

University of Toronto National Biology Competition 2026 Examination

April 8, 2026

Time: 75 minutes

Number of questions: 50

Should you guess the answers to questions about which you are not certain?

Since your score on the exam is based on the number of questions you answered correctly minus one-third of the number you answered incorrectly, it is improbable that guessing will improve your score (it is more likely to lower your score). No points are deducted or awarded for unanswered questions. However, if you are not sure of the correct answer but have some knowledge of the question and can eliminate one or more of the answer choices, then your chance of getting the right answer is improved, and it may be advantageous to answer such a question.

1. Which of the following processes can impact genotype frequencies, but not allele frequencies within populations?
 - a. Drift
 - b. Gene flow
 - c. Mutation
 - d. Non-random mating
 - e. Selection

2. Which of the following evolutionary forces would most likely lead to speciation?
 - a. Drift in a large population
 - b. Heterozygote selective advantage in a small population
 - c. Negative frequency-dependent selection
 - d. No migration following a population bottleneck
 - e. Positive frequency-dependent selection

3. The central dogma of biology states that DNA encodes RNA which encodes protein. Which of these molecules came first, and what ability allowed them to replicate without the others?
 - a. RNA, which could act like protein
 - b. Protein, which could act like RNA
 - c. DNA, which could act like RNA
 - d. Protein, which could act like DNA
 - e. RNA, which could act like DNA

4. Plants, animals and fungi are recognized as separate kingdoms from protists due to their analogous evolution of what?
 - a. Alternation of sexual and non-sexual generations
 - b. Complex multicellularity
 - c. Dominant diploid generation
 - d. Endosymbiotic acquisition of mitochondria
 - e. Motility within one or more life stages

5. The evolution of seeds in plants and amniotic eggs in animals allowed both these groups to do what?
 - a. Decrease sexual dimorphism
 - b. Decrease viral load
 - c. Increase genetic diversity through sexual reproduction
 - d. Increase pre-zygotic isolation
 - e. Increase their fundamental niche size

6. Measurements of diversity can be calculated based on species richness, species evenness, or both. Which is true based on the data provided?
- Index A and B both include richness and evenness
 - Index A includes evenness but not richness
 - Index A includes richness but not evenness
 - Index B includes evenness but not richness
 - Index B includes richness but not evenness

	Site 1	Site 2	Site 3
Species 1	10	40	10
Species 2	10	40	10
Species 3	10	10	10
Species 4	10	10	0
Species 5	10	10	0
Diversity Index A	5.0	2.5	3.0
Diversity Index B	1.0	0.5	1.0

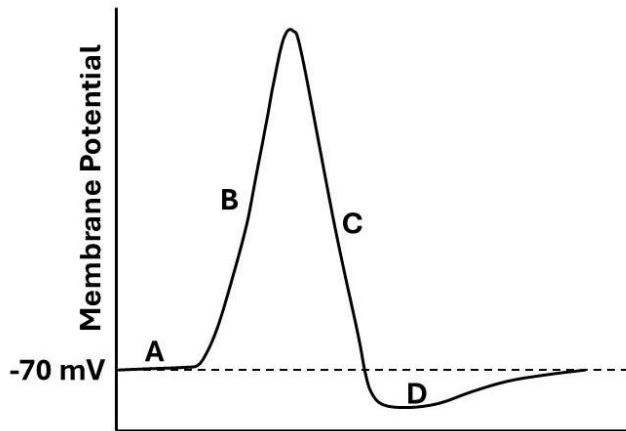
7. Which of the following enzymes would you expect a fungi that is an endosymbiont of plant roots to produce?
- Cellulase
 - Chitinase
 - Ligninase
 - Pectinase
 - Phosphatase
8. Which of the following is an example of net primary productivity?
- Carbon fixed through photosynthesis plus carbon fixed in respiration
 - Carbon fixed through photosynthesis minus carbon released in respiration
 - Carbon released through photosynthesis plus carbon released in respiration
 - Carbon released through photosynthesis minus carbon fixed in respiration
 - The carbon fixed through photosynthesis
9. There exists a band in the fossil record with a higher level of iridium. Which event does this layer of the record correspond to?
- The beginning of life
 - The Cambrian explosion
 - The extinction of the non-avian dinosaurs
 - The beginning of the industrial revolution
 - The impact of the moon and the Earth

10. Trees are hypothesized to have contributed to a mass extinction of marine animals during the Devonian period. How might this have occurred?
- Trees began to make too much oxygen, making the ocean hyperoxic
 - Trees began to make too much oxygen, making the ocean hypoxic
 - Trees consume too much CO₂ from the air, causing eutrophication
 - Trees consumed too much CO₂ from the air, which prevented phytoplankton from breathing
 - Tree roots increased soil production and weathering, releasing minerals into the ocean, causing eutrophication
11. Modern cladistics revised many traditional Linnaean classifications because some groups were defined based on what type of character?
- Apomorphy
 - Analogy
 - Homology
 - Synapomorphy
 - Symplesiomorphy
12. Complete the following statements with one of the options. In the lungs, the partial pressure of oxygen in the alveoli is _____ when the partial pressure of oxygen in the pulmonary (lung) capillaries is 5.33 kPa. In the systemic tissues, the partial pressure of carbon dioxide in the systemic capillaries is _____ when the partial pressure of carbon dioxide in the systemic tissues is 5.6 kPa.
- 13.3 kPa and 13.3 kPa
 - 2.3 kPa and 13.3 kPa
 - 13.3 kPa and 5.33 kPa
 - 5.6 kPa and 7.3 kPa
 - 5.33kPa and 5.6 kPa
13. What is the primary physiological mechanism by which a high salt diet may result in hypertension (high blood pressure)?
- Increased constriction of blood vessels
 - Decreased constriction of blood vessels
 - Increased blood volume
 - Decreased blood volume
 - Increased heart rate
14. Asthma is a common respiratory condition that can cause coughing, wheezing, and tightness in the chest. Which type of treatment would be most effective at reducing the symptoms of an asthma attack?
- A drug that reduces inflammation
 - A vaccination to prevent future asthma attacks
 - A blood thinner to clear blockages in the capillaries of the lungs
 - Regular exercise to improve lung function
 - Antibiotics

15. There is a type of congenital (you are born with it) heart defect that results in a hole between the right and left atria. Compared to a normal heart, which of the following changes would most likely be observed as a result of this defect?

- a. Lower partial pressure of oxygen in the pulmonary artery
- b. Higher partial pressure of oxygen in the pulmonary artery
- c. Higher partial pressure of oxygen in the aorta
- d. Higher partial pressure of oxygen in the left ventricle
- e. Lower partial pressure of oxygen in the left atrium

16. The following is a diagram of a typical neuronal action potential. Which of the following proteins is responsible for segment A of the action potential?



- a. Voltage gated Na⁺ channels
- b. Voltage gated K⁺ channels
- c. Voltage gated Ca²⁺ channels
- d. Na⁺/K⁺ ATPase
- e. H⁺ pump

17. The sympathetic nervous system is known as the ‘fight or flight’ arm of the autonomic nervous system. Which of the following physiological effects would you predict is a sympathetic effect?

- a. Increased heart rate
- b. Constricted airways
- c. Increased digestion
- d. Constricted pupils
- e. Decreased mobilization of glucose

18. When a diabetic takes too much insulin to regulate their blood glucose, which of the following effects may occur?
- Decreased plasma glucagon
 - Decreased plasma glucose
 - Increased plasma glucose
 - Decreased plasma norepinephrine
 - Decreased epinephrine
19. Which of the following substances can NOT filter through the glomerulus in the healthy kidney?
- Glucose
 - Proteins
 - Na⁺
 - Bicarbonate (HCO₃⁻)
 - Nitrogenous wastes
20. Which of the following statements best describes how epinephrine initiated a cellular effect?
- It binds to factors in the cytosol that influence the transcription of genes
 - It binds to factors in the nucleus that influence the transcription of genes
 - It binds to proteins on the cell surface that activate a cascade of intracellular events
 - It binds to protein channels on the cell surface that control ion transport
 - It binds to enzymes in the cytoplasm to initiate an effect
21. In the homeostatic control of thyroid hormone production where are the sensors that detect blood concentrations of thyroid hormone located?
- Thyroid gland
 - Pituitary gland
 - Heart
 - Bone
 - Hypothalamus
22. Fruit fly nuclei contain four pairs of homologous chromosomes. During oogenesis, how many different possible combinations of chromosomes could a daughter cell inherit at the end of Meiosis I?
- 8
 - 4
 - 32
 - 16
 - 64

23. What role does mitosis play during sperm development in humans?

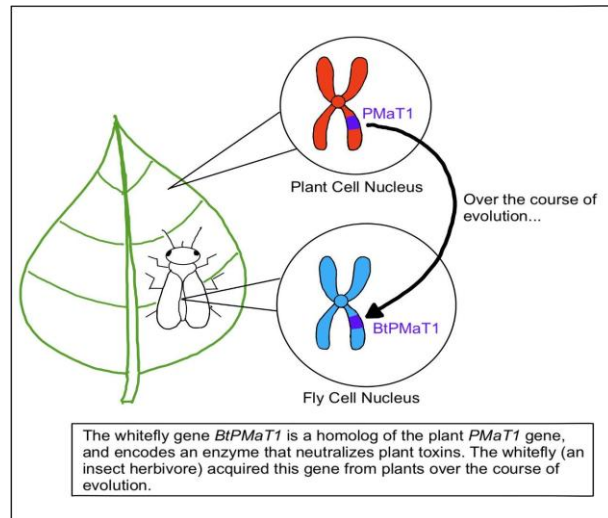
- a. reduces the genetic material from diploid to haploid
- b. expands the number of precursor cells that will undergo spermatogenesis
- c. allows for the recombination of genetic material between homologous chromosomes
- d. ensures that each of the four sperm cells that are generated are of equal size
- e. allows genetic variation through independent assortment

24. How does the production of the polar body contribute to oogenesis in humans?

- a. Ensures that egg cells only complete meiosis after puberty
- b. Promotes the generation of four egg cells at the end of meiosis
- c. Allows for the egg to retain a larger volume of cytoplasm
- d. Supports the future motility of the egg
- e. stores nutrients for the embryo

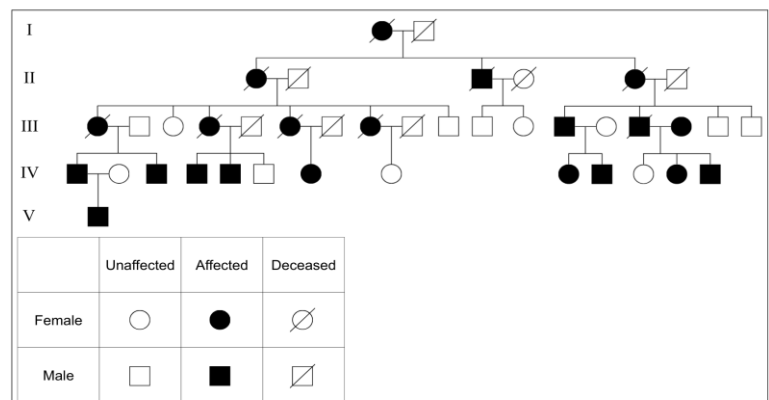
25. Which of the following options best describes the phenomenon shown in the diagram below?

- a. Horizontal gene transfer
- b. Non-disjunction
- c. Meiotic recombination
- d. Gene duplication
- e. Vertical gene transfer

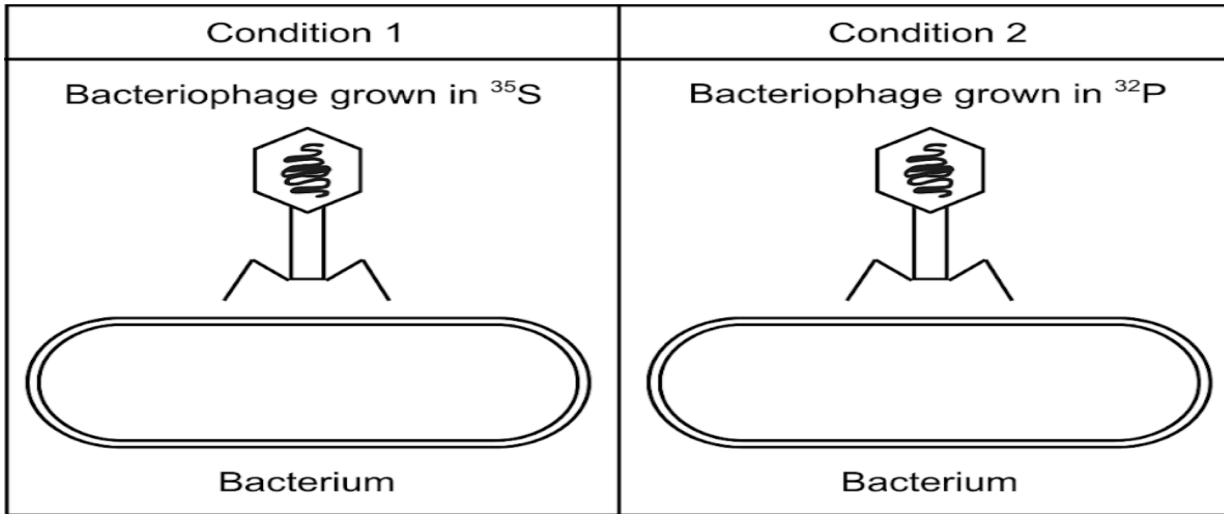


26. The pedigree below shows the inheritance of a genetic disorder across five generations. Which aspect of inheritance best explains the pattern shown?

- a. X-linked
- b. Y-linked
- c. Autosomal recessive
- d. Autosomal dominant
- e. Codominant

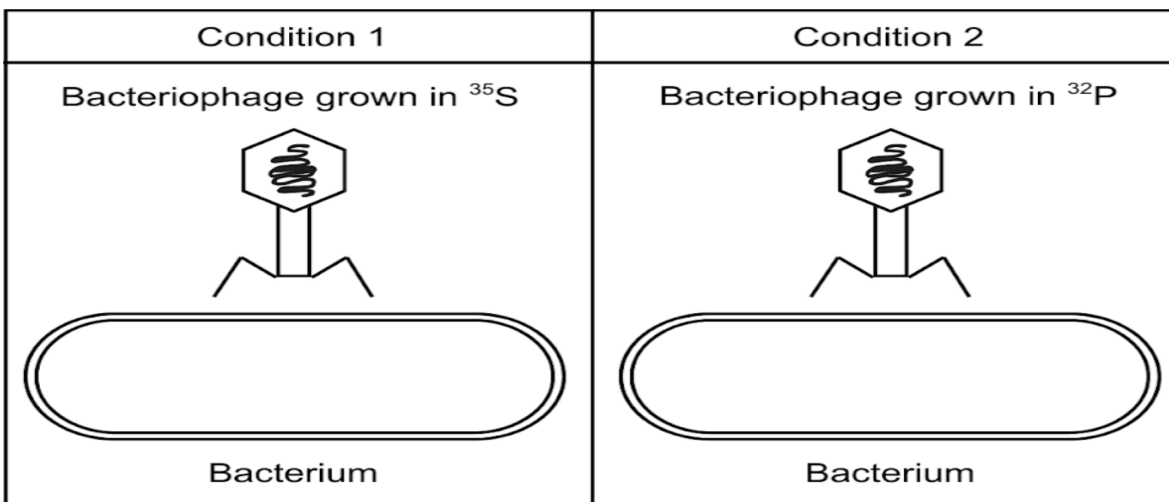


27. The diagram below shows a classic experiment conducted by two scientists in which two populations of bacteriophages were grown separately: one in ^{35}S and the other in ^{32}P . Each population infected identical bacterial cultures. After infection, the mixtures were blended and centrifuged. Which of the following describes the outcome of the experiment?



- a. In Condition 1 and Condition 2, radioactivity was primarily in the bacterial pellet
- b. In Condition 1, radioactivity was primarily in the bacterial pellet; in Condition 2, radioactivity was primarily in the supernatant
- c. In Condition 1, radioactivity was primarily in the supernatant; in Condition 2, radioactivity was primarily in the bacterial pellet
- d. In Condition 1 and Condition 2, radioactivity was primarily in the supernatant
- e. In Condition 1, radioactivity was primarily in the bacterial pellet; in Condition 2, radioactivity was equally distributed between the bacterial pellet and supernatant

28. The diagram below shows a classic experiment conducted by two scientists in which two populations of bacteriophages were grown separately: one in ^{35}S and the other in ^{32}P . Each population infected identical bacterial cultures. After infection, the mixtures were blended and centrifuged.



Which of the following conclusions depends most directly on the localization of radioactivity observed in the above experiment?

- a. Bacteriophages are made of both protein and nucleic acid
- b. Viral protein coats attach to the host cell during infection
- c. The material transferred into the bacterium contains the information required for viral replication
- d. Mechanical blending disrupts non-covalent protein interactions
- e. All of the above answer options are correct

29. You are analyzing a DNA fragment and found the % composition of guanine to be 30%. What is the % composition of thymine in the molecule?

- a. 30%
- b. 35%
- c. 20%
- d. 70%
- e. 40%

30. The following nucleic acid represents the coding sequence of a DNA molecule:

ATG TAC CCT ACA CCC GAT TTA TGA

However, the sequence was exposed to a beam of X-rays, inducing a mutation to the coding sequence:

ATG TAC ACT ACA CCC GAT TTA TGA

What kind of mutation would this be called?

- a. Frameshift
- b. Silent
- c. Nonsense
- d. Missense
- e. Insertion

31. Which protein relieves tension within DNA when it's unwound during DNA replication?

- a. DNA Helicase
- b. DNA gyrase
- c. Single-stranded binding proteins (SSBs)
- d. DNA ligase
- e. DNA primase

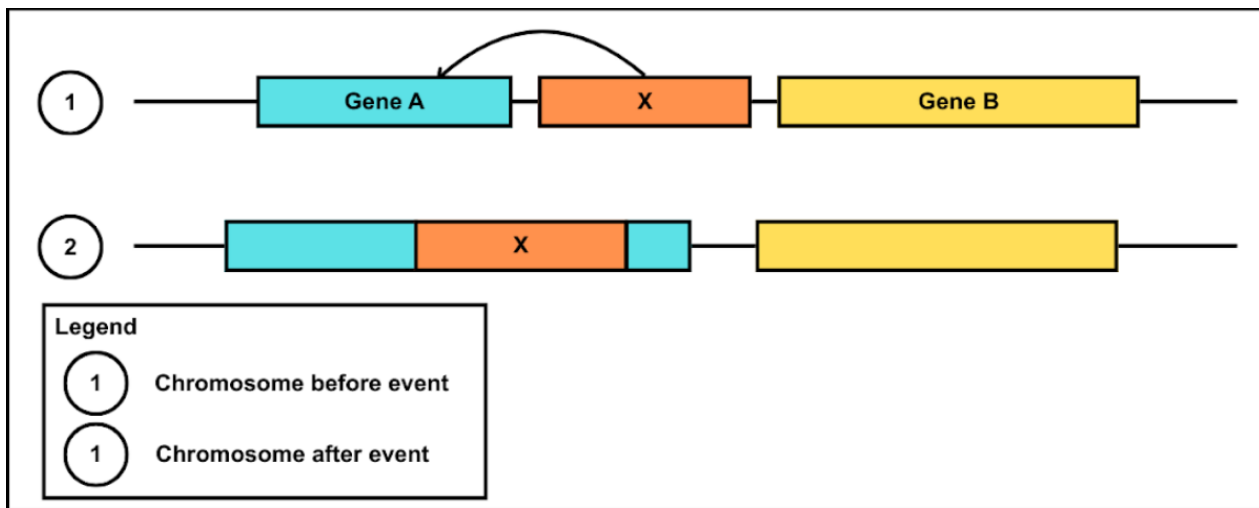
32. Why is Taq polymerase used in a polymerase chain reaction (PCR) instead of regular DNA polymerase?

- a. Taq polymerase only functions at low temperatures, making it ideal for PCR
- b. Regular DNA polymerase cannot recognize DNA nucleotides during PCR
- c. Taq polymerase doesn't require RNA primers in PCR
- d. Taq polymerase doesn't denature at high temperatures during PCR
- e. Taq polymerase synthesizes DNA faster

33. How does a gel electrophoresis experiment allow for the separation of DNA molecules?

- a. Separates DNA molecules based on their base composition; DNA molecules with more guanine-cytosine base pairs travel more slowly
- b. Separates DNA molecules based on their size; larger DNA molecules travel more slowly
- c. Separates DNA molecules based on their base composition; DNA molecules with more adenine-thymine base pairs travel more slowly
- d. Separates DNA molecules based on their size; smaller DNA molecules travel more slowly
- e. Separates DNA molecules based on their charge; positively and negatively charged DNA molecules approach oppositely charged electrodes

34. The diagram below shows a chromosome before and after a molecular event takes place. Gene A encodes protein A, and gene B encodes protein B. Initially, protein A and protein B are produced normally. After the event, protein A is no longer produced, while protein B continues to be produced normally. Which type of DNA element is most likely responsible for this change?



- a. Transposon
- b. Pseudogene
- c. Intergenic DNA
- d. Intron
- e. Duplicated gene

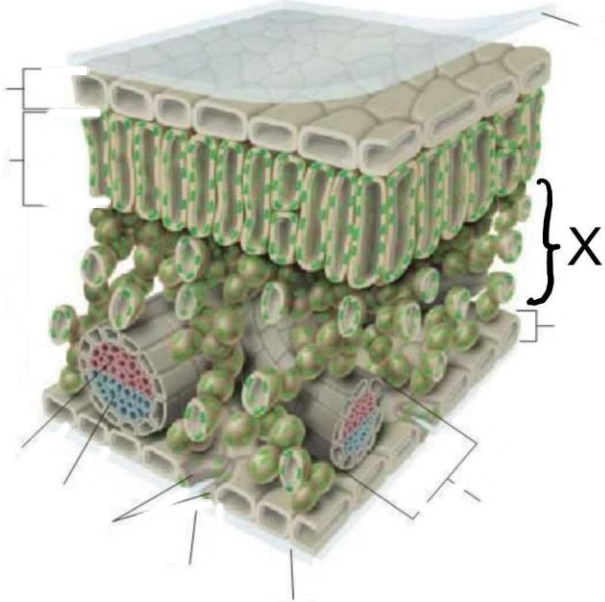
35. In recent years there has been a surge in the use of glucagon-like peptide-1 (GLP-1) drugs such as semaglutide (Ozempic) for the purpose of weight loss. Which of the following can be predicted as an effect of GLP-1 drugs based on its use for weight loss?
- Increase blood sugar levels to provide energy for muscles
 - Slows down rate of stomach emptying for a longer period of feeling full
 - It slows down the metabolism in the body so that there is less need for calories
 - It blocks the function of muscle cells so that the body requires fewer calories
 - Breaks down fat stored in the body for energy
36. Parietal cells in the stomach express a H⁺/K⁺ ATPase that is responsible for establishing a pH lower than 1 in the stomach lumen. Chloride ions move from inside the parietal cells to the lumen using passive transport to form HCl. Which of the following best describes the force that drives the movement of chloride ions?
- Exocytosis
 - Receptor mediated transport
 - Electrical gradient
 - Chloride ATPase
 - Concentration gradient
37. If you wanted to determine the activity of an ATPase pump in a test tube, which of the following would be the best thing to measure?
- Amount of sodium transported intracellularly over time
 - Amount of potassium transported extracellularly over time
 - Amount of free phosphate generated over time
 - Amount of diffusion that occurs over time
 - Amount of potassium transported intracellularly over time
38. Which of the following is an example of facilitated diffusion?
- Movement of sodium through sodium channels down its electrochemical gradient
 - Transport of potassium to the inside of the cell using the Na⁺/K⁺ ATPase
 - Endocytosis of membrane proteins in response to a chemical signal
 - Movement of hydrogen to the outside of the cell against its concentration gradient
 - Movement of oxygen across the cell membrane down its concentration gradient

39. Pancreatic cells have high secretory activity, in that by way of exocytosis they secrete large amounts of digestive enzymes. Which of the following organelles would you expect to be most abundant in these cells?
- Mitochondria
 - Lysosomes
 - Nucleus
 - Golgi apparatus
 - Rough endoplasmic reticulum
40. Which of the following is the most hydrophobic?
- Sodium
 - Cholesterol
 - Fructose
 - Water
 - Glycine
41. You dissolve 10 grams of maltose (a disaccharide) in water. If all of the maltose undergoes hydrolysis into glucose monomers, what would be the final mass of glucose if all the water was evaporated?
- 5.0 grams
 - Slightly less than 10 grams
 - 10 grams
 - Slightly more than 10 grams
 - 20 grams
42. The shape and property of an amino acid is determined by its?
- Amino group
 - R group
 - Three-dimensional structure
 - Carboxyl group
 - α -carbon
43. Adrenaline is the natural substrate for the enzyme called the adrenergic receptor, and when it interacts with this receptor in the heart it causes an increase in heart rate. What would you expect would happen to heart rate if an inhibitor of the adrenergic receptor, propranolol was given with adrenaline?
- Heart rate would increase
 - Heart rate would decrease
 - Adrenaline and propranolol would bind to each other
 - Heart rate would not change
 - Heart rate would initially decrease and then increase

44. Which of the following types of bonds occur between pairs of bases from two strands of DNA?

- a. Phosphodiester
- b. Nucleic acid
- c. Peptide
- d. Hydrogen
- e. Covalent

45. The diagram below/above shows a typical green plant leaf. What is the primary purpose of the leaf layer indicated in the diagram with an X?



- a. This layer stores water for the plant to use later
- b. This layer facilitates gas exchange between the atmosphere and mesophyll cells
- c. This layer is responsible for absorbing most of the light that enters the leaf
- d. This layer allows gases to enter and exit the epidermis of the leaf
- e. This layer allows nutrients to be transported to different parts of the leaf

46. Maple syrup, a famous Canadian sweetener, is produced by boiling sap extracted from maple trees in late winter, when the temperature at night is below freezing, and the temperature during the day is above freezing. Which tissue in the tree is the sap collected from?

- a. Phloem
- b. Xylem
- c. Cortex
- d. Epidermis
- e. Endodermis

47. A tree trunk is cut, and one annual growth ring is thinner than the other rings. Which of the following could have resulted in this thin ring?
- Reduced water transport in the xylem
 - Reduced sugar transport in the phloem
 - Increased transpiration
 - Decreased cell division in the apical meristem
 - Decreased cell division in the vascular cambium
48. A gardener sprays a plant with a growth regulator. After a week, the gardener comes back and notices that the stem has elongated and flower buds are developing. Which of the following growth regulators could be responsible for this growth?
- Auxins
 - Gibberellins
 - Cytokinins
 - Ethylene
 - Abscisic
49. A gardener grows two species of flowering plants, A and B, which can sexually reproduce. She notices that when a plant of species A is isolated, it does not bear any fruit. When a plant of species B is isolated, it produces fruit with seeds. Which of the following is true about species A and B?
- Species A and B can both self-pollinate
 - Species A must cross-pollinate
 - Species A is a gymnosperm while Species B is an angiosperm
 - Species A is an angiosperm while Species B is a gymnosperm
 - Species B generates more pollen than Species A

50. Which statement about this phylogenetic tree is CORRECT?

- Humans are equally closely related to cats and frogs.
- Lizards and cats are more closely related than lizards and humans.
- Fish are the most recent common ancestor of the other organisms in the tree.
- Geese and fish are more closely related than geese and frogs.
- Frogs are equally closely related to cats and lizards.

