- A. Parent in imprinting
- B. Nature in selection
- C. Dominant male in social organization
- D. Landmark in spatial learning
- E. Bottleneck effect

11_ Which one of the following statements is NOT a general precondition necessary for the evolution of reciprocal altruism?

- A. Benefits of receiving aid must exceed the cost of donating.
- B. Donors must be able to recognize partners, remember their previous actions, and refuse to cooperate with individuals that did not reciprocate.
- C. Interacting organisms must have a high coefficient of relatedness.
- D. Repeated pairwise interactions are needed to permit role exchanges between donor and beneficiary
- E. All of the above are necessary preconditions.

12_ Which of the following is a model of parental care paired with its correct description?

- A. Association model – strength of the pair bond between parents is directly associated with the amount of parental care
- B. Conflict model—females who compete against other females for resources provide less care
- C. Parental provision model – males are most likely to provide for offspring in species with internal fertilization
- D. Symbiosis model—Bidirectional exchange of resources between parent(s) and offspring
- E. Parental provision model – biological parents recruit alloparents to care for offspring

13_ For the phosphorus cycle, why (in the short term) does phosphorus cycling tend to be more localized than either carbon or nitrogen cycling?

- A. Because phosphorus is ultimately transferred almost entirely via the atmosphere rather than almost entirely via the soil (locally).
- B. Because phosphorus is both transferred locally in the atmosphere as well as in the soil (in the short term).
- C. Because carbon as well as phosphorus cycle in the soil (locally), while only nitrogen is transferred atmospherically.
- D. Because phosphorus is cycled almost entirely within the soil rather than transferred over long distances via the atmosphere.
- E. Because short-term phosphorus cycling is not localized more in either carbon or nitrogen cycling.

14_ Which of the following statements about allopatric speciation is UNACCEPTABLE?

- A. Allopatric speciation is also called geographic speciation.
- B. Allopatric speciation requires that daughter populations be fairly small when first separated.
- C. Continental drift resulted in allopatric speciation.
- D. The founder effect may result in daughter populations having a more limited set of alleles than the parent population.
- E. Allopatric speciation is the most common form of speciation.

15_ CO₂ emissions from the Northern Hemisphere are 6.1 Pg C/yr, and 0.8 Pg C/yr from the Southern Hemisphere. However, the total amount of CO₂ in the atmosphere over the Northern Hemisphere is not much greater than the amount in the atmosphere over the Southern Hemisphere (376 versus 374 Pg C). Why is there such a big difference in emissions between the two hemispheres?

- A. The presence of the tropical rainforests in the Southern Hemisphere results in a greater uptake of carbon dioxide.
- B. The presence of a higher population number of photosynthetic bacteria in the Southern Hemisphere results in a greater uptake of carbon dioxide.
- C. The destruction of tropical rain forests through slash-and-burn agriculture increases the emission of carbon dioxide.
- D. Carbon credits are being distributed solely to industries in the Northern Hemisphere.
- E. There is a greater land mass in the Northern Hemisphere, which supports more people and thus more burning of fossil fuels.

16_ In extremely dense populations (i.e., those exceeding carrying capacity):

- A. emigration must occur.
- B. decrease in reproduction must eventually occur.
- C. increased death rates must eventually occur.
- D. increased predation must occur.
- E. "natural disasters" may become more frequent and more severe.

17_ Microbiologists from around the world travel to Hawaii to study the interaction of *Euprymna scolopes*, the Hawaiian squid, with the bacterium *Vibrio fischeri*. *Vibrio* bacteria live inside the light organ and obtain nutrients from the squid. The bacteria produce light through a process known as bioluminescence, providing a mechanism for camouflage for the squid in the ocean. This is an example of:

- A. Commensalism.
- B. Parasitism.
- C. Behavioral Imprinting.
- D. Epigenetic modification.
- E. Mutualism.

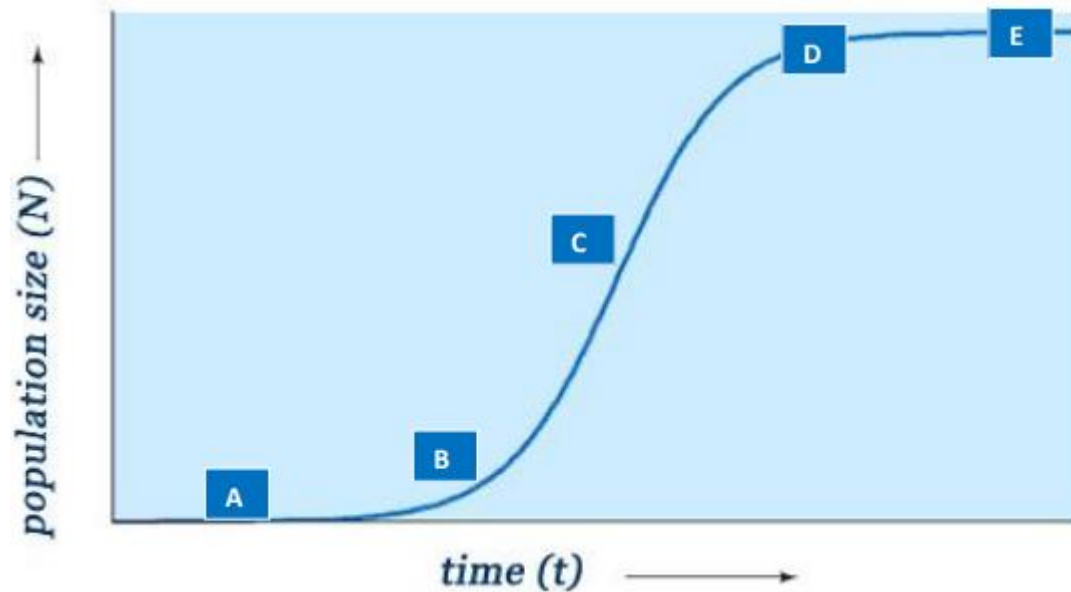
18_ A meaningful estimate of the minimum viable population for a species requires computing the effective population size. Which of the following statements is NOT true regarding factors that affect effective population size?

- A. An uneven breeding sex ratio can lower the effective population size.
- B. In an ideal population, the number of breeding individuals is constant between generations.
- C. Effective population size calculations assume that all members of a generation are born at the same time.
- D. In natural populations, the number of offspring for each individual often does not follow a Poisson distribution. This lowers the effective population size.
- E. Genetic drift can lower the effective population size.

19_ You are working on samples of *Phytophthora infestans* (potato blight) that you have sequenced from natural populations. You then obtain more samples from a museum in Ireland that date to the 1840s and 1850s, when the potato blight swept through Europe (the Irish Potato Famine). You build a phylogenetic tree and find that the samples cluster in the following way. Which of the following conclusions best describes the data?

- A. The Irish potato blight from the museum samples likely originated in Mexico.
- B. The Irish potato blight from the museum samples likely originated in Argentina.
- C. The Irish potato blight from the museum samples likely originated in the United States.
- D. All modern *Phytophthora* infectants comes from a strain that was ancestral to the Irish potato blight found in the museum samples, and you cannot determine its geographic origin from this data.
- E. All modern *Phytophthora* infectants is descended from a subset of the strain that caused the Irish potato famine, and you cannot determine its geographic origin from this data.

20_ In the graph below, which point indicates where populations should be harvested to best obtain optimal yield?



- A. A
- B. B
- C. D
- D. E
- E. B

21_ Of the following, which is the most significant explanation for the lack of a continuing abiotic origin of life on Earth today?

- A. There are no molten surfaces on which weak solutions of organic molecules could polymerize.
- B. All habitable places on Earth are already filled to capacity.
- C. There is much less visible light reaching Earth now than when life first originated.
- D. There is not enough lightning to provide an energy source.
- E. The oxidizing atmosphere of today's Earth is not conducive to the spontaneous formation of complex molecules.

22_ Robert MacArthur and E. O. Wilson studied island biogeography and developed the island equilibrium model. Which of the following scenarios will Result in island X having a greater equilibrium number of species than island Y?

- A. Island X is bigger than Island Y. The two islands are the same distance from the mainland.
- B. Island X is farther from the mainland than Island Y. The two islands are the same size.
- C. Island X is bigger than Island Y and farther from the mainland.
- D. Island X is smaller than Island Y and closer to the mainland.
- E. Island X and Y have the same rate of immigration and extinction.

23_ Net primary productivity, in most ecosystems, is important because it represents the:

- A. storage of chemical energy that would be available to heterotrophs.
- B. total solar energy converted to chemical energy by producers.
- C. energy used in respiration by heterotrophs.
- D. energy available to producers.
- E. biomass of all producers.

24_ Which of the following would be considered an example of bioremediation?

- A. adding nitrogen-fixing microorganisms to a degraded ecosystem to increase nitrogen availability.
- B. using a bulldozer to regrade a strip mine.
- C. dredging a river bottom to remove contaminated sediments.
- D. adding fertilizer to nutrients poor soil to increase plant growth.

25_ What is the term for an innate behavior pattern exhibited by all members of a species?

- A. Learned behavior.
- B. Instinct.
- C. Habituation.
- D. Condition.