

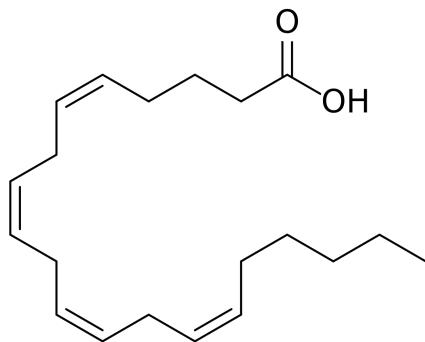
MCC

1. In which of the following cellular structures are proteins destined for export produced?
 - a. Golgi Apparatus
 - b. Nucleus
 - c. Rough Endoplasmic Reticulum
 - d. Smooth Endoplasmic Reticulum
 - e. Lysosomes
2. Given that the isoelectric point (pi) of a certain amino acid is 6.2, what is the net charge of this amino acid in a solution of pH 7.2?
 - a. -1
 - b. -0.9
 - c. 0
 - d. +0.9
 - e. There is insufficient information to determine the correct answer
3. A plant cell with an internal solute potential of -0.95 MPa is placed in a solution with a solute potential of -0.30 MPa. The cell maintains its volume and does not lyse or plasmolyze. Given this information, one can conclude that:
 - a. The cell contains many aquaporins.
 - b. The cell wall exerts a pressure potential of +0.65 MPa on the cell.
 - c. The cell wall exerts a pressure potential of -0.65 MPa on the cell.
 - d. The cell wall exerts a pressure potential of -1.25 MPa on the cell.
 - e. The cell wall is impermeable to water.
4. Which of the following amino acids would you LEAST expect to find in the transmembrane domain of an integral protein?
 - a. Lysine
 - b. Valine
 - c. Tryptophan
 - d. Alanine
 - e. Phenylalanine
5. Which of the following would NOT be related to the secondary structure of a protein?
 - a. Peptide bonds
 - b. Alpha helices
 - c. Hydrogen bonding
 - d. Ionic bonding
 - e. Beta-pleated Sheets

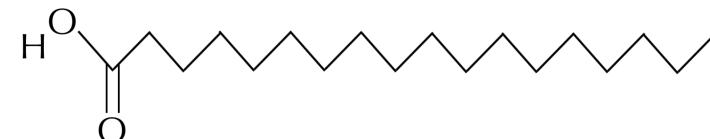
6. Scientists are constantly trying to develop new antibiotics to combat the effects of antibiotic resistance. Targets for antibiotics are typically found in bacterial cells but not human cells to limit side effects. Which of the following proteins could they target to develop an effective antibiotic?

- a. Flagellin
- b. G-protein Coupled Receptors
- c. Aquaporins
- d. DNA polymerase
- e. RNA polymerase

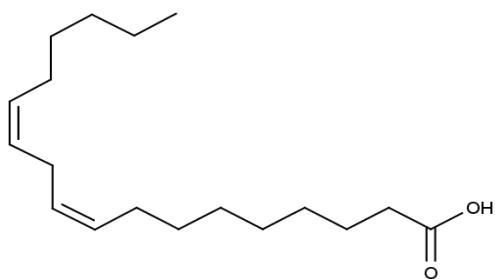
7. Which of the following fatty acids is most likely to have the highest melting point?



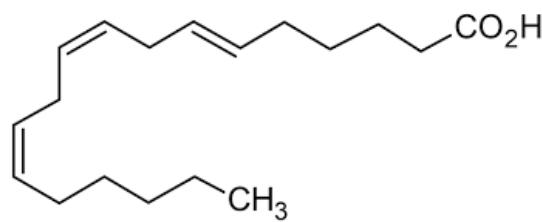
a.



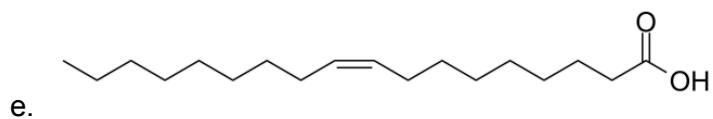
b.



c.



d.



8. Cholesterol and its derivatives serve all of the following purposes except:
 - a. Control transcription of certain loci in the nucleus
 - b. Control membrane fluidity at temperature extremes
 - c. Regulate contraction of muscles
 - d. Regulate metabolic activity
 - e. Regulate ion concentrations in blood

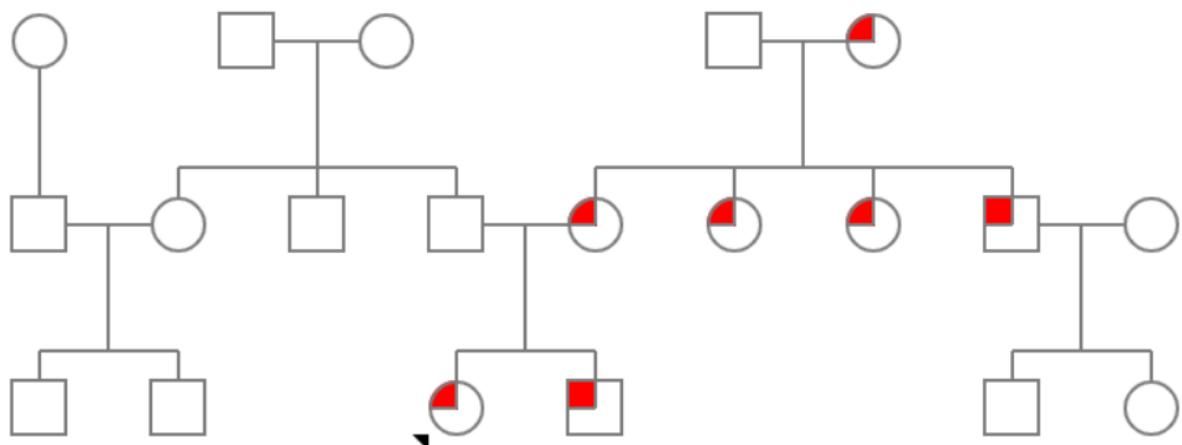
9. Which of the following reactions of glycolysis are irreversible under intracellular conditions?
 - I. Fructose 1,6-bisphosphate is cleaved to glyceraldehyde 3-phosphate and DHAP
 - II. Fructose 1,6-bisphosphate is formed from fructose 6-phosphate
 - III. Pyruvate and ATP are formed from phosphoenolpyruvate and ADP
 - IV. 3-phosphoglycerate and ATP are formed from 1,3-bisphosphoglycerate and ADP
 - A. II only
 - B. IV only
 - C. I and IV
 - D. II and III
 - E. III and IV

10. Which of the following compounds is not necessary for the pyruvate dehydrogenase complex to function?
 - a. NAD⁺
 - b. Lipoic acid
 - c. Ubiquinone
 - d. FAD
 - e. Pyruvate

GGG

1. A population of 20,000 colonists arrives at a nearby star system after a long journey from Earth. 1,250 of the colonists have Hitchhiker's thumb while 18,750 do not. After 10 generations, the population reaches 50,000. Given that Hitchhiker's thumb is determined by a recessive allele and assuming that the population satisfies Hardy-Weinberg equilibrium, how many colonists are expected to have Hitchhiker's thumb after 10 generations?
 - a. 0
 - b. 1,250

- c. 2,500
 - d. 3,125
 - e. There is insufficient information to determine the correct answer
2. Which of the following is NEVER true about chromosomes?
- a. They may undergo double-stranded breaks due to natural causes
 - b. They can fuse together to form one large chromosome
 - c. They can be replicated over and over to form a large chromosome
 - d. They can form rings due to errors during Meiosis
 - e. They sort into homologous pairs for meiosis
3. Look at this pedigree for a trait.



- Which of the following types of inheritance does this pedigree most likely display?
- a. Autosomal dominant
 - b. Autosomal recessive
 - c. X-linked dominant
 - d. Y-linked recessive
 - e. Mitochondrial
4. When a transformed bacterial cell undergoes binary fission, only one of the resulting daughter cells contains the introduced genetic material. Which of the following best explains this phenomenon?
- a. The original parent cell likely rejected the introduced gene.
 - b. The original parent cell was heterozygous with respect to the introduced gene.
 - c. After transformation, the original parent cell had a heteroduplex that only changed the sequence for one of the strands of DNA.
 - d. The gene had been successfully introduced to the parent cell, but the nucleic acid hadn't been integrated into the chromosome.

5. A hypothetical operon called the *Sto* operon is regulated by molecule F. The genes within the *Sto* operon are continuously transcribed at moderate levels when molecule F is not present. When molecule F is present, it binds to the operator of the *Sto* operon, and inhibits the transcription of the genes within the operon. The *Sto* operon is thus said to be what type of operon?
- Inducible Operon
 - Activated Operon
 - Inhibited Operon
 - Repressible Operon
 - Constituent Operon
6. A new species is discovered and its genome is analyzed. Scientists discover that 34% of the nitrogenous bases are Adenine (A) and 34% are Thymine (T). What percentage of the genome consists of purines?
- 16%
 - 22%
 - 32%
 - 50%
 - 68%
7. In the year 4347, astronauts set foot upon an alien planet and observe the interesting life forms which inhabit it. They discover that they have a genetic system incredibly similar to all life forms on Earth, and use a molecule very similar to DNA to store genetic information. The only difference is that their “DNA” uses 6 different nucleotides, and their proteins can be made from 32 different amino acids. If transcription and translation on this planet are conducted similarly to how it is done on Earth, what is the least amount of nucleotides needed for each codon?
- 1
 - 2
 - 3
 - 4
 - 5
8. Loss of function mutations in which of the following would most likely trigger a cell to become cancerous?
- DNA polymerase gene
 - RNA polymerase gene
 - Tumor suppressor genes
 - Proto-oncogenes

- e. Tumor inducer genes
9. Which of the following is not necessary to satisfy Hardy-Weinberg Equilibrium
- a. Large population size
 - b. No mutations
 - c. Population admixture
 - d. No immigration
 - e. No Selection
10. Which of the following sequences would have the greatest affinity for RNA polymerase
- a. Promoter
 - b. Start Codon
 - c. Coding sequence
 - d. Terminator
 - e. Poly-adenylation signal

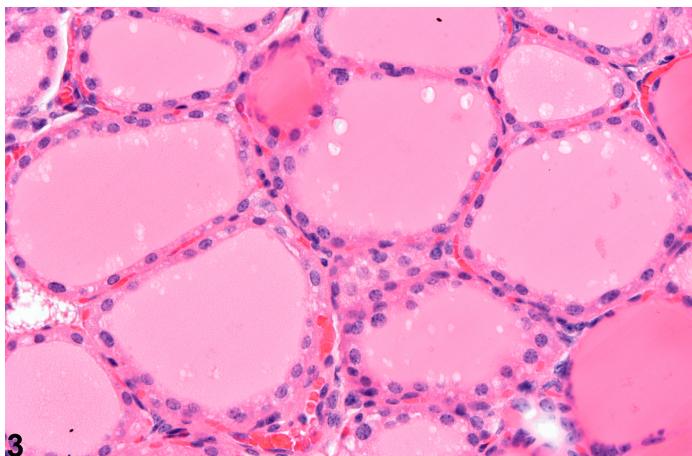
ANP

1. DN is a 40-year-old man, presenting to the ER complaining of light-headedness and dizziness. Doctors measure his heart rate and find it is abnormally low. His blood also has an abnormally low oxygen saturation level. Given his symptoms and the following ECG, what diagnosis should the doctors make?



- a. Ventricular Tachycardia
- b. Atrial Septal Defect
- c. Heart Failure
- d. Myasthenia Gravis
- e. Third Degree AV Block

2. A section of an unknown endocrine tissue is presented to you, and after staining and placing them under a microscope, you see multiple follicle-like structures with cells surrounding them. What organ is this tissue from?



3. BC is a 48-year-old woman, presenting to the ER after falling down the stairs. She complains about a persistent gait as well as difficulty walking. It was discovered that there was a disease in a region of her brain. Which region could it be?
- Suprachiasmatic nucleus
 - Corpus callosum
 - Amygdala
 - Cerebellum
 - Papez circuit
4. A Patent Foramen Ovale (PFO) is a condition in which two chambers of the heart are not separated properly. All individuals have a PFO as fetuses, as it allows blood to bypass normal circulation through one of the chambers of the heart. This is because the fetus already receives oxygen-rich blood from its mother, rendering blood flow through this chamber of the fetal heart unnecessary during gestation. Given this information, which chamber is this?
- Left Ventricle

- b. Right Ventricle
 - c. Right Atrium
 - d. Left Atrium
 - e. Central Atrium
- 5. Sports drinks companies often tout the benefits of the electrolytes in their beverages. Which of the following statements is NOT true about the role of electrolytes in muscle contraction?
 - a. An influx of calcium ions to the cytoplasm of muscle cells is required to bind to troponin and reveal binding sites between actin and myosin fibers for muscle contraction.
 - b. Sodium and potassium concentrations are used to generate the resting potential needed for nerve cells to conduct signals.
 - c. As action potentials travel down along nerves, nerve cells release sodium ions in exchange for potassium ions
 - d. Magnesium ions act as an antagonist to the actions of Calcium, and as such are involved in muscle relaxation.
 - e. Acetylcholine binds to acetylcholine receptors at the neuromuscular junction, opening ligand-gated ion channels in the plasma membrane of the muscle cell that allow sodium ions to flow into the cell
- 6. A patient presents to the emergency room complaining of extremely painful headaches. They reported they had drank 2 gallons of water 3 hours ago, and their blood osmolarity is measured to be unusually low. This caused a net flow of water across the blood-brain barrier, causing the brain to swell and press up against the patient's skull. Which of the following would be an effective treatment for the patient?
 - a. Intravenously administer a hypotonic saline solution.
 - b. Increase the concentration of ADH in the blood.
 - c. Administer a diuretic medication.
 - d. Intravenously administer an isotonic saline solution.
 - e. Run the patient's blood through a dialysis machine to remove excess solutes.
- 7. The overall decrease in length of a muscle during muscle contraction is due to decrease in the length of what functional unit?
 - a. Proteins
 - b. Nephrons
 - c. Sarcolemma
 - d. A bands
 - e. Sarcomeres
- 8. Which of the following is not true about glycogen breakdown?
 - a. Glycogen that you ingest from food is digested by the enzyme alpha-amylase in the small intestine.

- b. In the liver and skeletal muscle, endogenous glycogen is digested from the non-reducing end.
 - c. The reaction catalyzed by the enzyme glycogen phosphorylase forms the product glucose 6-phosphate.
 - d. Glucose 6-phosphatase, the enzyme that hydrolyzes glucose 6-phosphate, is present only in the liver and kidney.
- 9. Which of the following is true about lectins and their physiological applications?
 - a. Lectins are enzymes that bind lipids with high specificity, and they are associated with cell to cell recognition and signaling.
 - b. Selectins are a specific type of lectin that have applications in the movement of leukocytes through the capillary wall.
 - c. Selectins repress the inflammatory responses that are often found in arthritis, multiple sclerosis, and asthma, making them ideal candidates for drug development.
 - d. Interaction of lectins with their substrate causes the leukocytes to roll faster along the endothelial lining.
- 10. The myelin sheath is used in order to speed up transmissions of electrical impulse across a nerve cell's axon. Which of the following cells secrete this sheath in the brain?
 - a. Schwann cells
 - b. Microglia
 - c. Astrocytes
 - d. Oligodendrocytes
 - e. Ependymal cells

SBI

- 1. A new plant species is discovered that has vascular tissue and petals. Which of the following clades could this new species be classified under?
 - a. Lycophyta
 - b. Angiosperms
 - c. Bryophyta (mosses)
 - d. Ferns
 - e. Gymnosperms
- 2. You discover a strange plant with centrioles, strobilli, and coral-like roots. Which of the following plant clades would this species belong under?
 - a. Cycadophyta
 - b. Gnetophyta
 - c. Lycophyta
 - d. Anthocerophyta

- e. Bryophyta
3. While working in a lab, you see a slide containing a leaf cross-section sitting on a microscope. When you observe it, you see large bundles of cells surrounding vascular tissue. Which type of photosynthesis would this plant most likely use?
- a. C3 photosynthesis
 - b. Crassulacean acid metabolism
 - c. Alarm photosynthesis
 - d. C4 photosynthesis
4. Which of the following animals has the eye that is closest to the ones found in vertebrates in terms of function?
- a. Nautilus
 - b. Planarian
 - c. Giant Clam
 - d. Mantis Shrimp
 - e. Cube Jelly
5. In protostome development, which of the following patterns occur?
- a. The blastopore becomes the mouth and typically exhibits spiral cleavage
 - b. The blastopore becomes the anus and typically exhibits spiral cleavage
 - c. The blastopore becomes the mouth and typically exhibits indeterminate cleavage
 - d. The blastopore becomes the anus and typically exhibits indeterminate cleavage
 - e. The blastopore becomes either the anus or mouth and exhibits rotational cleavage
6. An environmental toxin is injected into each of the following organisms. Which would be LEAST able to filter it out?
- a. Flatworm
 - b. Earthworm
 - c. Roundworm
 - d. Inchworm
 - e. Tapeworm
7. Which segment of the insect leg is closest to the body?
- a. Coxa
 - b. Trochanter
 - c. Femur
 - d. Tibia
 - e. Tarsus

8. You move a houseplant that was completely straight to a sunny window. Your friend Joanna thinks the plant is cute and knits it a black felt hat which is placed on the top of the plant, leaving the lower leaves exposed to the sun. Assuming the plant has only a single stem, which of the following do you expect to see in a month?
- The plant will bend towards the window
 - The plant will bend away from the window
 - The plant will wither and die
 - The plant will grow completely straight
 - The plant will fall over.
9. Which of the following is a trait unique to fungi among multicellular eukaryotes?
- Presence of cell walls
 - Saprophytic/decomposer lifestyle
 - Cell junctions larger than nuclei
 - A multicellular haploid stage
 - Obligate heterotrophy
10. You discover a unicellular organism in the pond behind your house. It is able to perform photosynthesis but you also notice it eats smaller organisms through an oral groove. Which of the following could it be?
- Paramecium
 - Euglena
 - Volvox
 - Dinoflagellate
 - Plasmodium

EEE

1. Angiosperm clades with zygomorphic flowers often undergo greater rates of speciation than angiosperms with actinomorphic flowers. Explanations for this observation claim that bilateral symmetry of flowers restricts the potential directions of approach and movement on the flower for pollinators. Which of the following drivers of evolution is this an example of?
- Mechanical isolation
 - Genetic drift
 - Temporal isolation
 - Hybrid infertility

- e. Increased mutation rates
2. On a particularly rainy day, an orangutan watches as her brother takes a leaf from a nearby tree and places it on his head. She observes that the leaf acts as an umbrella and protects him from the rain. The first orangutan then copies her brother's behavior and also places a leaf on her head. What type of behavior is this?
 - a. Classical conditioning
 - b. Altruistic behavior
 - c. Fixed action pattern
 - d. Habituation
 - e. Social learning
3. Two species of plants, *G. Pombi* and *J. Neprosi* have flowers that look very similar to one another and bloom at the same time. They exist in separate habitats with similar conditions but are very far from one another geographically. A small population of *G. Pombi* is introduced into the natural habitat of *J. Neprosi*. Which of the following is LEAST likely to happen over time?
 - a. All *G. Pombi* individuals of the population are outcompeted and the local population dies off.
 - b. The flowers of both species change in appearance and look starkly different from each other after many generations.
 - c. The flowers of both species become more similar in appearance over many generations.
 - d. The flowers of one species do not change in appearance, but the flowers of the other change significantly in appearance.
 - e. The flowers of *G. Pombi* in the local population start to bloom earlier and the flowers of *J. Neprosi* start to bloom later.
4. Corals build hard calcium carbonate skeletons as they grow to protect themselves. These hard skeletons can build up over time, especially in locations where corals are densely populated. Eventually, a complex ecosystem can develop in these areas due to the creation of special habitats from the coral skeletons. Thus corals can BEST be defined as what type of species?
 - a. Founder species
 - b. Primary producer
 - c. Indicator species
 - d. Ecosystem engineer
 - e. Habitat fabricator
5. A certain ecosystem is inhabited by mice, ferrets, and hawks. Mice eat seeds, ferrets eat mice, and hawks eat ferrets. Assuming that a hawk requires 400 Calories per day, and

that a ferret contains 200 Calories, how many Calories of seeds must be consumed by the mice in the ecosystem every day to sustain one hawk?

- a. 400 Calories
 - b. 2,000 Calories
 - c. 4,000 Calories
 - d. 20,000 Calories
 - e. 40,000 Calories
6. A small marker is embedded just outside the cork cambium of a birch tree. After multiple growth cycles, how has the position of the marker changed?
- a. The marker has been shed and has fallen to the ground.
 - b. The marker has moved outwards from the center of the tree and has risen.
 - c. The marker has moved outwards from the center of the tree and has stayed at the same level.
 - d. The marker has risen from the ground and has stayed at the same distance from the center of the tree.
 - e. The marker has remained in the same place, surrounded by the tree
7. Which of the following can introduce novel traits or alleles into a population?
- a. Genetic drift
 - b. Mutation
 - c. Natural Selection
 - d. Sexual Selection
 - e. Bottleneck events
8. In which of the following biomes would net primary productivity be the highest?
- a. Chaparral
 - b. Tundra
 - c. Tropical rainforest
 - d. Temperate broadleaf forest
9. Professor Magnolia wants to estimate the population size of wild Dreepy in the Wild Area. Dreepy are fast creatures, and can occasionally turn invisible. Which of the following sampling methods should the Professor use?
- a. Transect Lines
 - b. Quadrants
 - c. Tag and Mark
 - d. Aerial Counting
 - e. Mark and Recapture
10. Which of the following man-made crises most affects ocean biodiversity now?
- a. Habitat loss
 - b. Microplastics
 - c. Garbage islands

- d. Fishing and Whaling
- e. Ocean Acidification