

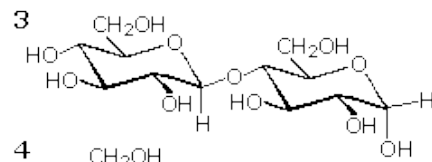
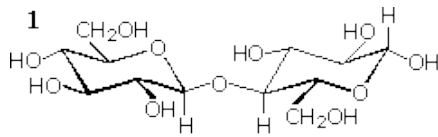
Bio League
Competition
2023 Phase
Two

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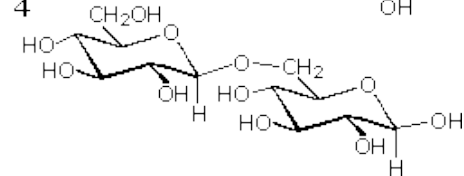
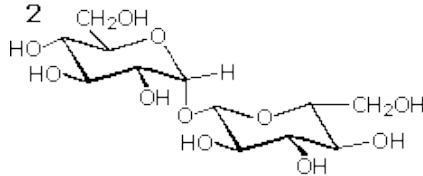
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Biochemistry & Cell Biology:

- 1- Which of the following disaccharides is the β -anomer of 4-O-(β -D-glucopyranosyl)-D-glucopyranose?

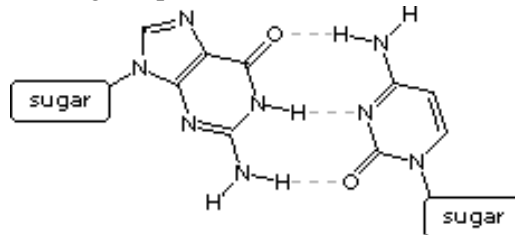


- a) 1
b) 2
c) 3
d) 4

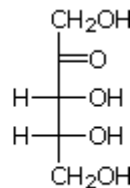
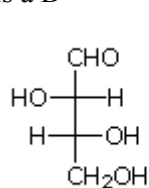
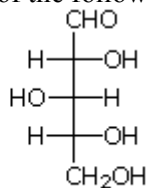
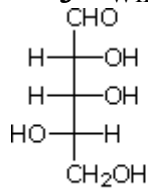


- 2- The H-bonded base pair shown on the right represents which of the following?

- a) adenine-thymine
b) guanine-cytosine
c) adenine-cytosine
d) adenine-guanine



- 3- Which of the following is a D-



- a) A
b) B
c) C
d) D

aldopentose?

- 4- The ionizable groups of amino acids are at least.

- a) 1
b) 2
c) 3
d) 4

- 5- For protein synthesis, an amino acid needs to be attached by its _____ group to the _____ of the tRNA molecule.

- a) amino; phosphoryl group on the 5'-end
b) carboxyl; phosphoryl group on the 3'-end
c) carboxyl; hydroxyl group on the 5'-end

- d) carboxyl; hydroxyl group on the 3'-end
- e) amino; base on the 5'end

6- Which of the following can cause the formation of a primary tumor, or cancer?

- I Oncogenes
- II Mutagens
- III Proto-oncogenes
- IV Metastasis

- a) All of the above
- b) II and IV only
- c) I and II only (proto-oncogenes are normal genes which, when altered by mutation, become oncogenes)
- d) I, II and III only

7- The ribosome is attached to messenger RNA through:

- a) Mg^{+2}
- b) Smaller subunit
- c) tRNA
- d) Larger subunit

8- Yeast artificial chromosomes (YACs) are genetically engineered chromosomes derived from the DNA of yeast, *Saccharomyces cerevisiae*. YACs are used as cloning vectors to transfer large fragments of DNA. Which of the following is/are essential to generate a yeast artificial chromosome (YAC) vector?

- I. Telomeric sequences
- II. Centromeric sequences
- III. Autonomously replicating sequences

- a. III only
- b. I and III only
- c. II and III only
- d. I, II and III

9- The chemiosmotic gradient of cellular respiration is an

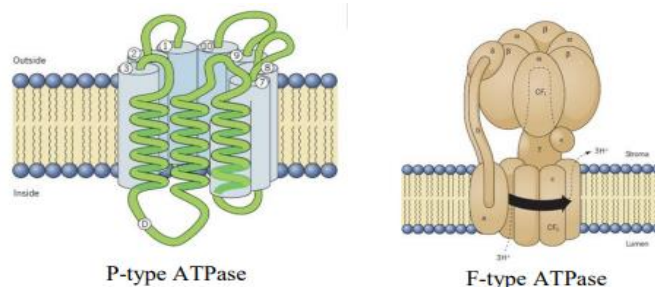
- a) ion gradient made by the pumping of hydrogen ions across the inner membrane using the energy of electrons as they are transported down the electron transport chain.
- b) ion gradient made by the pumping of hydrogen ions across the outer membrane using the energy of electrons as they are transported down the electron transport chain.
- c) ion gradient made by the pumping of oxygen ions across the inner membrane using the energy of electrons as they are transported down the electron transport chain.
- d) ion gradient made by the diffusion of hydrogen ions across the inner membrane using the energy of electrons as they are transported down the electron transport chain.

10- Proteins and phospholipids form major parts of several cellular structures such as plasma membranes. Properties of four structures found in living cells are listed in the table.

Structure	Cholesterol	Protein/lipid ratio (w/w)
1	Present	1.2
2	Present	4.6
3	Present	0.25
4	Absent	3.0

- Erythrocyte membrane, membrane of gram-positive bacterium, myelin, membrane of gram-negative bacterium.
- Erythrocyte membrane, myelin, membrane of liver cell, membrane of kidney cell.
- Membrane of intestinal epithelial cell, myelin, membrane of gram-positive bacterium, membrane of liver cell.
- Membrane of liver cell, membrane of intestinal epithelial cell, myelin, membrane of gram-positive bacterium.

11- ATPases are protein complexes which are found on different membranes of the cell. The following diagrams show the structure of two major types of ATPases, the P-type ATPase and F-type ATPase.



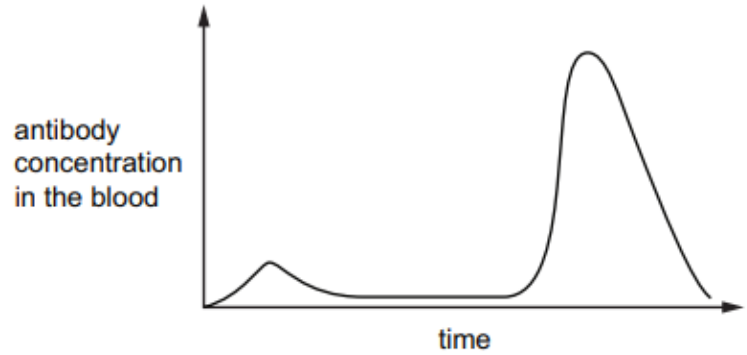
Which of the following statement/s regarding the ATPases is/are true?

- ATPases are always involved in the synthesis of ATP.
 - The P-type ATPase is formed from a single polypeptide.
 - The F-type ATPase is a multiprotein complex.
 - Both the above types of ATPases are directly involved in the active transport of ions.
- i only
 - ii and iii
 - i and iv
 - iv only

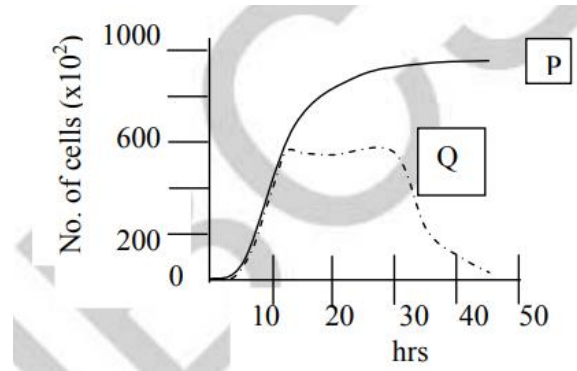
12- A child is vaccinated against measles. After a period of time the child is infected with the measles virus. The graph shows the concentration of measles antibodies in the child's bloodstream during this time.

Which statement is consistent with the information in the graph?

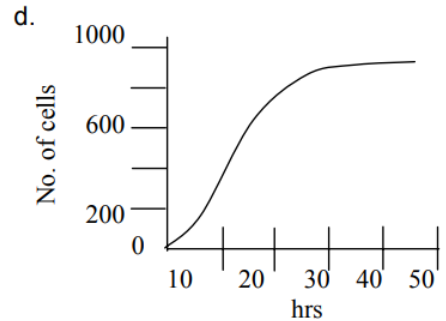
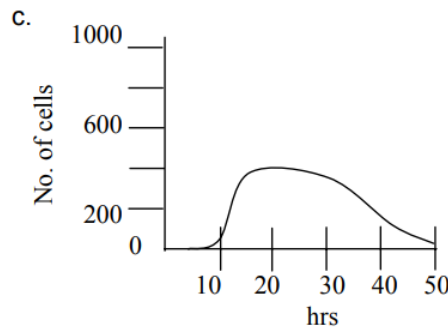
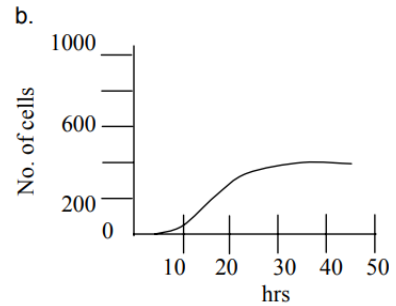
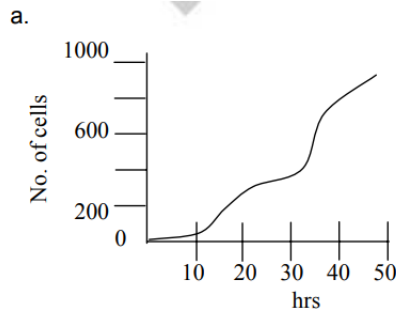
- a) After the vaccination, the child produced memory cells.
- b) The child had passive immunity against measles.
- c) The measles virus contains antibodies.
- d) The vaccination failed to protect the child against measles.



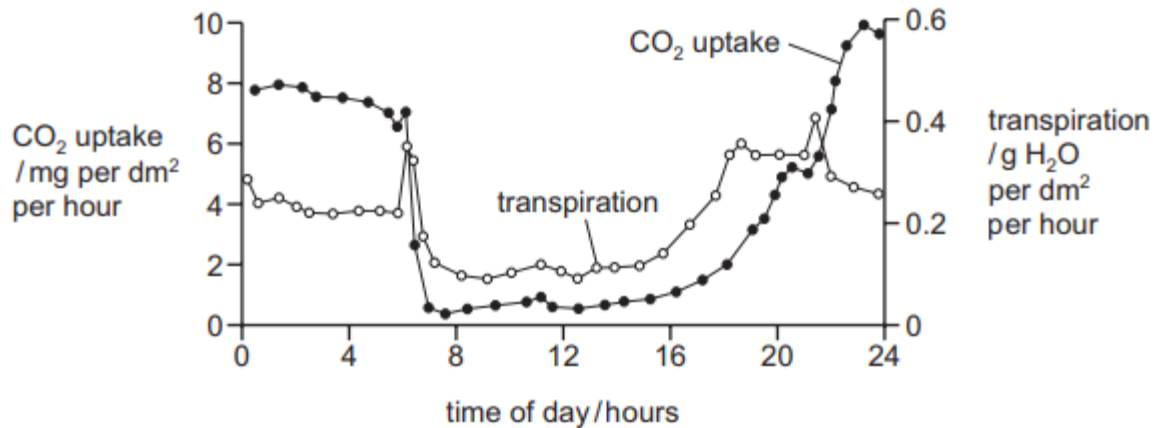
13- The following graph was obtained when bacterial cells were added to nutrient medium and then observed for next 50 hrs. If curves P and Q respectively indicate the total cell population and living cell population, then choose the curve that will correctly represent dying cell population:



- a) A
- b) B
- c) C
- d) D



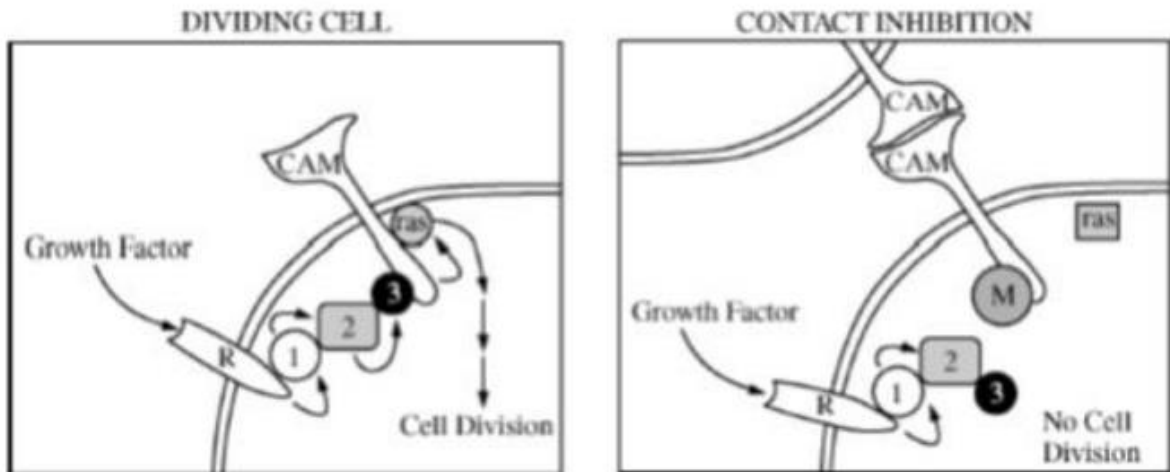
- 14- The graph shows daily carbon dioxide uptake and transpiration by the plant *Agave americana*. The plant is adapted to live in very dry conditions.



- a) More stomata are closed during dark periods.
 b) More stomata are closed during light periods.
 c) There is no carbon dioxide uptake during dark periods.
 d) There is no water uptake during light periods.
- 15- Which of the following enzyme is used for the diagnosis of thiamine deficiency?
 a) Transketolase
 b) Glucose-6-P dehydrogenase
 c) Trans aldolase
 d) Phosphogluconate dehydrogenase
- 16- If proteins were composed of only 12 different kinds of amino acids, what would be the smallest possible codon size in a genetic system with four different nucleotides?
 a) 1
 b) 2
 c) 3
 d) 4
 e) 12
- 17- Upon binding to ligand, the RTK class of receptors _____, then phosphorylate each other at _____ residues.
 a) Tyrosine, Dimerize
 b) Dimerize, Tyrosine
 c) Tetramer, Kinase
 d) Tyrosine, Kinase
- 18- Which Cell-Cell adhesion molecule is dependent on Ca⁺²?
 a) Integrin
 b) Cadherin
 c) N-CAM
 d) Fibronectin
 e) Hyaluronin

19- Many human cells can be stimulated to divide by hormone like growth factors that bind to receptor proteins (R) on the plasma membrane and trigger an internal signal transduction cascade. In many cases, however, the process on contact inhibition prevents mitosis when cells are in direct contact with one another. Contact inhibition occurs when proteins called cell adhesion molecules (CAMs) interact, causing them to change shape so that the growth-factor signaling proteins that normally associate with CAMs are replaced by another protein, called M. Both pathways are depicted in the figures below.

Which of the following statements accurately uses the information presented to support the hypothesis that interruption of M function in a single body cell can result in cancer?

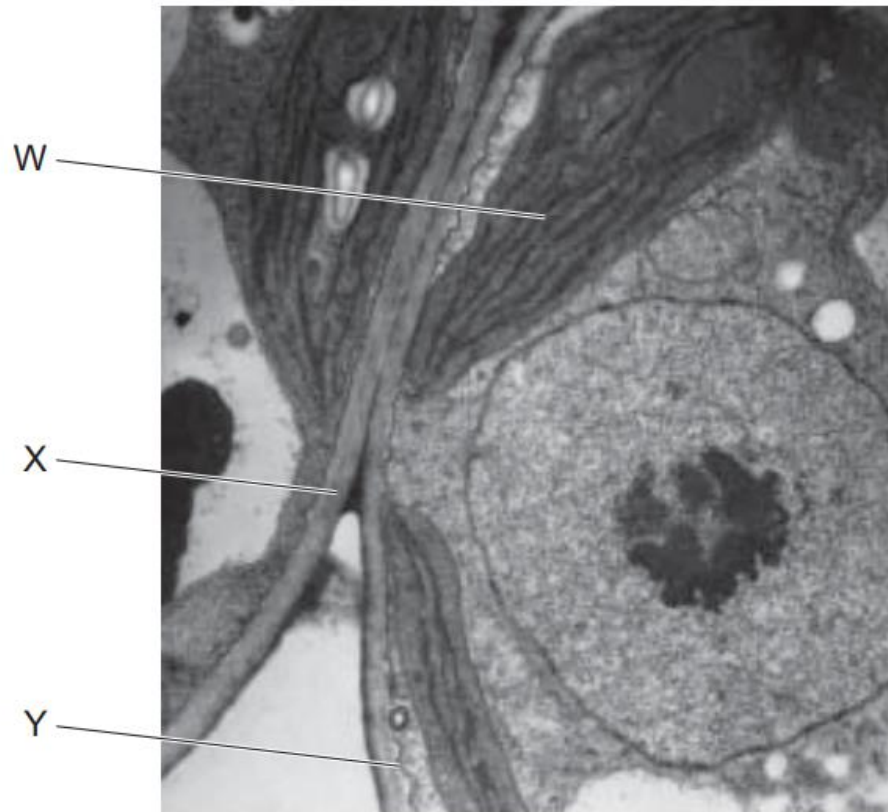


- Protein 3 will be prevented from interacting with CAMs, causing the cell cycle to stop permanently.
- The raw protein will remain bound to DNA, blocking expression of genes required for mitosis.
- Growth factor signaling can trigger mitosis in cells that are in direct contact with other cells.
- The receptor proteins of body cells will no longer bind to growth-factor proteins.

20- A non-membrane bound organelle found exclusively in animal cells is:

- Sphaerosome
- Glyoxisome
- Peroxisome
- Centriole

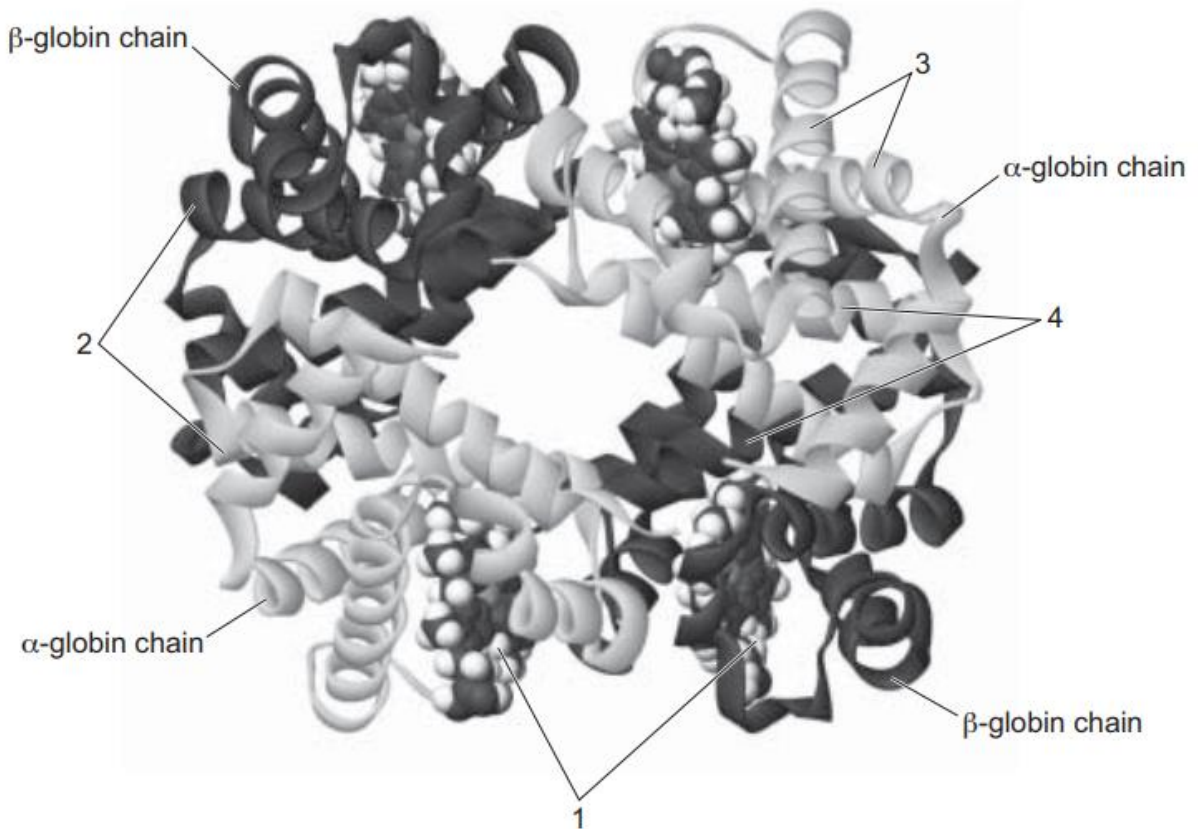
21- The electron micrograph shows part of two cells:



Which labelled features identify these cells as eukaryotic?

- a) W, X and Y
- b) W and X only
- c) W only
- d) X only

22- The following diagram shows a hemoglobin molecule, Which row identifies the different parts of the molecule?



	1	2	3	4
A	α -helix	β -pleated sheet	oxygen binding site	hydrophobic amino acids
B	oxygen binding site	hydrophilic amino acids	α -helix	hydrophobic amino acids
C	haem group	hydrophobic amino acids	α -helix	hydrophilic amino acids
D	hydrophobic amino acids	β -pleated sheet	haem atom	oxygen binding site

- a) 1
- b) 2
- c) 3
- d) 4

23- Bacterium divides every 35 minutes. If a culture containing 10^5 cells per mL is grown for 175 minutes, what will be the cell concentration per mL after 175 minutes?

- a) 5×10^5 cells
- b) 35×10^5 cells
- c) 32×10^5 cells
- d) 174×10^5 cells

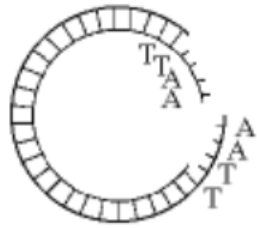
24- The Golgi apparatus plays a crucial role in modifying and sorting proteins within the cell. Imagine you are a researcher investigating a rare genetic disorder that affects the Golgi apparatus. You discover a mutant cell line where the Golgi apparatus is absent. To investigate the impact of this mutation, you decide to study the secretion of a specific protein in these cells. Which of the following outcomes would you expect to observe when comparing the mutant cells lacking Golgi apparatus to normal cells?

- a) Increased secretion of the protein due to the absence of Golgi-mediated sorting.
- b) Decreased secretion of the protein due to disrupted protein synthesis.
- c) Accumulation of the protein within the cytoplasm due to impaired protein transport.
- d) No change in the secretion of the protein as other organelles compensate for the absence of Golgi apparatus.

25- A patient presents with symptoms of muscle weakness, difficulty swallowing, and respiratory distress. After thorough examination, it is suspected that the patient is suffering from a mitochondrial disorder affecting the production of ATP. To confirm the diagnosis, a muscle biopsy is performed. Which of the following observations would support the diagnosis of a mitochondrial disorder?

- a) Abnormalities in the nuclear DNA of the muscle cells.
- b) Presence of enlarged and structurally abnormal mitochondria.
- c) Accumulation of glycogen granules within the muscle fibers.
- d) Decreased levels of creatine kinase in the bloodstream.
- e) None of them

Genetics & Evolution:

- 1- (1 mark) In many ways, the regulation of the genes of a particular group of viruses will be like the regulation of the host genes. Therefore, which of the following would you expect of the genes of the bacteriophage?
- regulation via acetylation of histones
 - positive control mechanisms rather than negative
 - control of more than one gene in an operon
 - reliance on transcription activators
 - utilization of eukaryotic polymerases
- 2- (1 mark) What is a genome?
- The complete complement of an organisms genes
 - A specific set of polypeptides within each cell
 - A specialized polymer of four different kinds of monomers
 - A specific segment of DNA that is found within a prokaryotic chromosome
 - An ordered display of chromosomes arranged from largest to smallest
- 3- (1 mark) Which enzyme was used to produce the molecule shown in the photo?
- ligase
 - transcriptase
 - a restriction enzyme
 - RNA polymerase
 - DNA polymerase
- 
- 4- (1 mark) Why might the cricket genome have 11 times as many base pairs than that of *Drosophila melanogaster*?
- The two insect species evolved at very different geologic eras.
 - Crickets have higher gene density.
 - Drosophila* are more complex organisms.
 - Crickets must have more non-coding DNA.
 - Crickets must make many more proteins.
- 5- (1 mark) The lactose operon is likely to be transcribed when
- there is more glucose in the cell than lactose.
 - the cyclic AMP levels are low.
 - there is glucose but no lactose in the cell.
 - the cyclic AMP and lactose levels are both high within the cell.
 - the cAMP level is high and the lactose level is low.
- 6- (1 mark) The role of a metabolite that controls a repressible operon is to
- bind to the promoter region and decrease the affinity of RNA polymerase for the promoter.
 - bind to the operator region and block the attachment of RNA polymerase to the promoter.
 - increase the production of inactive repressor proteins.

- d) bind to the repressor protein and inactivate it.
- e) bind to the repressor protein and activate it.

7- (1 mark) Why does the DNA double helix have a uniform diameter?

- a) Purines pair with pyrimidines.
- b) C nucleotides pair with A nucleotides.
- c) Deoxyribose sugars bind with ribose sugars.
- d) Nucleotides bind with nucleosides.

8- (1 mark) Replication in prokaryotes differs from replication in eukaryotes for which of these reasons?

- a) The prokaryotic chromosome has histones, whereas eukaryotic chromosomes do not.
- b) Prokaryotic chromosomes have a single origin of replication, whereas eukaryotic chromosomes have many.
- c) The rate of elongation during DNA replication is slower in prokaryotes than in eukaryotes.
- d) Prokaryotes produce Okazaki fragments during DNA replication, but eukaryotes do not.
- e) Prokaryotes have telomeres, and eukaryotes do not.

9- (2 marks) A species of insect was found to have developed resistance to a commonly used insecticide. Which of the following is the most likely explanation?

- a) Stabilizing selection caused development of resistance in the insect population.
- b) The original gene pool included genes that conferred resistance to the insecticide.
- c) The insecticide stimulated development of resistance in certain individuals and this was inherited.
- d) The insecticide caused a mutation that was favorable to resistance and this was inherited.

10- (2 marks) A population has 6 times as many heterozygous as homozygous recessive individuals. The frequency of the recessive allele will be:

- a) $1/3$
- b) $1/4$
- c) $1/2$
- d) $1/6$

11- (2 marks)

1. Formation of four new nuclei, each with half the chromosomes present in the parental nucleus
2. Alignment of tetrads at the metaphase plate
3. Separation of sister chromatids
4. Separation of the homologues; no uncoupling of the centromere
5. Synapsis; chromosomes moving to the middle of the cell in pairs

From the descriptions above, which of the following is the order that most logically illustrates a sequence of meiosis?

- a) 1, 2, 3, 4, 5
- b) 5, 4, 2, 1, 3
- c) 5, 3, 2, 4, 1
- d) 4, 5, 2, 1, 3
- e) 5, 2, 4, 3, 1

12- (2 marks) Independent assortment of chromosomes is a result of:

- a) the random and independent way in which each pair of homologous chromosomes lines up at the metaphase plate during meiosis I.

- b) the random nature of the fertilization of ova by sperm.
- c) the random distribution of the sister chromatids to the two daughter cells during anaphase II.
- d) the relatively small degree of homology shared by the X and Y chromosomes.
- e) All of the above

13- (2 marks) In seed cracker finches from Cameroon, small- and large-billed birds specialize in cracking soft and hard seeds, respectively. If long-term climatic change resulted in all seeds becoming hard, what type of selection would then operate on the finch population?

- a) disruptive selection
- b) directional selection
- c) stabilizing selection
- d) sexual selection
- e) No selection would operate because the population is in Hardy-Weinberg equilibrium.

14- (2 marks) If a cell were unable to produce histone proteins, which of the following would be a likely effect?

- a) There would be an increase in the amount of "satellite" DNA produced during centrifugation.
- b) The cell's DNA couldn't be packed into its nucleus.
- c) Spindle fibers would not form during prophase.
- d) Amplification of other genes would compensate for the lack of histones.
- e) Pseudogenes would be transcribed to compensate for the decreased protein in the cell.

15- (2 marks) In prophase I of meiosis in female *Drosophila*, studies have shown that there is phosphorylation of an amino acid in the tails of histones. A mutation in flies that interferes with this process results in sterility. Which of the following is the most likely hypothesis?

- a) These oocytes have no histones.
- b) Any mutation during oogenesis results in sterility.
- c) Phosphorylation of all proteins in the cell must result.
- d) Histone tail phosphorylation prohibits chromosome condensation.
- e) Histone tails must be removed from the rest of the histones.

16- (2 marks) The genetic code is essentially the same for all organisms. From this, one can logically assume all of the following except

- a) a gene from an organism could theoretically be expressed by any other organism.
- b) all organisms have a common ancestor.
- c) DNA was the first genetic material.
- d) the same codons in different organisms usually translate into the same amino acids.
- e) different organisms have the same number of different types of amino acids.

17- (2 marks) Which of these is the function of a poly (A) signal sequence?

- a) It adds the poly (A) tail to the 3' end of the mRNA.
- b) It codes for a sequence in eukaryotic transcripts that signals enzymatic cleavage ~10—35 nucleotides away.
- c) It allows the 3' end of the mRNA to attach to the ribosome.
- d) It is a sequence that codes for the hydrolysis of the RNA polymerase.
- e) It adds a 7-methylguanosine cap to the 3' end of the mRNA.

18- (2 marks) A researcher has used in vitro mutagenesis to mutate a cloned gene and then has reinserted this into a cell. In order to have the mutated sequence disable the function of the gene, what must then occur?

- a) recombination resulting in replacement of the wild type with the mutated gene
- b) use of a microarray to verify continued expression of the original gene
- c) replication of the cloned gene using a bacterial plasmid
- d) transcription of the cloned gene using a BAC
- e) attachment of the mutated gene to an existing mRNA to be translated

19- (3 marks) The genetic code is essentially the same for all organisms. From this, one can logically assume all of the following except

- a) a gene from an organism could theoretically be expressed by any other organism.
- b) all organisms have a common ancestor.
- c) DNA was the first genetic material.
- d) the same codons in different organisms usually translate into the same amino acids.
- e) different organisms have the same number of different types of amino acids.

20- (3 marks) In a population of insects, a particular gene has three alleles: A, B, and C. Alleles A and B are codominant, while allele C is recessive to both A and B. How many phenotypic classes would be expected in the progeny of a cross between an ABB individual and an AaBbCc individual?

- a) 6
- b) 9
- c) 12
- d) 18

21- (3 marks) Choose the features that confirm the hypothesis of endosymbiosis in respect of beginning of chloroplastids.

- 1. they have the genetic makeup of their own that includes circular DNA;
 - 2. they have ribosomes that do not differ from ribosomes of cytoplasm;
 - 3. they have a lot of common features with bacterium;
 - 4. they have a lot of common features with blue - green algae.
- a) 2,4
 - b) 3,1
 - c) 1,4
 - d) 2,3

22- (3 marks) A population of birds is studied over several generations. A certain allele, A, undergoes a mutation to allele a at a rate of 1.5×10^{-5} per generation. What is the approximate probability that the mutation will become fixed (reach a frequency of 1) in a population of 1000 individuals within 100 generations?

- a) 0.015
- b) 0.15
- c) 0.0015
- d) 0.00015

23- (3 marks) A research team is using CRISPR-Cas9 technology to edit a specific gene associated with a rare genetic disorder. They've identified the target sequence in the gene and designed the guide RNA accordingly. What is the role of the "PAM sequence" in the CRISPR-Cas9 system?

- a) It guides the Cas9 enzyme to the target site
- b) It determines the efficiency of gene editing
- c) It activates the CRISPR array
- d) It prevents self-targeting of the host genome

24- (3 marks) genes for ribosomal RNA in chromosomes are situated in the area of:

- a) telomere
- b) primary stretching
- c) kinetochore
- d) satellite
- e) secondary stretching.

25- (3 marks) Flagellum of prokaryotes move by means of the energy of:

- a) ATP
- b) proton-motive force
- c) phosphorylation
- d) GTP

Anatomy & Physiology:

- 1- (2 points) Which of the following statements best defines a portal system?
 - a) Part of the circulatory system where arteries subdivide into large number of branches of capillaries and again join with another artery.
 - b) A system of blood supply between heart and liver.
 - c) A system of veins which begins and ends with a bed of capillaries.
 - d) Part of the lymphatic circulatory system found in higher chordates where blood from organs is forwarded to open sinus through a network of capillaries.

- 2- (1 point) Which of the following is secreted by the chief cells?
 - a) Amylase
 - b) Pepsin
 - c) Pepsinogen
 - d) Mucus

- 3- (1 point) When the filtrate passes through the descending limb of the loop of Henle, which of the following substances moves out of the filtrate?
 - a) H₂O
 - b) NaCl
 - c) HCO₃⁻
 - d) B & C

- 4- (2 points) If you took a blood sample from an athlete while he was exercising to measure the blood pH, which of the following statements is true?
 - a) Blood pH is less than normal due to rising levels of CO₂ in tissues.
 - b) Blood pH is greater than normal due to rising levels of CO₂ in tissues.
 - c) Blood pH is less than normal due to rising levels of O₂ in tissues.
 - d) Blood pH is greater than normal due to rising levels of O₂ in tissues.
 - e) Blood pH is normal.

- 5- (2 points) Which of the following options completes the following statement? "The right atrioventricular valve..."
 - a) Is a semilunar valve
 - b) is prevented from everting by papillary muscles.
 - c) is open during systole.
 - d) prevents blood returning from the pulmonary trunk as the heart relaxes.

- 6- (2 points) Which sequence describes the systemic circulation?
 - a) Left ventricle → aorta → arteries → veins → capillaries.
 - b) Right ventricle → pulmonary trunk → arteries → capillaries → veins
 - c) Right ventricle → pulmonary trunk → arteries → veins → capillaries
 - d) Left ventricle → aorta → arteries → capillaries → veins.

- 7- (1 point) Rejection of transplanted organ is due to
- B-cell
 - Eosinophils
 - T-cells
 - Neutrophils
- 8- Which of the following systems is not part of the autonomic nervous system?
- Enteric
 - Sympathetic
 - Parasympathetic
 - Ventricular
- 9- (1 point) Which of the following is not part of the hindbrain?
- Pons
 - Myelencephalon
 - Mesencephalon
 - Cerebellar vermis
- 10- (3 points) A 26-year-old woman who undergone puberty at the age of 12 and has a child has produced how many polar bodies from oogenesis so far?
- 161
 - 159
 - 160
 - 155
- 11- (1 point) A child is born with intellectual disabilities due to damage to his central nervous system during development. In which trimester does this damage first start to appear?
- 1st trimester
 - 2nd trimester
 - 3rd trimester
 - 4th trimester
- 12- (2 points) Which of the following is the correct order of structures in the retina in terms of appearance from the outer to the inner side of the retina?
- Photoreceptors → ganglion cells → optic nerve fibers → pigmented epithelium
 - optic nerve fibers → ganglion cells → Photoreceptors → pigmented epithelium
 - ganglion cells → Photoreceptors → optic nerve fibers → pigmented epithelium
 - pigmented epithelium → optic nerve fibers → ganglion cells → Photoreceptors
- 13- (1 point) Which of the following sensory systems its associated stimulus doesn't pass through the thalamus in its path to the associated sensory cortex?
- Vision
 - Gustation

- c) Olfaction
- d) Hearing

14- (3 points) Which of the following neurons exhibits saltatory conduction and exists?

- a) A neuron in the myenteric plexus insulated by myelin sheath that is produced by oligodendrocytes.
- b) A neuron in the tegmentum insulated by myelin sheath that is produced by oligodendrocytes.
- c) A neuron in the corticospinal tract insulated by myelin sheath that is produced by Schwann cells.
- d) A neuron in the precentral gyrus insulated by myelin sheath that is produced by Schwann cells.

15- (2 points) Endocrine signaling differs from paracrine signaling because in endocrine signaling the

- a) secreted molecules diffuse into the bloodstream and trigger responses in target cells anywhere in the body while in paracrine signaling the secreted molecules diffuse locally and trigger a response in the cells that secrete them.
- b) secreted molecules diffuse locally and trigger a response in neighboring cells while in paracrine signaling the secreted molecules diffuse into the bloodstream and trigger responses in target cells anywhere in the body.
- c) secreted molecules diffuse locally and trigger a response in the cells that secrete them while in paracrine signaling the secreted molecules diffuse locally and trigger a response in neighboring cells.
- d) secreted molecules diffuse into the bloodstream and trigger responses in target cells anywhere in the body while in paracrine signaling the secreted molecules diffuse locally and trigger a response in neighboring cells.

16- Which hormone is responsible for regulating calcium levels in the blood and plays a crucial role in bone remodeling?

- a) Thyroxine (T4)
- b) Cortisol
- c) Parathyroid hormone (PTH)
- d) Insulin

17- During which phase of the cardiac cycle do the ventricles contract, pushing blood into the aorta and pulmonary artery?

- a) Atrial Systole
- b) Ventricular Diastole
- c) Atrial Diastole
- d) Ventricular Systole

18- In the respiratory system, which type of cells are responsible for producing surfactant, a substance that helps reduce surface tension in the alveoli and prevents their collapse?

- a) Goblet cells
- b) Ciliated cells
- c) Clara cells
- d) Type II alveolar cells

19- The hormone erythropoietin (EPO) is primarily produced in which organ and stimulates the production of red blood cells in the bone marrow?

- a) Liver
- b) Kidneys
- c) Pancreas
- d) Spleen

20- Which of the following cranial nerves is responsible for controlling eye movement and pupil constriction, and is often tested in neurological exams by assessing the "six cardinal fields of gaze"?

- a) Olfactory nerve (I)
- b) Trochlear nerve (IV)
- c) Abducens nerve (VI)
- d) Hypoglossal nerve (XII)

21- The process of muscle contraction involves a complex interplay of molecular events. Describe the steps involved in excitation-contraction coupling, starting from the arrival of an action potential at the neuromuscular junction and ending with the contraction of the sarcomere. Highlight the role of calcium ions, troponin, tropomyosin, and the sliding filament mechanism.

- a) Calcium ions bind to troponin, causing tropomyosin to move and expose active sites on actin. Myosin heads bind to actin and pull the filaments.
- b) Action potential causes calcium release from the sarcoplasmic reticulum, leading to ATP hydrolysis and cross-bridge formation between myosin and actin.
- c) Troponin binds to myosin, uncovering actin binding sites, and ATP binds to myosin heads, initiating the power stroke.
- d) Calcium ions inhibit the interaction between troponin and tropomyosin, allowing actin and myosin to slide past each other without binding.

22- The regulation of blood glucose levels is vital for maintaining homeostasis. Explain how insulin and glucagon work together to regulate blood glucose levels. Include the role of pancreatic cells, receptor signaling, and their effects on liver, muscle, and adipose tissue.

- a) Insulin promotes glycogen breakdown in the liver, releasing glucose into the bloodstream, while glucagon stimulates glucose uptake by muscle cells and adipose tissue.

- b) Insulin enhances glucose uptake by muscle and adipose cells, while glucagon increases glucose release from the liver by inhibiting glycogen breakdown.
- c) Insulin stimulates liver cells to convert glucose into glycogen, lowering blood glucose levels, while glucagon triggers muscle cells to release glucose into the bloodstream.
- d) Insulin and glucagon both inhibit glucose uptake by cells, causing blood glucose levels to rise as a protective mechanism against excessive glucose utilization.

23- The autonomic nervous system plays a crucial role in maintaining involuntary bodily functions. Describe the differences between the sympathetic and parasympathetic divisions of the autonomic nervous system in terms of neurotransmitters, effects on target organs, and their roles in the "fight or flight" and "rest and digest" responses.

- a) Both divisions release acetylcholine, but the sympathetic division stimulates body processes, while the parasympathetic division prepares the body for relaxation.
- b) Sympathetic division releases norepinephrine, activating the "rest and digest" response, while the parasympathetic division releases acetylcholine, triggering the "fight or flight" response.
- c) Sympathetic division releases epinephrine, increasing heart rate and dilating pupils, while the parasympathetic division releases acetylcholine, slowing heart rate and constricting airways.
- d) Both divisions release norepinephrine, but the sympathetic division prepares the body for emergencies, while the parasympathetic division conserves energy during rest.

24- Blood clotting is a complex process that prevents excessive bleeding after injury. Describe the sequence of events in the clotting cascade, beginning with the release of clotting factors and ending with the formation of a fibrin clot. Explain the role of platelets, fibrinogen, and thrombin in this process.

- a) Platelets release thrombin, which converts fibrinogen into fibrin, forming a mesh that traps blood cells and forms a clot.
- b) Clotting factors activate platelets, leading to the conversion of fibrinogen into fibrin by thrombin. Fibrin forms a net that traps blood cells and forms a clot.
- c) Thrombin activates clotting factors, leading to the activation of platelets. Platelets then release fibrinogen, which is converted into fibrin to form a clot.
- d) Clotting factors stimulate platelets to release fibrinogen, which is converted into fibrin by thrombin. Fibrin creates a network that stabilizes the clot by interacting with platelets.

25- The human respiratory system is vital for gas exchange and maintaining pH balance. Explain the process of oxygen transport from the atmosphere to the cells and the role of hemoglobin in this process. Additionally, describe how the respiratory system helps regulate blood pH through the bicarbonate buffering system.

- a) Oxygen diffuses directly across the alveolar walls into the bloodstream, where it binds to hemoglobin, forming oxyhemoglobin. Carbon dioxide is carried by hemoglobin and buffers blood pH through the chloride shift.
- b) Oxygen is carried by red blood cells and diffuses into the alveoli, where it binds to hemoglobin. Hemoglobin releases carbon dioxide into the alveoli, aiding in pH regulation.

- c) Oxygen diffuses across the respiratory membrane into the capillaries, where it binds to hemoglobin, forming oxyhemoglobin. Carbon dioxide combines with water to form carbonic acid, regulating blood pH.
- d) Oxygen is carried by hemoglobin and diffuses across the alveolar walls into the bloodstream. Hemoglobin transports carbon dioxide to the lungs, which is then released into the atmosphere to regulate pH.

Ecology & Ethology:

- 1- Prairie dogs give an alarm call when a suspected predator is nearby. When prairie dog habitats are located near trails used by humans or located in a zoo, they do not give alarm calls each time a human approach. This is an example of what type of behavior?
 - a) Imprinting
 - b) Spatial Learning
 - c) Associative Learning
 - d) Habituation

- 2- Which of the following statements is not a prediction of the Mac Arthur and Wilson Equilibrium model of island biogeography?
 - a) small islands have low immigration rates
 - b) large islands have high extinction rates
 - c) a large number of species on an island decreases immigration rate
 - d) large islands have high immigration rates
 - e) farther islands from the mainland have low immigration rates

- 3- A bird population of 170 in forest has a maximum annual rate of increase of 0.6. If the carrying capacity of the forest is 800 for this species, what is the expected population size in one year?
 - a) 255
 - b) 251
 - c) 240
 - d) 248

- 4- Compared to K-selection, r-selection favors...
 - a) Rapid development, smaller body size, and early, semelparous reproduction.
 - b) Rapid development, smaller body size, and early, iteroparous reproduction.
 - c) Slow development, larger body size, and late, semelparous reproduction.
 - d) Slow development, smaller body size, and late, iteroparous reproduction.

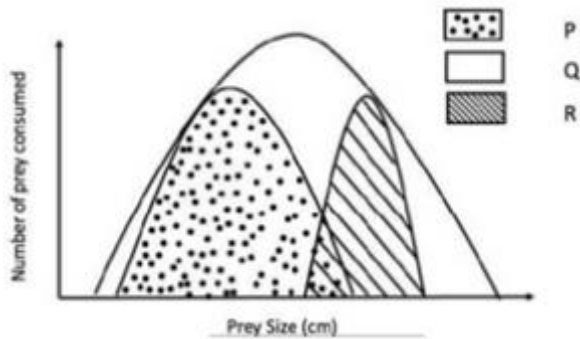
- 5- Cultivated bananas are sterile because
 - a) male flower-bearing plants are very rare.

- b) They lack natural pollinators in the crop plants.
- c) They are triploid and therefore seeds are not set.
- d) They are a cross of two unrelated species.

6- In a cooperatively breeding species, under which condition is a helper more likely to exhibit philopatry?

- a) If adult survivorship is higher for group members than for solitary individuals.
- b) When resources are abundant and widely distributed.
- c) When the chance of acquiring territory is higher.
- d) If the possibility of acquiring mates is higher outside the group

7- The figure below represents the fundamental and realized niche of two species. Which one of the following options correctly identifies the fundamental niche and realized niche of any one of the species?



- a) Fundamental niche - P; Realized niche - Q
- b) Fundamental niche - Q; Realized niche - P
- c) Fundamental niche - P • Realized niche - R
- d) Fundamental niche - R; Realized niche - P

8- Inclusive fitness of an animal can be measured as a sum of direct fitness and indirect fitness. Imagine you have 10 offspring. Through diligent parental care, 5 have survived to reproduce. You give your life in a heroic deed to save a total of 5 of your nieces and nephews. What is your inclusive fitness?

- a) 15
- b) 12.5
- c) 7.5
- d) 3.75

9- Which of the following is incorrect about a keystone species?

- a) Species other than consumers can be a keystone species.
- b) Keystone species has influence on a community proportionate to its abundance.
- c) Removing a keystone species can reduce species richness in a community.

- d) Removing a keystone species can affect successive trophic levels causing a trophic cascade.

10- The following four types of species were observed in a community:

- I. Species A has a large impact on the community because of its abundance.
- II. Species B has a large role in the community out of the proportion of its abundance.
- III. The status of species C provides an overall information about the health of the ecosystem.
- IV. Significant conservation resources are allocated to species D, which is single, large, and instantly recognizable.

According to the above descriptions, Species A, B, C, and D are...(Respectively)

- a) Dominant, Keystone, Flagship, Indicator.
- b) Dominant, flagship, Keystone, Indicator.
- c) Flagship, Dominant, Indicator, Keystone.
- d) Dominant, Keystone, Indicator, Flagship.

11- A specialist species has...

- a) Wider Niche, High efficiency of niche utilization.
- b) Wider Niche, Low efficiency of niche utilization.
- c) Narrower niche, Low efficiency of niche utilization.
- d) Narrow niche, High efficiency of niche utilization.

12- Individuals occupying a particular habitat and adapted to it phenotypically but not genotypically are known as?

- a) Ecospecies
- b) Ecotypes
- c) Ecophenes
- d) Coenspecies

13- The equilibrium model of island biogeography proposed by MacArthur and Wilson assumes that the number of species on an island represents a balance between...

- a) Resources consumption and predation rates.
- b) Birth and Death rates.
- c) Colonisation and Extinction rates.
- d) Speciation and Hybridization rates.

14- In the intricate tapestry of ecological interactions, there exists a certain group of species known for exerting a profound and disproportionate influence on their respective ecosystems. What is the primary role attributed to these remarkable species?

- a) They are the top predators, maintaining ecological balance.

- b) They are the most abundant species, ensuring ecosystem stability.
- c) They serve as keystone species, exerting disproportionate influence on the ecosystem's structure and function.
- d) They are the smallest species, making them crucial to nutrient cycling.

15- In the vast expanse of Earth's biomes, there is one where long, harsh winters are the norm, characterized by a blanket of snow and a layer of permanently frozen soil known as permafrost. Which of the following biomes best describes this challenging environment?

- a) The tropical rainforest, teeming with biodiversity.
- b) The tundra, with its frigid temperatures and permafrost.
- c) The vast grasslands, home to herds of grazing animals.
- d) The temperate deciduous forest, known for its seasonal changes.

16- Symbiotic relationships among organisms come in various forms, each with its unique ecological consequences. When one organism benefits from the association, while the other is neither helped nor harmed, what term best characterizes this type of symbiosis?

- a) Mutualism, where both parties benefit mutually.
- b) Commensalism, where one benefits while the other remains unaffected.
- c) Parasitism, where one benefits at the expense of the other.
- d) Competition, where both parties vie for limited resources.

17- Within the intricate web of a terrestrial ecosystem, organisms at which trophic level primarily harness sunlight to produce energy?

- a) Primary consumers, feeding on plants and algae.
- b) Primary producers, utilizing photosynthesis to convert sunlight into energy.
- c) Secondary consumers, preying on herbivores.
- d) Tertiary consumers, occupying the highest trophic level.

18- In the realm of ecology, what term is employed to denote the maximum population size that a particular environment can indefinitely sustain, considering available resources and environmental conditions?

- a) Population density, indicating the number of individuals per unit area.
- b) Limiting factor, signifying factors that restrict population growth.
- c) Carrying capacity, illustrating the sustainable population size
- d) Habitat niche, portraying an organism's role within its ecosystem.

19- In the realm of animal behavior, there exist innate and learned behaviors, each offering unique insights into an organism's adaptation to its environment. Which of the following behaviors is exemplified by an inherent, unlearned response that an animal displays without prior experience or training?

- a) Birdsong learning, involving the acquisition of complex vocalizations.
- b) Human language acquisition, highlighting the development of linguistic skills.
- c) A dog learning to sit through training and repetition.
- d) A spider's instinctual ability to spin an intricate web.

20- In the realm of mammalian biology, there exists a specialized sensory structure known as the vomeronasal organ, or Jacobson's organ. What is the primary function of this organ in many mammals?

- a) Capturing prey through heightened olfactory senses.
- b) Hearing high-frequency sounds in the ultrasonic range.
- c) Detecting airborne chemical signals known as pheromones.
- d) Discerning the scent of blooming flowers.

21- In the intricate study of ecosystems and trophic relationships, which type of ecological pyramid offers insights into the biomass at each trophic level, illustrating the relative mass of organisms at each stage of a food web?

- a) Pyramid of energy, showcasing the flow of energy through the ecosystem.
- b) Pyramid of numbers, indicating the population size of each trophic level.
- c) Pyramid of biomass, portraying the total organic matter at each trophic level.
- d) Pyramid of productivity, emphasizing the rate of energy production by producers.

22- In the realm of environmental science, secondary air pollutants are compounds that do not directly emit from a source but rather form through chemical reactions in the atmosphere. Among these compounds, which one is known to be a secondary air pollutant that can have both beneficial and harmful effects depending on its altitude in the atmosphere?

- a) Carbon monoxide (CO), a colorless, odorless gas.
- b) Nitrogen dioxide (NO₂), a reddish-brown gas.
- c) Ozone (O₃), a molecule consisting of three oxygen atoms.
- d) Sulfur dioxide (SO₂), a pungent gas released from burning fossil fuels.

23- In the dynamic process of ecological succession, what type of succession occurs in a barren, lifeless environment where no soil is present, often starting with the colonization of bare rock surfaces?

- a) Primary succession, involving pioneer species and soil formation.
- b) Secondary succession, following a disturbance in an existing ecosystem.
- c) Climax succession, marking the final stage of ecosystem development.
- d) Terrestrial succession, encompassing changes in land-based ecosystems.

24- Within the multifaceted domain of ecology, what term is employed to encapsulate the variety and diversity of different species present in a particular ecosystem or on Earth as a whole?

- a) Eutrophication, signifying nutrient enrichment in aquatic systems.
- b) Biodiversity, emphasizing the richness and variety of life forms.
- c) Succession, portraying the progressive changes in an ecosystem over time.
- d) Biomagnification, illustrating the accumulation of toxins through food chains.

25- In the realm of animal behavior and social structure, what term signifies the hierarchical ranking or social order within a group of animals, often determined by dominance, access to resources, and intricate social interactions?

- a) Territory, delineating an individual or group's defined area.
- b) Harem, highlighting a social structure with one dominant male and multiple females.
- c) Troop, describing a cohesive group of animals, often in primate societies.
- d) Pecking order, illustrating the rank-based social hierarchy.