The 55th Annual
Merck State Science Day Competition
May 17, 2005

Biology

Directions:

PLEASE DO NOT OPEN THE EXAM BOOKLET UNTIL DIRECTED.

Be sure to fill in your name on the answer sheet both by printing it in the correct space, and by filling in the corresponding letter in the provided spaces.

Use a #2 pencil only.

Carefully erase any errors, and do not make any extraneous marks on the answer sheet.
Do NOT use *White-Out* on any portion of the answer sheet.

The test has **120 items**. You have **90** minutes in which to answer all the questions.

There is only one correct answer per question. Do not spend too much time on any one question. Do the items you find easier first, and then go back to those you find more difficult or time consuming during the time you have remaining. Your individual score will be computed on the basis of the number of correctly answered items. (There is no penalty for guessing.)

MERCK State Science Day 2005 Biology

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

1. Glucose is to glycogen as amino acids are to _____.
A) triglycerides
B) proteins
C) steroids
D) nucleotides
E) oligosaccharides

2. All of the following may be used as alternative hydrogen sources to drive aerobic cellular respiration if blood glucose becomes unavailable EXCEPT;
A) fatty acids
B) amino acids
C) glycerol
D) nucleotides
E) amine groups

3. Evolution is the biological theme that ties together all the others. This is because the process of evolution:
A) Explains how organisms become adapted to their environment
B) Explains the diversity of organisms
C) Explains why all organisms have characteristics in common
D) Explains why distantly related organisms sometimes resemble one a
E) All of the above are explanations

4. According to the induced fit hypothesis of enzyme function, which of the following is correct?
A) The binding of the substrate depends on the shape of the active site
B) Some enzymes become denatured when activators bind to the substrate
C) A competitive inhibitor can out compete the substrate for the active site
D) The binding of the substrate changes the shape of the enzyme slightly
E) The active site creates a microenvironment ideal for the reaction

5. Zebra mussel populations are growing explosively in the river systems of the central United States. The best explanation for this unchecked population growth is;
A) they muddy the water around them, making it difficult for their natural enemies to see them
B) they are considered an invasive species and have no natural predators to slow down their population growth
C) they are better adapted to the environment than competing species
D) they are feeding on a source of food that had been previously unavailable
E) a mutation caused by pollution has increased their reproductive rate

6. Which example best describes a homeostatic control system?
A) The core body temperature rise from 37^0C to 45^0C
B) Motility in the digestive tract increases following a meal
C) The blood pressure increases in response to an increase in blood volume
D) The kidneys excrete salt into the urine when dietary salt levels rise
E) A blood cell shrinks when placed in a solution of salt and water

7. Which of the following is *not* a fundamental difference between monocot and dicot morphology and anatomy?
Monocots have _____, while dicots have _____.
A) one cotyledon; two cotyledons
B) parallel veins; net veins
C) vascular bundles in a ring; vascular bundles scattered throughout the stem
D) fibrous roots; taproots
E) none of the above: all are fundamental differences between the two groups

8. In a hypothetical situation, a bacterium lives on the surface of a leaf, where it obtains nutrition from the leaf's nonliving, waxy covering, and where it inhibits the growth of other microbes that damage the plant. If this bacterium accidentally gains access to the inside of a leaf, it causes a fatal disease in the plant. Once the plant dies, the bacterium and its offspring decompose the plant. What is the correct sequence of ecological roles played by the bacterium in this given situation?
1. saprobe
2. mutualist
3. commensal
4. parasite
5. primary producer

A) 1, 3, 4
B) 2, 3, 4
C) 2, 4, 1
D) 1, 2, 5
E) 1, 2, 5

9. Which of the following best summarizes the relationship between condensation reactions and hydrolysis?
A) Condensation reactions assemble polymers and hydrolysis breaks them apart
B) Hydrolysis occurs during the day and condensation reactions happen at night
C) Condensation reactions can occur only after hydrolysis
D) Hydrolysis synthesizes monomers and condensation reactions break them
E) Condensation reactions occur in plants and hydrolysis happens in animals

10. Which of these statements about plant hormones is correct?
- **A)** Auxins, such as IAA, are only found in very young or beginning germinating plants
- **B)** Auxins and cytokinins act synergistically to promote lateral growth at the apical meristem
- **C)** Cytokinins do not occur naturally in plants
- **D)** Ethylene is a gas that plays a role in senescence
- **E)** Gibberellins, such as GA_3, play a predominant role in the generation of statoliths

11. Inflammatory responses may include all of the following EXCEPT?
- **A)** clotting proteins sealing off a localized area
- **B)** increased activity of phagocytes in an inflamed area
- **C)** reduced permeability of blood vessels to conserve plasma
- **D)** release of histamines to increase the blood supply to an inflamed area
- **E)** release of substances to stimulate the release of white blood cells from bone marrow

12. A mutation that renders the regulator gene of a repressible operon inactive in an *E.coli* cell would result in:
- **A)** continuous transcription of the structural gene controlled by that regulator
- **B)** complete inhibition of transcription of the structural genes
- **C)** irreversible binding of the repressor to the operator
- **D)** inactivation of RNA polymerase
- **E)** Both B and C are correct

13. All of the following statements concerning gene expression in eukaryotes are rue EXCEPT?
- **A)** Chromosome puffs are sites of active mRNA synthesis
- **B)** The mRNA synthesized in the nucleus is modified before it goes to the ribosome and becomes translated
- **C)** euchromatic regions of a chromosome contain active genes while the heterochromatic regions contain inactive genes
- **D)** Promoter regions function as regulatory sites that influence the binding of RNA polymerase
- **E)** Gene expression in the nucleus is controlled by histone proteins

14. A number of characteristics are very similar between the Charophyta green algae and the kingdom Plantae. Of the following, which characteristic does NOT provide evidence for an evolutionarily close relationship between these two groups?
- **A)** chloroplast structure
- **B)** alternation of generations
- **C)** cell plate formation during cytokinesis
- **D)** sperm cell ultrasound structure
- **E)** ribosomal RNA signatures

15. In the systemic blood circuit, the __ half of the heart pumps ___ blood to all body regions; then ____ blood flows back to the heart through the _____.
A) left; deoxygenated; oxygenated; pulmonary arteries
B) right ; deoxygenated; oxygenated; vena cavas
C) left; oxygenated; deoxygenated; vena cavas
D) right ; oxygenated; deoxygenated; pulmonary veins
E) left; oxygenated; deoxygenated; pulmonary veins

16. The processes responsible for urine composition and volume generally occur in which of the following orders?
A) pressure filtration; selective reabsorption; selective secretion
B) selective secretion; selective reabsorption; pressure filtration
C) selective reabsorption; selective secretion; pressure filtration
D) selective secretion; pressure filtration; selective reabsorption
E) selective reabsorption; pressure filtration; selective reabsorption

17. Which of the following statements is *not* true for a disease that is inherited as a rare X-linked dominant trait?
A) All daughters of an affected male will inherit the disease
B) Sons will inherit the disease only if their mothers have the disease
C) An affected female, whose husband is also affected, may produce an unaffected son
D) Daughters will inherit the disease only if their father has the disease
E) None: all of the above statements are true

18. **For questions 18 -19 use the following information:**
In Drosophila, two red-eyed, long-winged flies are bred together and produce the offspring given in the following table:

	FEMALES	MALES
red-eyed, long-winged	76	43
red-eyed, vestigial-winged	23	12
white-eyed, long-winged	---	38
white-eyed, vestigial-winged	---	16

The most logical explanation for these results is that:
A) both traits obey the law of dominance/recessiveness
B) the parents both display the wild type autosomal dominant traits
C) eye color is autosomal whereas wing type is sex-linked
D) eye color is sex-linked, whereas wing type is autosomal
E) both A and D are correct

19. If one of the red-eyed, vestigial winged females was mated with one of the white-eyed, vestigial winged males: which of the following would not be possible for the offspring to inherit?
A) red-eyed, vestigial-winged female
B) white-eyed, vestigial-winged female
C) red-eyed, vestigial-winged male
D) white-eyed, vestigial-winged male
E) red-eyed, long-winged female

20. You sample a population of butterflies and find that 42% are heterozygous for a particular gene. What would be the frequency of the recessive allele in this population?

A) 0.09
B) 0.3
C) 0.49
D) 0.7
E) Not enough information

21. In a large, sexually reproducing population, the frequency of an allele changes from 60% to 20%. From this change, one can most logically assume

A) that the allele is linked to a detrimental (lethal) allele
B) that the allele mutates rapidly
C) that the allele reduces fitness
D) that there is no sexual selection
E) that random processes have changed allelic frequencies

22. For questions 22-23: Use the following diagram

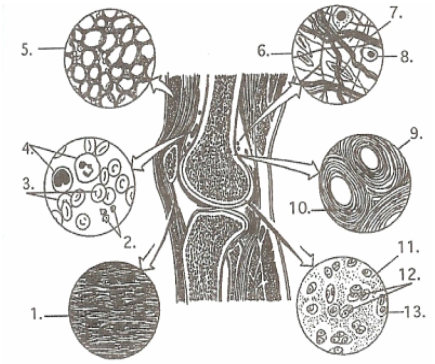


Figure 40.1

The description that best fits the tissue of 9 & 10:

A) would contain chondrocytes and use for support and protection
B) would contain osteocytes and contain erthroyctes
C) is a fluid connective tissue used for transport of materials
D) would contain osteocytes and Haversian canals
E) would contain chondrocytes and Haversian canals

23. The most widespread tissue in the vertebrate body that binds epithelia to underlying tissues and functions as packing material is represented by:

A) 1
B) 5
C) 6, 7, 8
D) 9, 10
E) 11, 12, 13

24. Which of the following is the correct order of floral organs from the outside to the inside of a complete flower?

A) petals – sepals – stamens - carpels
B) sepals – stamens – petals – carpels
C) spores – gametes – zygote – embryo
D) sepals – petals – stamens – carpels
E) male gametophyte – female gametophyte – sepals – petals

25. Refer to the Figure below to answer questions 25-26. *The solutions in the arms of a U-tube are separated at the bottom of the tube by a selectively permeable membrane. The membrane is permeable to sodium chloride but not to glucose. Side A is filled with a solution of 0.4 molar glucose and 0.5 molar sodium chloride (NaCl) and side B is filled with a solution containing 0.8 molar glucose and 0.4 molar sodium chloride. Initially, the volume in both arms is the same.*

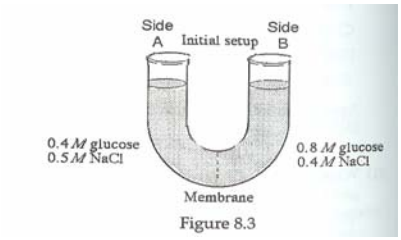


Figure 8.3

At the beginning of the experiment:

A) side A is hpypertonic to side B
B) side A is hypotonic to side B
C) side A is isotonic to side B
D) side A is hypertonic to side B with respect to glucose
E) side A is hypotonic to side B with respect to sodium chloride

26. After 24 hours if you examine side A, you would expect:

A) a decrease in the concentration of NaCl and glucose and an increase in the water level
B) . a decrease in the concentration of NaCl, an increase in water level, and no change in the concentration of glucose
C) no net change in the system
D) no change in the concentration of NaCl and glucose and an increase in the water level
E) a decrease in the concentration of NaCl and a decrease in the water level

27. Which of the following is the correct sequence during alternation of generations in a flowering plant?

A) sporophyte – meiosis – gametophyte – gametes – fertilization – diploid zygote
B) sporophyte – mitosis – gametophyte – meiosis – sporophyte
C) haploid gametophyte – gametes – meiosis – fertilization – diploid sporophyte
D) sporophyte – spores – meiosis – gametophyte – gametes
E) haploid sporophyte – spores – fertilization – diploid gametophyte

28. A disadvantage of a monoculture is that;
- **A)** the whole crop ripens at the same time
- **B)** genetic uniformity makes a crop vulnerable to a new pest or disease
- **C)** it predominantly uses vegetative propagation
- **D)** most grain crops self-pollinate
- **E)** it allows for the cultivation of larges areas of land

29. Uniform spacing patterns in plants such as the creosote bush are most often ssociated with which of the following?
- **A)** chance
- **B)** patterns of high humidity
- **C)** the random distribution of seeds
- **D)** antagonistic interactions among individuals in the population
- **E)** the concentration of resources within the population's range

30. All of the following are correct statements about the regulation of populations *EXCEPT*?
- **A)** Density-independent factors have a greater effect as a population's density increases
- **B)** The logistic equation reflects the effect of density-dependent factors, which can ultimately stabilize populations around the carrying capacity
- **C)** Because of the overlapping nature of population-regulating factors, it is often difficult to precisely determine their cause-and-effect relationships
- **D)** High densities in a population may cause physiological changes that inhibit reproduction
- **E)** The occurrence of population cycles in some populations may be the result of crowding or lag times in the response to density-dependent factors

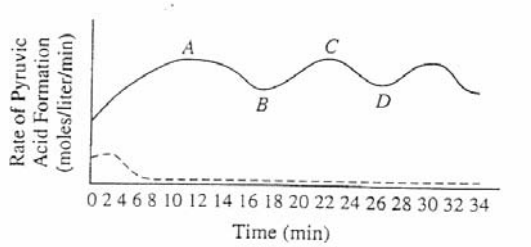
31. Human use of prokaryotic organisms to help detoxify a polluted wetland would be an example of;
- **A)** indicator species analysis
- **B)** keystone species introduction
- **C)** biological control
- **D)** bioremediation
- **E)** population viability analysis

32. Which of the following could cause a realized niche to differ from a fundamental niche?
- **A)** suitable habitat
- **B)** food size and availability
- **C)** temperature limitations
- **D)** water availability
- **E)** competition from other species

33. Hormones involved in the production of urine include all of the following *EXCEPT*?
- **A)** aldosterone
- **B)** angiotensin
- **C)** secretin
- **D)** ADH
- **E)** atrial natriuretic factor

34. What characteristics do ammonia, urea, and uric acid all share?
- **A)** They are all nitrogenous wastes
- **B)** They all need large amounts of water for excretion
- **C)** They all require about the same amount of energy to produce
- **D)** They are all equally toxic
- **E)** They are all produced in the kidney

35. For questions 35-38 refer to the following graph and information:
A tissue culture of vertebrate muscle was provided with a constant excess of glucose under anaerobic conditions starting at time zero and the amounts of pyruvic acid and ATP produced were measured. The solid line in the graph below represents the pyruvic acid produced in moles per liter per minute. ATP levels were also found to be highest at points A and C, lower at B and D. A second culture was set up under the same conditions, except that substance X was added, and the results are indicated by the dotted line.



The rate of pyruvic acid formation fluctuates because;
- **A)** all glucose has reacted
- **B)** all enzymes have been used up
- **C)** the reaction is accelerated by positive feedback
- **D)** the reaction is affected by negative feedback
- **E)** coenzymes have begun to function

36. It is most reasonable to hypothesize that, in the breakdown of glucose, substance X is;
- **A)** an activator
- **B)** an inhibitor
- **C)** a substrate
- **D)** a coenzyme
- **E)** a cofactor

37. Which of the following best accounts for the shape of the solid line between points A and D?
- **A)** After ten minutes the cellular enzymes became ineffective
- **B)** Respiration became controlled
- **C)** ATP acted as an allosteric inhibitor on one or more of the enzymes
- **D)** The measurements of pyruvic acid were unreliable
- **E)** The cells required more glucose than was provid

38. Which of the following is most likely to result if oxygen is added to the tissue culture?
- **A)** Lactic acid formation will increase
- **B)** For each glucose molecule consumed, more ATP will be formed
- **C)** The levels of ATP produced will decrease
- **D)** Ethyl alcohol will be produced
- **E)** No change in the production of pyruvic acid will be observed

39. There is some evidence that interferon may be effective against certain forms of cancer. This finding suggests that some cancer may involve;
A) viruses
B) bacteria
C) uric acid deposition
D) allergic reactions
E) an overproduction of white blood cells

40. In a mammalian embryo, the somites give rise to
A) the notochord
B) the central nervous system
C) the lining of the intestine
D) the eyes
E) muscles and vertebrae

41. If an invertebrate possesses nephridia as an excretory system, skin as a gas exchange system, and a closed circulatory system, the animal most likely belongs to the group:
A) Platyhelminthes
B) Gastropoda
C) Annelida
D) Insecta
E) Cnidaria

42. Which of the following characteristics indicates that mollusks are more closely related to arthropods than to chordates?
A) presence of an endoskeleton
B) type of respiratory structures
C) pattern of coelom formation
D) symmetry
E) eumetazoans

43. It is theoretically possible for a gene from any organism to function in any other organism. Why is this possible?
A) All organisms have the same universal genetic code
B) All organisms are made up of cells
C) All organisms have similar nuclei
D) All organisms have ribosomes
E) All organisms have transfer RNA

44. If you discovered a bacterial cell that contained no restriction endonuclease, which of the following would you expect to happen?
A) The cell would not be able to replicate its DNA
B) The cell would create incomplete plasmids
C) The cell would be easily infected and lysed by bacteriophages
D) The cell would become an obligate parasite
E) Both A and D would occur

45. All of the following influenced Darwin as he synthesized the concept of natural selection *EXCEPT*:
A) the finches of the Galapagos islands
B) Lyell's *Principles of Geology*
C) Malthus' *Essays of Populations*
D) Mendel's laws of inheritance
E) the results of artificial selection

46. Which of the following *incorrectly* pairs a sporophyte embryo with its food source?
A) pine embryo – female gametophyte tissue in nucleus
B) grass embryo – 3n endosperm tissue in seed
C) fern embryo – photosynthetic gametophyte
D) club moss embryo – subterranean, nonphotosynthetic gametophyte
E) moss embryo – female sporophyte tissue

47. Angiosperms are the most successful terrestrial plants. This success is due to all of the following *except*;
A) animal pollination
B) sperm cells with flagella
C) reduced gametophytes
D) fruits enclosing seeds
E) xylem with vessels

48. In an analysis of the nucleotide composition of DNA, which of the following would be true?
A) A = C
B) A = G and C = T
C) A + C = G + T
D) A + T = G + C
E) Both B and C are true

49. In trying to determine whether DNA or protein was the genetic material, Hershey and Chase made use of which of the following facts?
A) DNA does not contain sulfur, whereas protein does
B) DNA contains phosphorus, but protein does not
C) DNA contains greater amounts of phosphorus than does protein
D) Protein contains greater amounts of sulfur than does DNA
E) Both A and B are correct

50. For questions 50 -52 refer to the following simple metabolic pathway:

enzyme *a* enzyme *b*

A ----------→ B ----------→ C

According to the Beadle and Tatum's one gene-one polypeptide theory, at least ___ gene(s) is (are) necessary for this pathway.

A) 0
B) 1
C) 2
D) 3
E) It cannot be determined from the pathway

51. A mutation results in a defective enzyme *a*. Which of the following would be a consequence?

A) an accumulation of A and no production of B and C
B) an accumulation of A and B and no production of C
C) an accumulation of B and no production of A and C
D) an accumulation of B and C and no production of A
E) an accumulation of C and no production of A and B

52. One strain of a diploid organism is homozygous for a recessive allele coding for a defective enzyme *a*. Another strain is homozygous for a recessive allele coding for a defective enzyme *b*. Crossing those two strains will result in a strain that would grow on which of the following?

A) a minimal medium (supplying A)
B) a minimal medium (supplying A), supplemented with B
C) a minimal medium (supplying A), supplemented with C
D) a minimal medium (supplying A), supplemented with B and C
E) all of the above are correct

53. All of the following are adaptations that help reduce water loss from a plant except;

A) transpiration
B) sunken stomates
C) C_4 photosynthesis
D) small, thick leaves
E) Crassulacean acid metabolism (CAM plants)

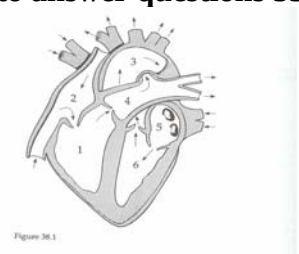
54. For question 54, refer to the following information

1. *neurotransmitter binds with receptor*
2. *sodium ions rush into neuron's cytoplasm*
3. *action potential depolarizes the presynaptic membrane*
4. *ion gate opens to allow particular ion to enter cell*
5. *synaptic vesicles release neurotransmitter into the synaptic cleft*

Given the steps above, which of the following is the correct sequence for transmission at a chemical synapse?

A) 1, 2, 3, 4, 5
B) 2, 3, 5, 4, 1
C) 3, 2, 5, 1, 4
D) 4, 3, 1, 2, 5
E) 5, 1, 2, 4, 3

55. Refer to the following diagram to answer questions 55 – 57:



Chambers or vessels that carry oxygenated blood include which of the following?

A) 1 and 2 only
B) 3 and 4 only
C) 5 and 6 only
D) 1, 2, and 4
E) 3, 5, and 6

56. Blood is carried directly to the lungs from which of the following?

A) 2
B) 3
C) 4
D) 5
E) 6

57. The correct sequence of blood flow beginning at the pulmonary semi-lunar valve and passing through the systematic circulation is:

A) 2 – 1– 4 – systematic – 3 – 6 – 5
B) 3 – 6 – 5 – systematic – 4 – 1 – 2
C) 4 – 5 – 6 – 3 –systematic – 2 –1
D) 4 – 6 – 3 – systematic – 2 –1 – 5
E) 5 – 6 – 3 – systematic – 2 – 1 – 4 --3

58. What is the role of ATP in muscle contraction?

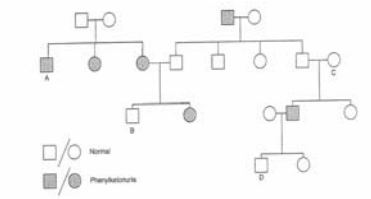
A) to form cross-bridges between thick and thin filaments
B) to break the cross-bridge when it binds to myosin and provide energy to myosin to form its high-energy configuration
C) to remove the tropomyosin-troponin complex from blocking the binding sites on actin
D) to bend the cross-bridge and pull the thin filaments toward the center of the sacromere
E) to replace the supply of creatine phosphate required for movement of actin past myosin

59. Calico cats are usually always female and have multiple patches of differently colored fur. This phenomenon is caused by:

A) epistasis
B) incomplete penetrance
C) presence of codominant alleles
D) random X-chromosome inactivation (Barr bodies)
E) somatic hypermutation

60. Which of the following fungi have sexual spores borne externally on club-shaped structures?
A) Ascomycota
B) Basidiomycota
C) Chytridiomycota
D) Zygomycota
E) Deuteromycota

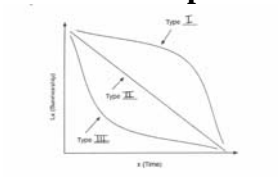
61. For questions 61 – 62: Use the following diagram and legend.



Phenylketonuria is classified as which of the following modes of transmission?
A) autosomal, recessive allele
B) autosomal, dominant allele
C) sex-linked, recessive allele
D) sex-linked, dominant allele
E) not enough information is available from the above pedigree to determine

62. If individual B and spouse are expecting a child, what percent chance do they have of producing an affected child?
A) 0%
B) 25%
C) 50%
D) 75%
E) 100%

63. For question 63 use the survivorship curve graph depicted below



Type III survivorship curve is typical of;
A) species that produce many offspring and long-term parental care
B) species that produce few offspring and little, if any, parental care
C) species that produce few offspring and long-term parental care
D) species that produce many offspring and little, if any, parental care
E) species that reflect a constant death rate at all ages: (e.g. lizards)

64. For questions 64 – 67: *Match the term with the correct description for the behavioral scenario described. (Note: Behavioral scenarios may be used once, more than once, or not at all.)*
A bird pecks at a button in its cage and receives a sunflower seed

A) imprinting
B) habituation
C) classical conditioning
D) operant conditioning
E) maturation

65. A mouse, raised by a gerbil, prefers to play with other gerbils, not mice, as an adult

A) imprinting
B) habituation
C) classical conditioning
D) operant conditioning
E) maturation

66. A monkey is undisturbed by a rubber snake it has seen on multiple occasions

A) imprinting
B) habituation
C) classical conditioning
D) operant conditioning
E) maturation

67. A fish swims to the surface whenever red light is flashed on the aquarium

A) imprinting
B) habituation
C) classical conditioning
D) operant conditioning
E) maturation

68. Which feature of osmoregulation do both marine and freshwater bony fish have?

A) loss of water through gills
B) gain of salt through gills
C) large volume of urine
D) no drinking
E) gain of water through food

69. Which of the following statements about hormones is *correct*?

A) steroid and peptide hormones produce different effects but use the same biochemical mechanisms
B) steroid and peptide hormones produce the same effects but differ in the mechanisms that produce the effects
C) steroid hormones affect the synthesis of proteins, whereas peptide hormones affect the activity of proteins already present in the cell
D) steroid hormones affect the activity of certain proteins within the cell, whereas pepetide hormones directly affect the processing of mRNA
E) steroid hormones affect the synthesis of proteins to be exported from the cell, whereas peptide hormones affect the synthesis of proteins that remain in the cell

70. For questions 70 – 74: Match the disorder with the symptom it generates

Loss of muscle tissue, increased blood glucose, decreased inflammatory response

A) high thyroid hormone
B) high parathyroid hormone
C) high adrenal corticosteroids
D) high anti-diuretic hormone
E) loss of insulin

71. Low blood pH, increased urine, excessive thirst

A) high thyroid hormone
B) high parathyroid hormone
C) high adrenal corticosteroids
D) high anti-diuretic hormone
E) loss of insulin

72. Weight loss, insomnia, tiredness, sensitivity to heat

A) high thyroid hormone
B) high parathyroid hormone
C) high adrenal corticosteroids
D) high anti-diuretic hormone
E) loss of insulin

73. Decreased urine volume, high urine osmolarity

A) high thyroid hormone
B) high parathyroid hormone
C) high adrenal corticosteroids
D) high anti-diuretic hormone
E) loss of insulin

74. Loss of bone density

A) high thyroid hormone
B) high parathyroid hormone
C) high adrenal corticosteroids
D) high anti-diuretic hormone
E) loss of insulin

75. Large organic molecules are usually assembled by polymerization of a few kinds of simple subunits. Which of the following is an exception to the above statement?

A) a steroid
B) cellulose
C) DNA
D) an enzyme
E) a contractile protein

76. A fatty acid is partially oxidized to form 10 molecules of acetyl CoA. Starting with these 10 molecules, how many molecules of ATP will be made directly by the Krebs cycle only?

A) 10
B) 20
C) 32
D) 100
E) 200

77. Colchicine is a drug that binds to the protein that forms microtubules, thereby preventing microtubules from forming. Colchicine has been used to study mitosis because it stops the process. Most likely this is due to;

A) prevention of sister chromatid formation
B) prevention of kinetochore formation
C) inhibition of DNA synthesis
D) alteration of centriole structure
E) prevention of cell-plate formation

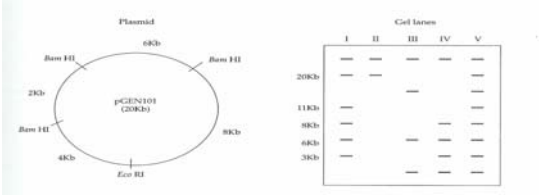
78. Genes A and B are linked with 12 map units between them. A heterozygous individual Ab/aB would be expected to produce gametes in which of the following frequencies?

A) 44% AB; 6% Ab; 6% aB; 44% ab
B) 6% AB; 44% Ab; 44% aB; 6% ab
C) 6% AB; 6% Ab; 44% aB; 44% ab
D) 12% AB; 12% Ab; 38% aB; 38% ab
E) 6% Ab; 12% aB; 50% AB; 32% ab

79. The gene that stimulates tumorogenesis in Burkitt's lymphoma is expressed when it is moved to chromosome 14 from chromosome 8. This is an example of gene expression regulated by;

A) diffusible factors
B) gene amplification
C) steroid hormones
D) translocation
E) point mutations

80. For questions 80-81: Use the following information and the diagram below.
The plasmid pGEN101 shown below was treated with various mixtures of restriction enzymes. The electorphoresis gel shows the results of each of the digests.



Which lane represents the fragments produced using *Bam* HI only?

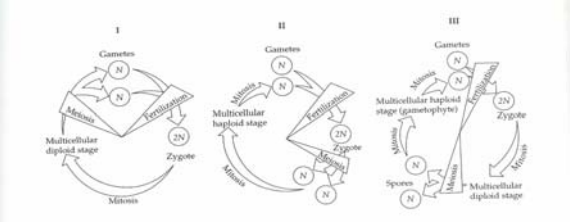
A) I
B) II
C) III
D) IV
E) V

81. Which lane represents the fragments produced when the plasmid was cut with both *Eco* RI and *Bam* HI?

A) I
B) II
C) III
D) IV
E) IV

This question was eliminated.

82. For questions 82 – 85 refer to the life cycles illustrated below:



Which of the life cycles is typical of animals?

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

83. Which of the life cycles is typical for plants and some algae?

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

84. Which of the life cycles is typical for many fungi and some protists?

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

85. Which life cycle would generate the greatest genetic diversity and why?

A) I – because haploid forms are less important
B) II – because haploid forms are more important
C) III – because it has the best balance between haploid and diploid forms
D) III - because meiosis and fertilization are more equally spaced
E) None – they all generate equivalent genetic diversity

86. Which of the following technologies would you use when trying to determine the evolutionary relationship between horses and zebras?

A) All of the techniques below might prove useful
B) analysis of fossil DNA
C) restriction mapping of DNA
D) DNA-DNA hybridization
E) analysis of cytochrome *c* differences

87. Which of the following is an advantage of a complete digestive system over a gastrovascular cavity?
A) food items are retained longer
B) specialized regions are possible
C) digestive enzymes can be more specific
D) extensive branching is possible
E) intracellular digestion is easier

88. In a given organism, how do cells at the completion of meiosis compare with cells that are just about to begin meiosis?
A) They have twice the amount of cytoplasm and half the amount of DNA
B) They have half the number of chromosomes and half the amount of DNA
C) They have the same number of chromosomes and half the amount of DNA
D) They have half the number of chromosomes and one-fourth the amount of DNA
E) They have half the amount of cytoplasm and twice the amount of DNA

89. The direct energy source that drives ATP synthesis during respiratory oxidative phosphorylation is;
A) oxidation of glucose to CO_2 and water
B) the flow of electrons from NADH to the mitochondrial electron transport carriers
C) the final transfer of electrons to oxygen
D) the difference in H^+ conconetrations between the matrix and the 'space'
E) the transfer of the inorganic phosphate group to ADP during substrate-level phosphorylation in glycolysis

90. Photorespiration lowers the efficiency of photosynthesis by removing which of the following from the Calvin cycle?
A) CO_2
B) PGAL
C) ATP
D) RuBP
E) RuBP-carboxylase

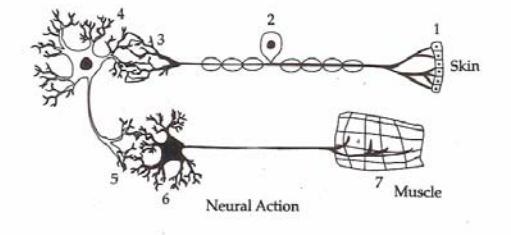
91. All of the following are usually considered disorders of the immune system *except*;
A) AIDS
B) SCIDs
C) allergic anaphylaxis
D) multiple sclerosis
E) MHC-induced transplant rejection

92. Probably the most important factors affecting the distribution of biomes are;
A) climate and topography
B) day length and rainfall
C) community succession and climate
D) species diversity and abundance
E) wind and water current patterns

93. In C_4 photosynthesis, carbon fixation takes place in the ___ cells, and then is transferred as malic or aspartic acid to ___ cells, where carbon dioxide is released for entry into the Calvin cycle.
A) stomatal; mesophyll
B) bundle-sheath; epidermal
C) mesophyll; bundle sheath
D) guard cells; mesophyll
E) stomatal; bundle sheath

94. Of the following terms, which is least related to the others?
A) duplication
B) nondisjunction
C) inversion
D) translocation
E) deletion

95. **For questions 95 – 97 refer to the following diagram and information.**
To understand the workings of neurons, an experiment was conducted to study the neural pathway of a reflex arc in frogs. A diagram of a reflex arc is given below.



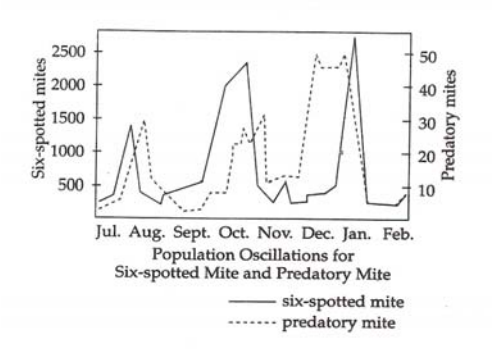
Which of the following represents the correct pathway taken by a nerve impulse as it travels from the spinal cord to the effector cells?
A) 1-2-3-4
B) 6-5-4-3
C) 2-3-4-5
D) 4-5-6-7
E) 7-6—4

96. If the brain of the frog is destroyed and a piece of acid-soaked paper is applied to the frog's skin; each time one leg moves upward. Which of the following conclusions is best supported by the experiment?
A) Reflex actions are not automatic
B) Some reflex actions can be inhibited or facilitated
C) All behaviors in frogs are primarily reflex responses
D) Reflex responses account for a large part of the total behavior in frogs
E) This reflex action bypasses the central nervous system

97. A nerve impulse requires the release of neurotransmitters at the axonal bulb of a presynaptic neuron. Which of the following best explains the purpose of neuro-transmitters, such as acetylcholine?

A) They speed up the nerve conduction in a neuron
B) They excite or inhibit the postsynaptic neuron
C) They open the sodium channels in the axonal membrane
D) They open the potassium channels in the axonal membrane
E) They force potassium ions to move against the concentration gradient within the axonal membrane

98. **For questions 98 – 100 refer to the graph and information below**:
The population dynamics between predatory mites and the six-spotted mites are presented to demonstrate the predator-prey interactions in this population.



As the six-spotted mite population increases beginning in the month of August, which of the following statements is true?

A) The predator immediately kills off the prey
B) The predator population increases at an extremely slow rate
C) The six-spotted mite population provides food for the predator mite
D) The prey population continues to increase until December

99. Which of the following best accounts for the sluggish growth of the predator population during the month of September?

A) There is too much competition among the predatory mites for the prey
B) The predator-prey relationship has not stabilized
C) The six-spotted mites are attempting to destroy the predator mites while the numbers are low
D) It takes time for the energy obtained from food to be converted into successful reproductive efforts
E) It is not the season during which the predator is reproductively active

100. All of the following are density-dependent controls that can influence the size and density of a population except;

A) disease
B) parasitism
C) predation
D) toxic wastes
E) earthquakes

101. In woody dicots, primary xylem and phloem cells are replaced by secondary xylem and phloem cells which arise from the;
- **A)** apical meristem
- **B)** vascular cambium
- **C)** epidermis
- **D)** cork cambium
- **E)** lenticels

102. Which structure in bird and mammalian embryos functions like the blastopore of a frog embryo?
- **A)** primitive streak
- **B)** neural plate
- **C)** archenteron
- **D)** notochord
- **E)** somites

103. All of the following are true of homeotic genes except;
- **A)** They are the primary inducer of frog morphogenesis
- **B)** They are a DNA sequence of 180 nucleotides common to all of the genes
- **C)** They are translated into peptide sequences called homeodomains
- **D)** The peptide gene product is a regulatory protein that controls transcription
- **E)** A mutation in the gene may cause misplacement of body segments

104. If there were no mycorrhizae, which of the following would be true?
- **A)** There would be fewer infectious diseases
- **B)** We wouldn't have antibiotics like penicillin
- **C)** There would be no mushrooms for pizza
- **D)** A lot of trees would not grow well
- **E)** Cheeses like blue cheese or Roquefort could not exist

105. All of the following statements about prokaryotes are correct except?
- **A)** The gradual accumulation of oxygen caused the extinction of many prokaryotes
- **B)** Glycolysis probably evolved in prokaryotes to regenerate ATP in anaerobic environments
- **C)** The first prokaryotes were likely photoautrotrophs that could utilize the abundant light energy and inorganic minerals of early Earth
- **D)** Early photosynthetic prokaryotes probably used pigments and light-powered photosystems to fix carbon dioxide
- **E)** The gradual accumulation of oxygen led to the evolution of respiratory mechanisms to either tolerate or capitalize on rising oxygen levels

106. For questions 106-109 refer to the following information:

A eukaryotic gene for insulin has sticky ends produced by the restriction *endonuclease Eco R1. It is added to a mixture containing Eco R1 and a bacterial plasmid that carries two genes: one that makes it resistant to penicillin and the other codes for a 'blue' color. The plasmid has one recognition site for Eco R1 located within the 'blue' color gene. This mixture is incubated for several hours and then added to bacteria growing in nutrient broth. The bacteria are allowed to grow overnight and are streaked on a plate using a technique that produces isolated colonies that are clones of the original. Samples of these colonies are then grown on two different media: nutrient broth only, and nutrient broth containing penicillin.*

The bacteria containing the engineered plasmid would grow in;

A) the nutrient broth only as white colonies
B) the nutrient broth only as blue colonies
C) the nutrient broth and the nutrient broth plus penicillin as white colonies
D) the nutrient broth and the nutrient broth plus penicillin as blue colonies
E) the nutrient broth plus penicillin only as white colonies

107. Why was the gene inserted in the plasmid before it was mixed with the bacteria?

A) The plasmid acted as a vector to introduce the gene into the bacteria
B) The plasmid contains control regions necessary for the replication of the gene
C) The eukaryotic gene contains introns which must be removed by the plasmid
D) Only A and B are correct
E) A, B, and C are correct

108. The bacteria that contained the plasmid, but not the eukaryotic gene, would grow in;

A) the nutrient broth only as white colonies
B) the nutrient broth only as blue colonies
C) the nutrient broth and the nutrient broth plus penicillin as white colonies
D) the nutrient broth and the nutrient broth plus penicillin as blue colonies
E) the nutrient broth plus penicillin only as blue colonies

109. The purpose of the experiment was to isolate only those bacteria that now could express the eukaryotic gene and produce insulin. Which agar plate and color of bacteria would you isolate and manufacture in mass amounts?

A) nutrient broth – white colonies
B) nutrient broth – blue colonies
C) nutrient broth with penicillin – white colonies
D) nutrient broth with penicillin – blue colonies
E) Both A and C, but not B and D

110. The formation of a land bridge between North and South America about three million years ago resulted in which of the following?

I. allopatry of marine populations that were previously sympatric
II. sympatry of marine populations that were previously allopatric
III. sympatry of terrestrial populations that were previously allopatric

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

111. All are true of cladograms except:
- **A)** each branch point represents a point in absolute time
- **B)** organisms represented at the base of such cladograms are ancestral to those represented at higher levels
- **C)** the more branch points that occur between two taxa, the more divergent their DNA sequences should be
- **D)** the common ancestor represented by the highest branch point existed more recently in time than the common ancestors represented at lower branch points
- **E)** the more branch points there are, the more instances of cladogenesis are represented

112. An antigen presenting cell releases interleukin I to stimulate:
- **A)** the antibody immune response to activate B cells and plasma cells
- **B)** the cell mediated immune response to activate the cytotoxic cells
- **C)** the T-helper cells to alert both the antibody and cell mediated pathway
- **D)** the T-suppressor cells to signal the antigens have been eliminated
- **E)** complement to activate lysis of the infected cells

113. Which of the following is not a *scientific* concern relating to creating genetically modified crops?
- **A)** Herbicide resistance may spread to weedy species
- **B)** Insect pests may more rapidly evolve resistance to toxins
- **C)** Nontarget species may be affected
- **D)** The monetary costs of producing genetically modified plants are significantly greater than traditional breeding techniques
- **E)** Genetically modified plants may lead to unknown risks to human health

114. Two groups of tomatoes were grown under laboratory conditions, one with humus added to the soil and one a control without the humus. The leaves of the plants grown without humus were more 'yellow' than those of the plants growing in humus-enriched soil. The best explanation for this difference is that;
- **A)** the healthy plants used the food in the decomposing leaves of the humus for energy to make chlorophyll
- **B)** the humus made the soil more loosely packed, so the plants' roots grew with less resistance
- **C)** the humus contained minerals such as magnesium and iron, needed for the synthesis of chlorophyll
- **D)** the heat released by the decomposing leaves of the humus caused more rapid growth and chlorophyll synthesis
- **E)** the plants absorbed chlorophyll from the humus

115. Which of the following statements would be least acceptable to most zoologists?
- **A)** Modern cephalochordates are contemporaries of vertebrates, not their ancestors
- **B)** The modern cephalochordates are the immediate ancestors of the vertebrates
- **C)** The first fossil resembling cephalochordates appeared in the fossil record at least 550 million years ago
- **D)** Recent work in molecular systematics supports the hypothesis that cephlochordates are the most recent common ancestor of all vertebrates
- **E)** Cephalochordates display the same method of swimming as do fishes

116. One of the major distinctions between plants and the green algae is that;
- **A)** only green algae have flagellated, swimming sperm
- **B)** only plants form a cell plate during cytokinesis
- **C)** chlorophyll pigments in green algae are different from those in plants
- **D)** meiosis proceeds at a faster pace in green algae than in plants
- **E)** embryos are not retained within parental tissues in green algae

117. A particular eukaryotic protein is 300 amino acids long. Which of the following could be the maximum number of nucleotides in the DNA that codes for the amino acids in this protein?
- **A)** 3
- **B)** 100
- **C)** 300
- **D)** 900
- **E)** 1800

118. Using the following events of protein synthesis – place them in the proper sequence.
1. An aminoacyl-tRNA binds to the A site
2. A peptide bond forms between the new amino acid and a polypeptide chain
3. tRNA leaves the P site and the P site remains vacant
4. UAC tRNA translocates to the P site
5. aminoacyl-tRNA translocates to the P site

- **A)** 1, 3, 2, 4, 5
- **B)** 4, 1, 2, 5, 3
- **C)** 5, 4, 3, 2, 1
- **D)** 4, 1, 3, 2, 5
- **E)** 2, 4, 5, 1, 3

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

120. Extinction is a natural phenomenon. It is estimated that 99% of all species that ever lived are now extinct. Why, then, do we say that we are now in a biodiversity crisis?

A) Because of our biophilia, humans feel ethically responsible for protecting endangered species

B) Scientists have finally identified most of the species on Earth and are thus able to quantify the number of species becoming extinct

C) The current rate of extinction is as much as 1,000 times higher than at any other time
in the last 100,000 years, so the fuel for evolution is disappearing at an alarming rate

D) Humans have greater medical needs than ever before, and need to protect potential medicinal plants before they become extinct

E) Most biodiversity hot spots have been destroyed by recent ecological disasters

End of Test

MERCK State Science Day 2005 — Biology

Answer Section

MULTIPLE CHOICE

1. B
2. D
3. E
4. D
5. B
6. D
7. C
8. C
9. A
10. D
11. C
12. A
13. E
14. B
15. C
16. A
17. D
18. E
19. E
20. E
21. C
22. D
23. A
24. D
25. B
26. E
27. A
28. B
29. D
30. A
31. D
32. E
33. C
34. A
35. D
36. B
37. C
38. B
39. A
40. E
41. C
42. C
43. A
44. C
45. D
46. E
47. B
48. C
49. E
50. C
51. A
52. E
53. A
54. C
55. E
56. C
57. C
58. B
59. D
60. B
61. A
62. C
63. D
64. D
65. A
66. B
67. C
68. E
69. C
70. C
71. E
72. A
73. D
74. B
75. A
76. A
77. B
78. B
79. D
80. C
81. ~~D~~ eliminated
82. A
83. C
84. B
85. E
86. A
87. B
88. D
89. D
90. D
91. E
92. A
93. C
94. B
95. D
96. E
97. B
98. C
99. D
100. E
101. B
102. A
103. A
104. D
105. C
106. C
107. D
108. D
109. C
110. E
111. A
112. C
113. D
114. C
115. B
116. E
117. E
118. B
119. A
120. C