2006 Open Examination

For each of the following questions, choose the best answer among the five choices, A-E.

1. Insulin injected by diabetics to control blood sugar levels is derived from bacteria whose DNA has been modified by the addition of the human gene for insulin, which is then produced by the prokaryotes. This is an example of:
   A. acid therapy.
   B. cloning.
   C. genetic engineering.
   D. gene therapy.
   E. pluripotency.

2. Isolated RNA molecules are generally less stable than DNA at physiological pH because:
   A. RNA has ribose.
   B. RNU is always linear.
   C. RNA has U instead of T.
   D. RNA is usually single stranded.
   E. there are many more RNAse enzymes.

3. Which of the following molecules is able to cross the lipid bilayer?
   A. antibodies
   B. ATP
   C. insulin
   D. Na+
   E. steroid hormones

4. If the rate constant of a first order reaction that converts substrate S into product P is 0.693 min^{-1} then what is the half life of the reaction?
   A. 0.010 min
   B. 0.346 min
   C. 0.693 min
   D. 1.000 min
   E. 1.440 min

5. The local swimming pool is contaminated with an organism that is causing "swimmers itch." You think you have identified cyanobacteria in your sample. Which features would you expect this organism to LACK?
   A. chlorophyll
   B. cell membrane
   C. differentiated cell types such as spores, vegetative cells, and heterocysts
   D. nucleoid region
   E. nucleolus

6. Suppose radioactive thymine was added to an actively dividing culture of *E.coli* bacteria. What would happen if a cell replicated once in the presence of this radioactive base?
    A. one of the daughter cells, but not the other, would have radioactive DNA
    B. neither of the two daughter cells would be radioactive
    C. all four bases of the DNA would be radioactive
    D. radioactive thymine would pair with nonradioactive guanine
    E. DNA in both daughter cells would be radioactive

7. If radioactive sulfur (^{35}S) is used in the culture medium of bacteria that harbor bacteriophage viruses, it will later appear in:
    A. bacterial RNA.
    B. bacterial cell walls.
    C. viral DNA.
    D. viral RNA.
    E. viral coats.

8. Which of the following would probably be LEAST DAMAGED by a lipid-dissolving enzyme (lipase)?
    A. endoplasmic reticulum
    B. mitochondria
    C. ribosomes
    D. nuclei
    E. plasma membrane

Questions 9 & 10 refer to the following information.
The concentration of ions inside an amoeba is expressed below as ion-units per milliliter. The composition of the extracellular environment (ECE) is given for comparison. Assume the amoeba has been in the environment for some time.

	Na^+	K^+	Cl^-	HCO_3^-
Amoeba	1	42	3	119
ECE	21	16	41	119

9. As the number of (+) and (-) ions in the amoeba and in the ECE are not equal, one might assume that:
    A. the amoeba and the ECE are very acidic.
    B. the amoeba and the ECE are very basic.
    C. either K^+ or Na^+ has a different valence.
    D. a mistake in measurements had been made.
    E. other ions are also involved.

10. The differences in concentration of K^+ and Na^+ inside and outside of the amoeba indicate that:
    A. amoeba are dead.
    B. diffusion is not occurring.
    C. energy has been increased.
    D. energy has been expended.
    E. osmosis has occurred.

11. Five events occur in a cell constituting a cause-and-effect sequence:

    1. an enzyme is manufactured at the ribosomes
    2. cellulose is deposited in a cell wall
    3. a molecule of RNA is transcribed
    4. a carbohydrate polymer is synthesized
    5. a nucleic acid migrates from nucleus to ribosome

The order in which these events occur is:
    A. 1, 3, 5, 4, 2
    B. 2, 1, 4, 5, 3
    C. 3, 5, 1, 4, 2
    D. 4, 2, 1, 3, 5
    E. 5, 3, 4, 1, 2

12. When bacterial cells multiply maximally during the logarithmic phase, the total number of cells (b) after some time interval (t) is equal to the original number of cells (B) multiplied by 2^n, where n is the number of generations formed during the time interval: $n = t/g$ and $b = (B)(2^n)$. The generation time (g) for type A cells is 28 minutes (assume no cell death).

Estimate the LEAST amount of time required for a population of type A cells to increase by 300 percent.
    A. approximately 42 minutes
    B. approximately 48 minutes
    C. approximately 52 minutes
    D. approximately 58 minutes
    E. more than 62 minutes

There was some question on the validity of the answer provided. Can you confirm? Tlh

13. A population of 2800 flowers is in Hardy-Weinberg equilibrium, and 2352 of them are red in color. The red allele [R]is the dominant allele; the allele for white color [r] is recessive. What would be the frequency of heterozygotes in the population?
    A. .03
    B. .16
    C. .48
    D. .71
    E. .84

14. The cause of trisomy 21 is:
    A. error during meiosis.
    B. chromosomal insertion.
    C. error during mitosis.
    D. incomplete duplication of chromosome 21.
    E. over duplication of chromosome 21.

15. The molecular weight of fumarate is 160.0. How many grams of fumarate are there in 200 mL of a 0.1 M fumarate solution?
  A. 0.32 grams
  B. 3.20 grams
  C. 8.00 grams
  D. 80.00 grams
  E. 3.20 kg

16. Replacement of a lysine with a glycine in a protein could result in all of the following EXCEPT a :
  A. change in the quaternary structure of the protein.
  B. change in the secondary structure of the protein.
  C. loss of catalytic activity of the protein.
  D. loss of a negatively charged side chain.
  E. loss of the protein's ability to interact with other proteins.

Following general mutagensis, a researcher found in regard to lactose metabolism by a bacterium:

Lactose Metabolism	Temperature	
(+)	37º C	42º C
Normal	(+)	(+)
Mutated	(+)	(-)

17. The bacterial genome was sequenced and a mutation found in a gene adjacent to β-galactoside. How would you best explain these research findings? The:
  A. sequencing data is incorrect.
  B. mutation lies in a regulatory gene.
  C. mutation renders the enzyme responsible for lactose transport sensitive to high temperatures.
  D. promoter protein in this pathway must be mutated such that it is denatured by the higher temperature.
  E. mutation must lie in the operator gene.

18. Researchers found that the arginine code AGG is poorly represented in genes of *E.coli*. Interestingly, they also found that this triplet, when present, binds to the ribosome 7-9 base pairs upstream from the starting ATG triplet (methionine). What does this information suggest in regard to the AGG codon?
A. it is a codon rarely found in this bacterium
B. it is conserved in most prokaroytic organisms
C. it may have a regulatory function in the cell
D. both B and C
E. A, B and C
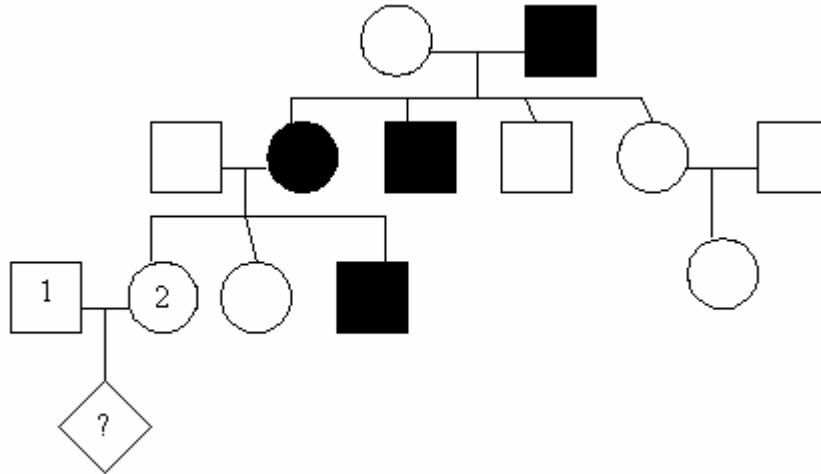
19. The above pedigree results from a rare SEX-LINKED disease. If individual 1 and 2 have a baby, what is the likelihood that the child, noted with a ?, will have the disease?
A. 50% if it is a girl; 50% if it is a boy
B. 0% if it is a girl; 50% if it is a boy
C. 50% if it is a girl; 0% if it is a boy
D. 0% if it is a girl; 0% if it is a boy
E. 0% if it is a girl; 25% if it is a boy

20. The diversity of animal and plant species found on the Galapagos Islands differs from that of the mainland because of:
A. climate change.
B. convergent evolution.
C. divergent evolution.
D. parallel evolution.
E. random distribution.

21. In many species of flowering plants, the characteristics of the flower; its scent, color, time of flowering, time of day it opens, kind and amount of food it offers, are matched to the pollinating organism's size, form, physiology and reproductive cycle. The term that describes this relationship is:
A. convergent evolution.
B. coevolution.
C. divergent evolution.
D. parallel evolution.
E. pseudoevolution.

22. Mountain goats may have a thicker coat of hair than goats at lower altitudes in the same general geographical area. This adaptation to the cooler climate of the mountains most likely arose as a result of:
A. allopathic selection.
B. bottleneck effect.
C. directional selection.
D. genetic drift.
E. stabilizing selection.

23. A given polyclonal antibody molecule can bind to:
A. only one molecule of antigen per antibody molecule.
B. more than one molecule of the same antigen per antibody molecule.
C. two different antigens at once.
D. more than one epitope on the same antigen molecule.
E. two different epitopes at once.

24. If a mouse is exposed to cycles of 12 hours of light followed by 12 hours of dark, the mouse is mostly active in the dark and has a rest-activity cycle of 24 hours. If the mouse is then kept in a constantly dark environment, the period of the rest-activity cycle is slightly less than 24 hours. Why does the mouse's cycle shorten in the dark environment?
A. the mouse's clock genes get harmful mutations
B. the mouse's circadian clock requires environmental cues to reset it
C. the mouse's circannual rhythm is inhibited
D. the mouse's pineal gland secretes too much melatonin
E. the mouse's suprachiasmatic nuclei are over-stimulated by the darkness

25. Why is pepsinogen secreted as a zymogen into the stomach? To:
A. change the pH of the stomach fluids to aid digestion.
B. digest complex carbohydrates.
C. digest tough cellulose material.
D. inactivate pepsinogen.
E. prevent digestion of the gastric glands.

26. During alcoholism, the protein content and osmotic potential of the blood decreases severely because the liver is the major producer of blood proteins. In this situation, which of the following outcomes is to be expected?
A. body tissues will swell
B. blood impurities will not be filtered out appropriately
C. capillaries will become more impermeable to blood proteins
D. solute concentration in the blood will decrease
E. thoracic ducts will produce more blood proteins to compensate

27. The anatomy of an animal from a cold climate differs from that of an animal from the tropics in that:
A. the animal from the cold climate has smaller ears.
B. the animal from the cold climate has larger ears.
C. the animal from the tropics has more fat.
D. the animal from the tropics has a more spherical body shape.
E. there is no difference except perhaps for coloration.

28. A person suffering from nerve gas exposure is given atropine to counteract the effects. Why?
A. atropine binds to the nerve gas and inactivates it
B. atropine inactivates acetylcholine esterase and allows more acetylcholine to cross the synaptic cleft
C. atropine blocks the acetylcholine receptor which blocks the excess acetylcholine lingering in the synaptic cleft
D. atropine blocks the sites where nerve gas acts
E. atropine stimulates the production of an enzyme that breaks down the nerve gas

29. Which of the following does NOT describe synovial joints?
A. bones held together by cartilage
B. joint cavity
C. joint surfaces of bones covered with articulating cartilage
D. most freely movable of joints
E. two-layered joint capsule

30. Which of the following processes aid in skeletal muscle relaxation after contraction?
A. acetylcholinesterease degrades acetylcholine
B. calcium is released from intracellular storage sites
C. motor neurons send electrical signals to the muscle
D. sodium is released from intracellular storage sites
E. troponin binds calcium

31. In India, "night blindness" is a condition mostly found in children, but it can also be found in adults. This condition is an early sign of:
A. cataracts.
B. glaucoma.
C. myopia.
D. retinal degeneration.
E. vitamin A deficiency.

32. A dog was kept in a room at a temperature of 40°C for two weeks. At the end of that time, it was determined that the dog was sterile. An investigator conjectured that the high temperature had caused the animal's sterility. In order to conjecture this hypothesis, an investigator should be able to show that:
A. a cat kept in the same room did not become sterile.
B. the dog's pituitary gland had not degenerated.
C. the dog was homozygous for temperature sensitivity.
D. the dog was not sterile before the experimental period began.
E. the high temperature did not alter the dog's blood pressure.

33. An antidiuretic hormone:
A. decreases absorption of urea.
B. decreases plasma glucose after meals.
C. decreases sodium reabsorption from the ascending limb of the Loop of Henle.
D. increases free-water transfer from the distal convoluted tubule and collecting duct to the capillary blood.
E. increases osmolarity.

34. Which one or combination of the following explains why patients with sickle cell anemia have difficulty breathing at high altitudes?
1. elongation of the red blood cells reduces surface to volume ratios
2. self-associated hemoglobin proteins have altered cooperative binding affinities
3. soluble oxygen is unable to diffuse through the membrane of red blood cells in sickle cell patients

A. 1 only
B. 1 and 2 only
C. 1 and 3 only
D. 2 and 3 only
E. all of the above

35. Which of the following is NOT required by nitrogen-fixing organisms for growth?
A. carbon dioxide
B. nitrate
C. nitrogen
D. oxygen
E. all are required

36. A scientist established a controlled squirrel population within a woods containing 60 Oak trees and one pair of squirrels in 1975. She did a count of squirrels each year for five years. The data that she collected are shown below.

Year	Run 1	Run 2	Run 3	Run 4	Run 5	Average
75	2	2	2	2	2	2
76	6	5	6	4	5	5.2
77	16	11	16	9	11	12.6
78	40	27	41	21	27	31.2
79	101	67	100	52	67	77.4

Assuming no emigration or immigration, what is the closest approximation of the natural rate of increase of this population?
A. 2
B. 3
C. 4
D. 5
E. 6

37. The photobiont of a lichen is most likely to be:
A. green algae or cyanobacteria.
B. green or red algae.
C. moss or cyanobacteria.
D. red algae or moss.
E. sponge.

38. Xerophytic adaptations are exemplified by which combination of the following features?
1. stomata close at night and open during the day
2. rolled leaves
3. thick waxy cuticles
4. reduction in leaf area
5. hairy leaves

A. 1, 2 & 3
B. 1, 2, 3 & 4
C. 2, 3 & 4
D. 2, 3, 4 & 5
E. all of the above

39. The denitrifying activity of denitrifying bacteria will be REDUCED by which of the following?
A. decrease in oxygen concentration
B. decrease in nitrogen concentration
C. increase in nitrate concentration
D. increase in oxygen concentration
E. increase in soil moisture content

40. Of the following statements, which combination correctly represents the characteristics of primary production?
1. it is carried out only by green plants
2. it is carried out only by photoautotrophs
3. it determines the total energy flow through an ecosystem
4. it determines the amount of life that an ecosystem can support
5. gross productivity minus respiration is equal to net productivity

A. 1, 2, 3 & 4
B. 2, 3 & 4
C. 2, 3 & 5
D. 2, 3, 4 & 5
E. all of the statements

41. Cattle trample and kill small plants surrounding a water hole as they stand near it to drink water. This is an example of:
A. amensalism.
B. Batesian mimicry.
C. commensalism.
D. Mullerian mimicry.
E. mutualism.

42. If you were to see a child pulling a toy, followed by three young domestic geese, which of the following would be the most likely explanation for the goslings' behavior:
A. associative learning.
B. displacement.
C. imprinting.
D. instinct.
E. training.

43. The movement of water from the soil to the top of a tall tree is primarily the result of:
A. active transport of water from xylem vessels into leaf cells.
B. active transport of water into xylem vessels.
C. higher water potential in leaf cells as compared to root cells.
D. root pressure.
E. transpiration.

44. If a scientist adds a chemical that specifically inhibits diffusion of protons out of the thylakoid through the ATP synthase complex, the result would be:
A. an increase of NADP in the interior of the thylakoids.
B. an increase in the pH in the interior of the thylakoids.
C. increased production of ATPs.
D. no net change in ATP production.

45. When Darwin covered the tip of an oat coleoptile with foil and then illuminated it from one side, the coleoptile:
A. bent away from the light.
B. failed to grow toward the light.
C. grew toward the light.
D. had reduced growth in length.
E. wilted and died.

46. According to the pressure-flow hypothesis of phloem transport:
A. combination of a high turgor pressure in the "source" and transpiration water loss from the "sink" moves solutes through phloem conduits
B. formation of starch from sugar in the "sink" increases osmotic pressure
C. pressure in the phloem of a root is normally greater than the pressure in the phloem of a leaf
D. solute moves from a higher concentration in the "source" to a lower concentration in the "sink"
E. water is actively transported into the "source" region of the phloem to create the needed turgor pressure

47. During the reproductive process, all of the following transitions occur EXCEPT that the:
A. microspores become pollen grains.
B. ovulary becomes a fruit.
C. ovules become seeds.
D. flower petals fall off.
E. tube nucleus becomes a sperm nucleus.

48. In order to flower, what does a short-day plant need?
A. burst of red light in the middle of the night
B. burst of far-red light in the middle of the night
C. day that is longer than a certain critical length
D. higher ratio of $P_r : P_{fr}$ during the day
E. night that is longer than a certain critical length

49. Which of the following is the function of arbuscules in endomycorrhizae? To:
A. aid the digestion of dead organic matter in the soil.
B. serve as a nutrient/water bridge between fungus and plant root.
C. serve as a reproductive structure.
D. store nutrients that have been digested.
E. all of the above.

50. The subkingdom Eumetazoa branches into which of the following taxonomic clades?
A. deuterostomia and protostomia
B. lophotrochozoa and ecdysozoa
C. parazoa and bilateria
D. radiata and bilateria
E. radiata and parazoa