USABO Open Exam
February 7 to 17, 2017

1. **A virus has been discovered. The virus has no envelope and consists of a helical capsid surrounding its dsDNA genome. During assembly, the *pac* site of the genome ensures that it is properly packaged by the capsomeres. Which of the following amino acids is/are expected to be on the capsomere domain that interacts with the *pac* site?**

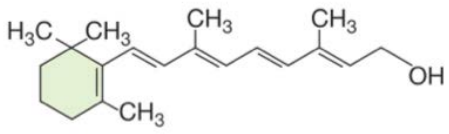
   A. Lysine.
   B. Methionine.
   C. Glycine.
   D. Arginine.
   E. A and D.

2. **Developing diagnostics for the Zika virus has proven to be difficult due to cross reactivity displayed by antibodies for other flaviviruses. If a person has been previously exposed to certain flaviviruses (i.e. yellow fever or West Nile virus), then he/she may have antibodies which diagnostics erroneously attribute to Zika virus exposure. The issue stems from antibodies that resulted from a prior immune response. In the classic immune response, which cells are primarily responsible for the production of antibodies?**

   A. Macrophages.
   B. Eosinophils.
   C. Plasma cells.
   D. T lymphocytes.
   E. Goblet cells.

3. **The structure shown is an example of a(n)… (Select the BEST answer.)**

   A. Carbohydrate.
   B. Lipid.
   C. Nucleic acid.
   D. Saturated lipid.
   E. Unsaturated lipid.



4. You are analyzing a receptor that is expressed on the cell surface of two different cell types (Cell Type I and Cell Type II). Based on the information given in the table below, identify the cell type whose receptor is more sensitive to the ligand?

	K1 (μM^{-1}/min)
Cell Type 1	8
Cell Type 2	16

A. Cell Type 1 is more sensitive, because its k_D is larger.
B. Cell Type 1 is more sensitive, because its k_D is smaller.
C. Cell Type 2 is more sensitive, because its k_D is larger.
D. Cell Type 2 is more sensitive, because its k_D is smaller.

5. You are observing the response of Type 1 and Type 2 cells to a specific protein ligand. Type 1 cells proliferate rapidly in response to the ligand unlike Type 2 cells. Circle the option(s) from below that can explain the observed difference.

A. The gene encoding the ligand specific receptor in Type 1 cells has a methylated promoter
B. Type 1 cells express intracellular receptors unlike Type 2 cells.
C. Type 1 cells express plasma membrane receptors unlike Type 2 cells.
D. Type 1 cells lack the transcription factor needed for the expression of the gene encoding the ligand specific receptor.
E. The gene encoding the ligand specific membrane receptor in Type 1 cells has a frame-shift mutation that generates a premature stop codon.

6. The following reactions are the free energy changes associated with four biological reactions. Which reaction will have the highest ratio of products to reactants at equilibrium?

A. ΔG = -2.5 Kcal/mole.
B. ΔG = -1.5 Kcal/mole.
C. ΔG = +2.5 Kcal/mole.
D. ΔG = +1.0 Kcal/mole.

7. Which of the following is a plausible reason that explains why extreme halophiles can tolerate high salt conditions?

A. They can accumulate compatible solutes, such as glycerol and sucrose, in their cytoplasm.
B. They can prevent the entrance of protons in their cytoplasm.
C. They have less porins or transport proteins, which makes them less permeable to solutes.
D. They have more saturated fatty acids in their membranes than unsaturated fatty acids.
E. They have more unsaturated fatty acids in their membranes than saturated fatty acids.

8. NADPH oxidase is a complex of five proteins that forms (not hydrolyzes) reactive oxygen species such as O_2^{--} and H_2O_2 by catalyzing the reduction of oxygen (O_2) by hydride ions (H^{-}) from NADPH. Loss of function mutations in NADPH oxidase components were found in the 1950-60's to underlie an inherited human immunodeficiency disorder called chronic granulomatous disease (CGD). CGD is characterized by the inability of neutrophils to destroy phagocytosed bacteria, especially if the bacteria are capable of hydrolyzing H_2O_2. Based on your knowledge of phagocytosis by immune cells, in which subcellular organelle or compartment of neutrophils is NADPH oxidase activity found to be highest?

A. Cytosol.
B. Lysosome.
C. Mitochondrion.
D. Peroxisome.
E. Smooth endoplasmic reticulum.

9. Which statement about the life cycle of the human immunodeficiency virus (HIV) is most accurate?

A. The viral glycoproteins that coat the mature virion's lipid envelope's outer surface are synthesized by host cell ribosomes in the cytosol.
B. The mature virus particle does not contain reverse transcriptase; the protein is translated from the RNA genome after entry into the host cell.
C. If a scientist were to extract just the viral genome from HIV virions and inject the nucleic acid into a human cell, the genome would integrate as a provirus into the host's genome.
D. In HIV positive individuals, HIV provirus can be found latent in CD4 positive cells years after initial infection.
E. The high error rate of reverse transcriptase enables the virus to evade the host's circulating antibodies by changing the antigenicity of its internal capsid protein.

10. The progression of cancer is often driven by genetic and epigenetic alterations. Which of the following is not likely to contribute to tumorigenesis?

A. Loss-of-function mutation in the p53 gene.
B. Upregulation of pro-apoptotic proteins.
C. Duplication of the telomerase gene.
D. Increased secretion of growth factors.
E. Moderately high level of oxidative stress.

11. Which of the following incorrectly compares C3 versus C4 plants?

	C3 plants	C4 plants
A.	Rubisco performs initial carbon fixation step	PEPase performs initial carbon fixation step
B.	Loses water and energy through photorespiration	No or very low photorespiration rate
C.	RuBP initially accepts carbon diozide	PEP initially accepts carbon dioxide
D.	Most plants	Tropical grasses
E.	Spatial separation of carbon fixation and photosynthesis	Temporal separation of carbon fixation and photosynthesis

12. Grace is attempting to identify what organism a tissue sample came from. She finds linear cellulose synthesizing complexes. Which of the following organisms could it have come from?

I. Plant
II. Charophycean
III. Green Alga

A. I only.
B. II only.
C. III only.
D. I and II.
E. II and III.

13. Which of the following statements about vascular plant anatomy is FALSE?

A. The bark is a coat of waxy suberin produced by the epidermis of woody plants.
B. Trichomes are modified epidermal cells, often resembling hairs, that some species have adapted to reflect excess sunlight or to deter herbivorous insects.
C. The phloem is composed of live sieve-tube elements and companion cells.
D. Plant stems arise by the apical meristem's production of nodes (regions where leaves and other appendages are attached) separated by internodes (regions where most of the stem elongation occurs).
E. In flowering plants, the xylem and phloem form a vascular cylinder that runs down the center of the root.

14. Soil chemistry greatly influences the availability of nutrients to plant roots. Which one of the following statements accurately describes such a relationship?

A. Some plants are able to grow in low soil pH by secreting anions, such as citrate or oxalate that can chelate toxic calcium ions (Ca^{2+}) and prevent their absorption by roots.
B. High soil pH can prevent plants from absorbing Ca^{2+} ions due to Al^{3+} ions solubilizing at high pH.
C. At a soil pH of 8 or greater, the iron (Fe^{2+}) needed by plants is unavailable.
D. Anions such as phosphate and sulfate bind to soil particles and are not easily leached from the soil.
E. Atmospheric nitrogen and nitrogenous compounds in the humus are the first and second most important reservoirs of bioavailable nitrogen for plants in most habitats.

15. Consider the following experiment similar to those first performed in the 1950's. Individual *Arabidopsis thaliana* plants are grown in a hydroponic solution (without soil). Some plants (Group A) are grown in water labeled (20%) with oxygen-18 and atmospheric air with unlabeled CO_2, while others (Group B) are grown in unlabeled water and atmospheric air with 50% of the CO_2 labeled with oxygen-18. Gases produced by the plant are collected for 20 minutes. After 1 day, the following are analyzed for oxygen-18 content: the collected gas, tissue from the plants, and tissue from the plants baked until dry. The results are as follows, where a + indicates a statistically significant enrichment and a - indicates no enrichment:

	Collected gas	**Plant tissue**	**Dried plant tissue**
Group A (H_2O labeled)	+	-	-
Group B (CO_2 labeled)	-	+	+

Assuming that the detailed mechanisms of photosynthesis have not yet been discovered, what would be concluded about photosynthesis from this experiment?

A. The oxygen atoms in plant sugars (or other organic compounds) are derived from water.
B. The oxygen atoms in the CO_2 produced by plant respiration originated from water.
C. The oxygen atoms in the labeled CO_2 were incorporated into plant sugars (or other organic compounds) only.
D. Oxygen (O_2) is formed from the splitting of water during photosynthesis.
E. The oxygen in the labeled CO_2 was released as O_2.

16. One day, you discover a mysterious blue dye in dusty old cabinet at the end of your lab bench. After experimentation, you realize that your dye binds to acidic solutions. You apply this dye to some plant specimens and find that certain parts of cell are especially dyed. Out of the following four choices you find that exactly two of them bind to your dye. Which of the following bind to your dye? Choose ALL that apply.

A. Thylakoid lumen.
B. Chloroplast stroma.
C. Cell cytosol.
D. Mitochondria matrix.

17. In your laboratory, you have *Arabidopsis thaliana* in pot A and pot B. You water the *Arabidopsis* in pot A each day and keep it in very limited sunshine. For the *Arabidopsis* in Pot B, you add salt to the soil and expose it to very strong sunshine with very limited water. You measure the water potential of plants in both pots at the root, stems and the leaves. Select ALL the following statements about the plants that are TRUE.

A. In the plant in pot B, since there is salt in the soil, the water potential in the root is lower than the water potential in the stem.
B. In the plant in pot B, since there is a lot of evaporation in the leaves, the water potential of the leaves is lower than the water potential of the stems.
C. Water typically moves from lower potential to higher potential.
D. In the plant in pot A, the potential of the leaves is higher than the potential of the stem as there is little evaporation from the sun.

18. Which of the following statements about eudicot plant anatomy is most accurate?

A. The phelloderm is a thin layer of parenchyma cells derived from the vascular cambium.
B. Lateral roots arise from the pericycle and push through the cortex, endodermis, and epidermis during their growth.
C. Secondary growth refers to growth of a branch once all primary growth along that given branch has finished.
D. One may distinguish leaves from the leaflets of a compound leaf by the absence or presence, respectively, of an axillary bud at the base of the structure in question.
E. Secondary phloem develops along the outer circumference of primary phloem during secondary growth.

19. Which of these systems cannot be found in *Caenorhabditis?*

A. Circulatory and excretory systems.
B. Circulatory and nervous systems.
C. Circulatory and respiratory systems.
D. Secretory, circulatory and respiratory systems.
E. Excretory and respiratory systems.

20. One of your colleagues is attempting to isolate the receptor for testosterone. He decides to copy your protocol for isolating the receptor for epinephrine by radiolabeling the hormone, isolating the membrane fraction, and purifying radioactive protein complexes. Realizing that your colleague has probably not slept in days, you review the experimental procedure to ensure that it actually works. Which one of the following is a reason why your colleague's experiment would not work?

A. Radiolabels on testosterone do not last very long.
B. Testosterone is a steroid hormone and diffuses across the cell membrane.
C. Testosterone binds only briefly to its receptor and then rapidly dissociates.
D. Radiolabeling the hormone would result in cell death.
E. None of the above.

21. In order to study the effects of certain hormone deficiencies, you inject a mouse with a tyrosine hydroxylase inhibitor. Since tyrosine hydroxylase is the rate-limiting step in the synthesis of catecholamines, which one of the following hormones do you expect to NOT be affected:

A. Serotonin.
B. Epinephrine.
C. Dopamine.
D. Norepinephrine.
E. None of the above.

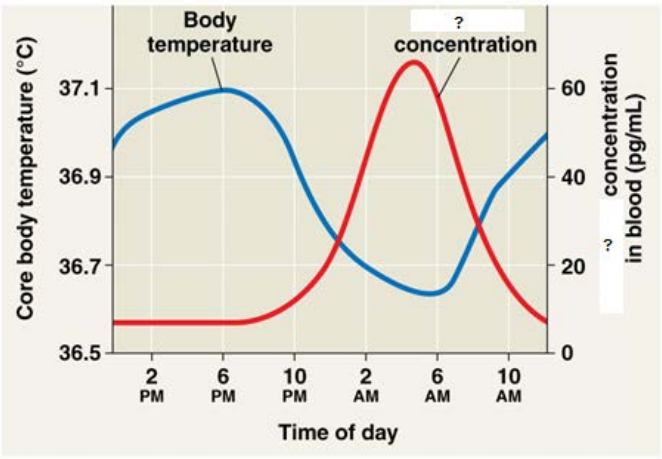
22. An animal experiences an acid-base imbalance in the arterial blood that results in respiratory alkalosis. To decrease pH toward normal, which direction would the ventilation rate be changed and what would be the corresponding change in arterial P_{CO2}?

A. Ventilation rate increases, arterial P_{CO2} increases.
B. Ventilation rate increases, arterial P_{CO2} decreases.
C. Ventilation rate decreases, arterial P_{CO2} increases.
D. Ventilation rate decreases, arterial P_{CO2} decreases.
E. None of the above.

23. Select all of the following choices that correctly match the tissue to the embryonic germ layer from which it is primarily formed (*Select ALL that apply*):

A. Ectoderm – spinal cord.
B. Mesoderm – heart.
C. Endoderm – thyroid.
D. Ectoderm – epidermis.
E. Endoderm – liver.

24. Circadian rhythms can include periodic changes in homeostatic setpoints. With that in mind, consider the following graph of variation in core body temperature and the concentration of an associated hormone in the blood.



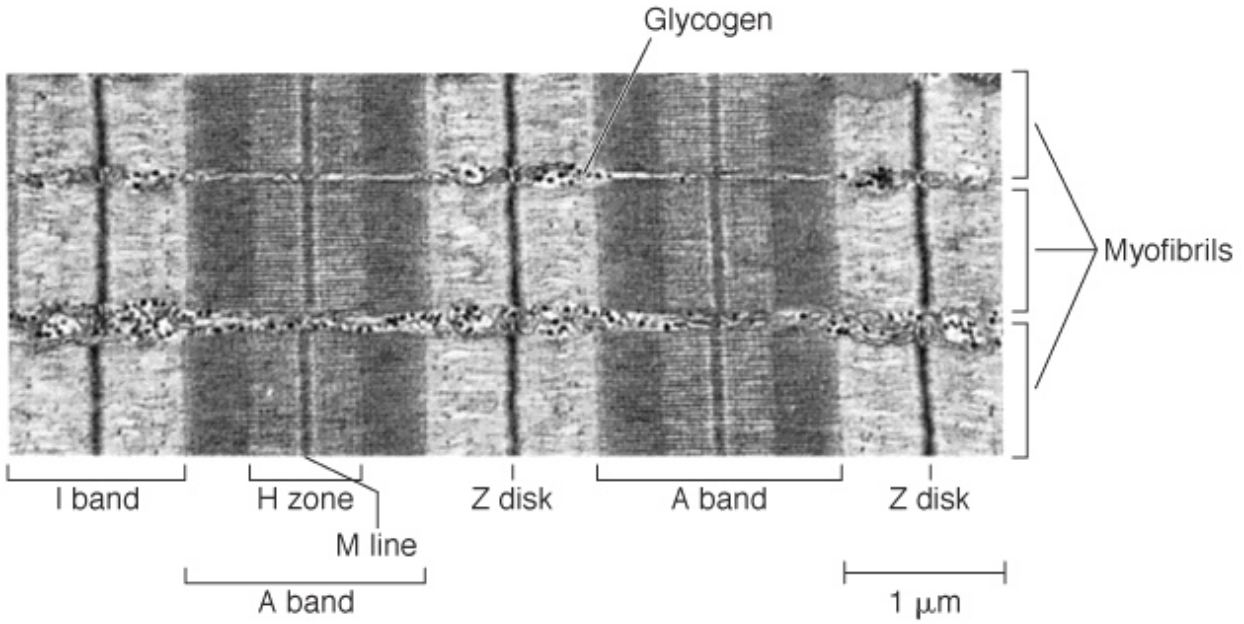
The hormone with its concentration plotted is released from which of the following glands?

A. Adrenal medulla.
B. Anterior pituitary gland.
C. Hypothalamus.
D. Pineal gland.
E. Posterior pituitary gland.

25. In Graves' disease, abnormal antibodies that activate the thyroid-stimulating hormone (TSH, or thyrotropin) receptor are made by the patient's plasma cells. TSH stimulates thyroid follicular cells to grow and produce hormones. Using this information and your knowledge of thyroid hormone regulation, which of the following statements would one expect an individual with advanced Grave's disease to possess (*Select ALL that apply*)?

A. The individual would have a high body temperature and substantial weight loss.
B. The individual would have an enlarged thyroid gland.
C. The individual would have high levels of thyrotropin-releasing hormone (TRH).
D. The individual would have high levels of TSH.
E. The individual would have high levels of thyroxine.

26. The sliding filament model of muscle contraction, first proposed in the 1950's, has been supported over the decades by a number of independent experimental approaches. Which of the following experimental observations would NOT have been consistent with the currently accepted sliding filament model? A diagram of a skeletal muscle fiber is shown below for your reference.



A. Light microscopy video shows that frog sarcomere shortens during contraction and slightly increases in diameter.
B. When myosin filaments fixed to a glass slide (and fluorescently labeled red) are exposed to a solution of purified actin filaments (labeled green) in the presence of ATP, red and green filaments are seen in the microscope to glide past each other.
C. Light microscopy of a contracting sarcomere reveals that the I bands of the sarcomere shortened, while the A bands did not.
D. X-ray crystallography of live, relaxed muscle indicates that filaments of two different diameters are intermixed in a regular hexagonal pattern when the sarcomere is viewed end-on.
E. An electron micrograph shows both actin and myosin organized into long protein filaments at all points throughout the entire length of one myofibril.

27. The Starling equation is a widely used model of the movement of fluid across capillary walls in animals. Essentially, the fluid flux is proportional to the net pressure from oncotic and hydrostatic pressures, and to the permeability of the capillary wall to water. The oncotic pressure is simply the osmotic pressure contributed by proteins in the blood serum like albumin.

$J_v = K_f [(P_c - P_i) - (\pi_c - \pi_i)]$, where

J_v = fluid movement/flux out of the capillary (mL min-1)
K_f = hydraulic conductance (mL min-1 mmHg-1)
P_c = capillary hydrostatic pressure (mmHg)
P_i = interstitial hydrostatic pressure (mmHg)
π_c = capillary oncotic pressure (mmHg)
π_i = interstitial oncotic pressure (mmHg)

Which of the following physiologic changes would increase the fluid volume of the interstitial space of tissues? Select ALL where the change will increase the fluid volume of the interstitial space.

A. Scarring of and decreased albumin synthesis by the liver from chronic alcohol abuse.
B. Constriction of a precapillary smooth muscle sphincter upstream of the capillary bed.
C. The release of histamine and cytokines that increase capillary permeability.
D. Formation of a thrombus downstream of the capillary bed.
E. Severe protein malnourishment, such as in the condition kwashiorkor.

28. Select ALL of the following parts of the nephron where water is reabsorbed from the filtrate:

A. Collecting duct.
B. Proximal tubule.
C. Bowman's capsule.
D. Ascending limb of loop of Henle.
E. Descending limb of loop of Henle.

29. You are performing an experiment on neural embryonic development, and you decide to knock out a gene that leads to the normal formation of the metencephalon. Select ALL of the following structures in the CNS that would be affected:

A. Cerebellum.
B. Basal nuclei.
C. Midbrain.
D. Pons.
E. Medulla.

30. During your rounds as a medical student, your mentor asks you to identify potential causes for the pernicious anemia of the patient that you are visiting. Having recently studied your GI physiology, you correctly answer that it could have been caused by (*Select ALL that apply*):

A. Faulty iron absorption.
B. Damage to the absorptive cells of the duodenum.
C. Damage to chief cells.
D. Damage to parietal cells.
E. Damage to the absorptive cells of the ileum.

31. Which of the following best represents the type of mimicry characteristic of multiple poisonous butterflies having similar coloration?

A. Mertensian mimicry.
B. Müllerian mimicry.
C. Batesian mimicry.
D. Wasmannian mimicry.
E. Vavilovian mimicry.

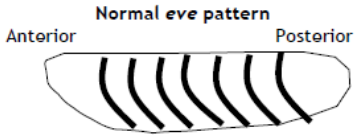
32. Optimal foraging can depend on the densities of different food sources. Assuming the goal is to maximize the rate of food acquisition, how might this relationship manifest (*Select ALL that apply*)?

A. In a clustered distribution, a greater distance between clusters translates to more time spent at each cluster.
B. In a clustered distribution, a greater distance between clusters translates to less time spent at each cluster.
C. A less prevalent prey species which is easier to eat than a more prevalent species can be preferred.
D. A more prevalent prey species which is harder to eat than a less prevalent species can be preferred.
E. Ignoring certain prey on a hunting trip may be the optimal strategy.

33. You wish to understand the nature of birds' song and divide a group of baby birds of the same species into three groups— Control Group, Experimental Group I, and Experimental Group II. The Control Group is reared with their species and sings this species' song. The Experimental Group I is placed with a different bird species with a different song and never learns to sing the different species' song. Experimental Group II is raised with no parents for the first week, they sing no song even when re-wilded with the control birds at a relatively young age. Which of the following best describes these birds behavior with respect to singing (*Select ALL that apply*)?

A. Learned.
B. Innate.
C. Has a Critical Period.
D. Plastic.
E. Automimicry.

34. Which of the following will best describe how the pattern of even-skipped expression would be altered in embryos from a mother expressing 4 copies of the *bicoid* gene? A normal *eve* pattern is shown below for your reference. Assume that *bicoid* and *eve* expression are independent.



A. *eve* stripes are shifted anteriorly.
B. *eve* stripes are shifted posteriorly.
C. The whole embryo will be colored with *eve* gene with no stripes.
D. *eve* stripes will be concentrated into a small dot toward the anterior.
E. *eve* stripes will be concentrated into a small dot toward the posterior.

35. Retinoblastoma protein (pRb) prevents the G1-> S transition when it is active. You are analyzing the cell cycle of a somatic cell (2n). What is the DNA content of a mutant somatic cell that has a constitutively active pRb?

A. n (analogous to the state in the gamete).
B. 2n (analogous to somatic cells which have just completed cytokinesis).
C. 4n (analogous to mid anaphase).
D. 2n (analogous to early prophase).
E. 4n (analogous to mid telophase.

36. Consider a diploid snail species that has 34 chromosomes (2n = 34). This species has an XX/XY-like sex determination system, with males hemizygous for a particular locus on chromosome 2. Without considering crossing over, how many genetically unique individuals can one pair of snails potentially produce when reproducing sexually?

A. 68.
B. $2^{34} \times 2^{34}$.
C. 2×34^2.
D. $2^{17} \times 2^{17}$.
E. It is impossible to know.

37. Unlike the eukaryotes, there is only one origin of replication (ori site) in the bacterial genome. If DNA polymerase enzyme adds nucleotides at the rate of 10,000 base pairs/minute in one direction and the bacterial cells replicate their entire genome every 20 minutes, what is the size of the bacterial genome?

A. 4 X 10^5 base pairs.
B. 2 X 10^5 base pairs.
C. 4 X 10^5 base.
D. 2 X 10^5 base.

Questions 38 to 41. Next Generation Sequencing (NGS) technologies automate sequencing of billions of base pairs (bp) across many pooled samples, each sample previously labeled with a unique oligonucleotide "barcode" allowing for subsequent identification of sequences with the samples they came from. Suppose you wanted to study the composition of oral bacteria from 100 patients by using NGS to sequence the DNA isolated from saliva and then aligning the resulting sequences to a database in order to compare the compositions of bacteria identified from each patient. You were able to sequence 9×10^9 bp of total bacterial sequence among all your samples. Below is a table of sequencing data for some of the samples.

Table of read depths and compositions

Sample #	Barcode	Number of Sequencing Reads
1	ATGCGCAT	121854
4	ATATCTGC	394553
26	ATGTCCGC	67502

Assuming that each sequence consists of 300bp, could be sequenced from either the forward or reverse strand of the DNA, and for simplicity, that all sequences were of good quality, indicate if each of the following statements is TRUE (Use A) or FALSE (Use B):

38. Since Sample 4 has the most sequence read, Sample 4 has the most bacterial diversity.

39. Sample 26 contains two particular sequences, one starts with ATGCGACTACG and the other ends with CGTAGTCGCAT. These could not represent identical bacterial strains.

40. Errors during the labeling steps resulting in two transition mutations in the barcode for Sample 26 could result in the same barcode used for Sample 4.

41. The experiment yielded 3×10^7 sequences.

42. Influenza is a negative-sense, single-stranded RNA virus, which means that its genome is copied into complementary, positive-sense mRNA that is then translated into protein. Use the codon table provided below to determine what protein sequence is produced by this 3-codon segment of the influenza virus genome.

5'-ACGUACUGU-3'

Standard genetic code

1st base	2nd base								3rd base
	U		C		A		G		
U	UUU	(Phe/F) Phenylalanine	UCU	(Ser/S) Serine	UAU	(Tyr/Y) Tyrosine	UGU	(Cys/C) Cysteine	U
	UUC		UCC		UAC		UGC		C
	UUA	(Leu/L) Leucine	UCA		UAA	Stop (*Ochre*)	UGA	Stop (*Opal*)	A
	UUG		UCG		UAG	Stop (*Amber*)	UGG	(Trp/W) Tryptophan	G
C	CUU		CCU	(Pro/P) Proline	CAU	(His/H) Histidine	CGU	(Arg/R) Arginine	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	(Gln/Q) Glutamine	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	(Ile/I) Isoleucine	ACU	(Thr/T) Threonine	AAU	(Asn/N) Asparagine	AGU	(Ser/S) Serine	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	(Lys/K) Lysine	AGA	(Arg/R) Arginine	A
	AUG[A]	(Met/M) Methionine	ACG		AAG		AGG		G
G	GUU	(Val/V) Valine	GCU	(Ala/A) Alanine	GAU	(Asp/D) Aspartic acid	GGU	(Gly/G) Glycine	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	(Glu/E) Glutamic acid	GGA		A
	GUG		GCG		GAG		GGG		G

Image: Creative Commons via Wikipedia

A. TYC.
B. CYT.
C. RVT.
D. TVR.
E. TY*..

43. John has Downs Syndrome. At a given locus on chromosome 21 in a region with low crossover, John's genotype is ACC. At this same locus, his father has genotype AC and his mother BC. In which stage of his parents' meiosis could nondisjunction have occurred (*Select ALL that apply*)?

A. Meiosis I of the father.
B. Meiosis II of the father.
C. Meiosis I of the mother.
D. Meiosis II of the mother.
E. None of the above.

44. Which of the following statements is correct about diversity in ecological environments?

A. Ecological stress increases diversity.
B. Animals that share a common habitat are typically more closely related that animals in different environments.
C. Natural selection generally decreases diversity.
D. Diversity is most often seen in small populations.
E. Changes in diversity of host species have little effect on other species.

45. Which set of organisms is correctly paired with a habitat inhabited by all organisms in the set?

A. Kelp (*Laminaria*), echinoderms, barnacle (*Balanus*): littoral zone of freshwater lakes
B. Chemosynthetic bacteria, pogonophorans (giant tube worms), blind crabs: deep-sea hydrothermal vent (abyssal benthic zone)
C. Sphagnum moss, alligator, methanogenic archaea, heron: rocky intertidal zone
D. Nudibranch (sea slug), crinoids (feather star), corals, spiny lobster (*Palinurus*): pelagic zone
E. Kelp, barnacle, limpet, chiton: wave-exposed sandy intertidal zone

46. Which of the following climates describes that of the chaparral biome?

A. Precipitation < 30 cm/year. Wide temperature variation on daily and yearly time scales.
B. Precipitation 150 to 200 cm/year, 6-7 month dry season. Temperature 25 to 29°C with little seasonal variation.
C. Precipitation 30 to 50 cm/year, seasonal with cool, rainy winters and long, dry summers. Winter temperatures 10 to 12°C.
D. Precipitation 30 to 100 cm/year, seasonal with dry winters and wet summers. Winter temperatures can fall to -10°C.
E. Precipitation 70 to 200 cm/year, year-round. Winter temperature around 0°C with snow, summer temperature 35°C.

47. You have been recently studying a small alien ecosystem that is near you. The ecosystem consists of trogs that eat brogs that eat progs. Progs produce energy from the sun. Given that there is 190kJ worth of biomass of progs, approximately how much energy does the biomass of trogs represent?

A. 1900J
B. 3800J
C. 19000J
D. 38000J

48. Select ALL of the following that correctly match the species to its survivorship curve and survival strategy:

A. Humans: Type I curve, K-selection.
B. Songbirds: Type II curve, neither r nor K-selection.
C. Trees: Type III curve, r-selection.
D. Frogs: Type III curve, K-selection.
E. Elephants: Type I curve, neither r nor K-selection.

49. You are pleasantly enjoying your afternoon in Bali, Indonesia, when you stumble upon a street stand that has a conspicuous "DO NOT TOUCH" sign. Below the sign, there are two bats. This scary tourist trap owes its existence to which mammalian order?

A. Monotremata.
B. Chiroptera.
C. Rodentia.
D. Lagomorpha.
E. Sirenia.

50. Chef Grace is trying to experience the taste of dolphin without actually eating dolphin. She presumes that taste is evolutionary and changes much the same way genes do. Which of the following organisms should she eat based on this hypothesis?

A. Elephant
B. Bighorn Sheep
C. Manatee
D. Lemur
E. Koala