

1. Which of the following is the most important type of force used to stabilize secondary structure in proteins?

- a) ionic bonds
- b) hydrogen bonds
- c) aromatic-aromatic ring interactions
- d) hydrophobic Interactions
- e) peptide bonds

2. Reactions associated with the light dependent reaction of photosynthesis (in eukaryotic cells) may be found in:

- a) grana only
- b) stroma only
- c) inner surface on the thylakoids only
- d) inner and outer surface of the thylakoids
- e) outer membrane of the chloroplast envelope

3. In the genetic pathway containing genes A, B, and C, gene A negatively regulates gene B, which in turn negatively regulates gene C. If a loss-of-function mutation were introduced into gene B, what would be the resulting effect on the expression of gene C?

- a) changes in expression levels of gene C would be the same as those for gene A
- b) changes in expression levels of gene C would be the same as those for gene B
- c) decreased expression of gene C
- d) increased expression of gene C
- e) no effect on expression of gene C

4. For terrestrial and most aquatic environments, neither animal nor plant life could exist without the metabolic "services" provided by:

- a) chemoheterotrophs
- b) extremophile archaeans
- c) fungi
- d) *Homo sapiens*
- e) nitrogen-fixing bacteria

5. Excessive production of which hormone may cause a patient to develop gastric ulceration refractory to medical management:

- a) bilirubin
- b) cholecystikinin
- c) gastrin
- d) secretin
- e) somatostatin

6. Which of the following is NOT true of allosterically regulated enzymes?

- a) they follow Michaelis-Menten kinetics
- b) they demonstrate cooperativity
- c) their activity can be modulated by effector molecules
- d) their activity can be modulated by substrate concentration
- e) plots of their rate of product formation versus substrate concentration are sigmoidal in shape

7. Which of the following is correctly matched with its tissue system?

- a) xylem...ground tissue system
- b) phloem...epidermis
- c) cortex...ground tissue system
- d) pith...vascular tissue system
- e) all of the above are correctly matched

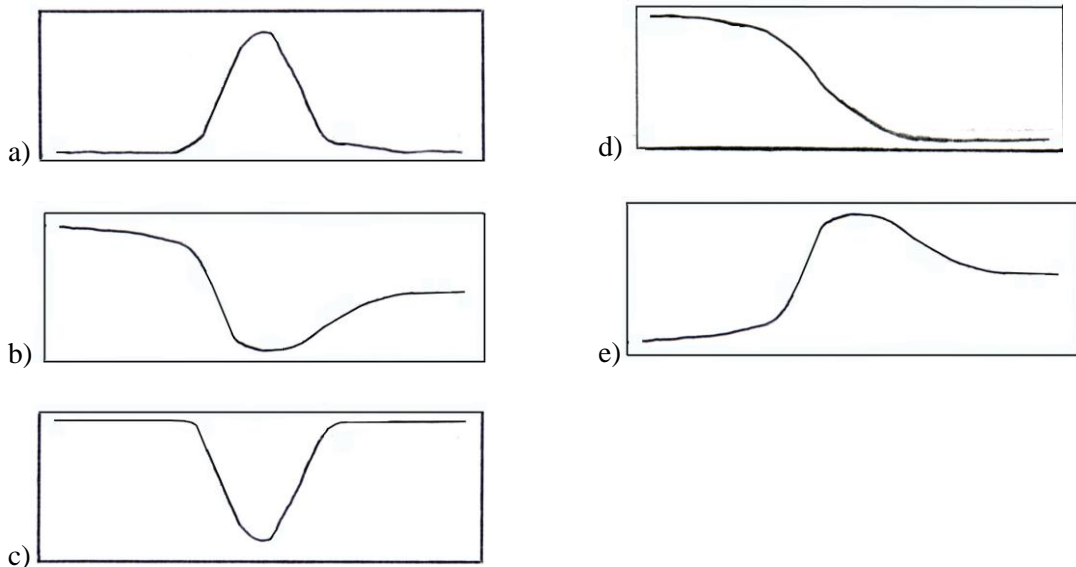
8. A researcher performs a cross between 2 mice, both having black fur (black fur is dominant over white fur). 75% of the offspring have black fur and 25% have white fur. The researcher can assume that the parent genotypes were most likely:

- a) BB x BB
- b) BB x Bb
- c) BB x bb
- d) Bb x Bb
- e) bb x bb

9. While walking to school one day, you notice a group of purple ants that all walk sideways. Excited by your discovery, you decide to classify your ants. Which of the following characteristics would classify the purple ants as a new strain of ants and NOT a new species?

- a) the purple ants have a similar DNA polymerase as the tropical fire ant *Solenopsis geminate*
- b) the purple ants may produce fertile offspring when crossed with *Solenopsis geminate*
- c) the purple ants have ribosomal subunits of the same size as *Solenopsis geminate*
- d) the purple ants are found to inhabit similar areas as *Solenopsis geminate*
- e) both b and d are necessary characteristics

10. Which of the following graphs correctly displays the relationship of blood flow velocity in humans as the blood flows from the aorta → arteries → arterioles → capillaries → venules → veins → venae cavae:



11. Lowering the level of a hedge with a hedge trimmer stimulates the hedge to become bushy because:

- a) it stimulates the production of ethylene gas
- b) removing the apical meristems makes more auxin, which stimulates lateral branch buds to grow
- c) removing the apical meristems makes less ethylene, which stimulates lateral branches to grow
- d) removing the apical meristems results in less auxin, which then allows lateral branches to grow
- e) removing the lateral buds results in apical dominance under the influence of cytokinins

12. Which two amino acids are usually phosphorylated by protein kinases?

- a) Leucine, Isoleucine
- b) Serine, Threonine
- c) Methionine, Cysteine
- d) Valine, Alanine
- e) Glycine, Tyrosine

- 13. You discover an unidentified weed that you cut with a lawn mower almost to the ground. Soon it is as tall as it was before you cut it. This growth is likely due to what growth region?**
- basal meristem
 - root apical meristem
 - shoot apical meristem
 - cork cambium
 - vascular cambium
- 14. If you rely exclusively on the biological species concept, which of the following shows evidence that the populations belong to 2 separate species?**
- in two groups of tamarins copulation takes place, but the hybrid embryos are spontaneously aborted
 - matings between two guenon monkey species results in live born, but infertile offspring
 - red and black howler monkeys do not interbreed in the wild because they have different mating calls
 - only a and b are examples of two separate species
 - a, b, and c are examples of two separate species
- 15. The coefficient of relatedness between an uncle/aunt and his/her nephew is:**
- 0.125
 - 0.25
 - 0.5
 - 1.0
 - cannot be determined
- 16. Which of the following are likely to cause cellular changes when injected directly into the appropriate cells cytoplasm?**
- triiodothyronine (T_3)
 - cortisol
 - insulin
 - epidermal growth factor
- I, II
 - I, IV
 - II, III
 - II, IV
 - III, IV
- 17. cc**
- 18. The part of the flower that is adapted to catch pollen is the:**
- anther
 - ovule
 - sepal
 - stigma
 - style
- 19. Assuming that in the year 2500, five human male and five human female space colonists from Earth settled on an uninhabited Earth-like planet in the Andromeda Galaxy. The colonists and their offspring randomly mate for many generations. All ten of the colonists expressed ‘Hitchhiker’s Thumb’ (useful, if you’re out in the middle of nowhere in space), though two were heterozygous for this trait. ‘Hitchhiker’s Thumb’ (S) is dominant and ‘Straight Thumb’ (s) is recessive.**
- If one assumes that Hardy-Weinberg equilibrium applies to this population of colonists, approximately how many people will express ‘Straight Thumb’ when the planet’s population reaches 10,000?**
- 100
 - 400

- c) 800
- d) 1000
- e) not enough information to determine

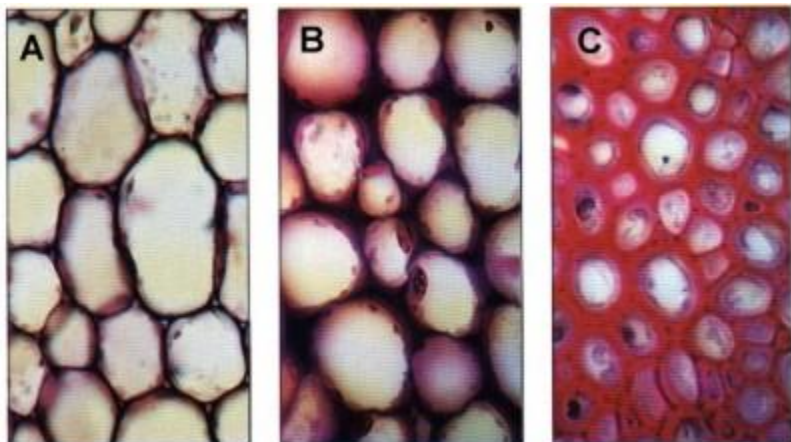
20. What is the most likely result if carnivores are removed from an ecosystem?

- a) decrease in the number of herbivores, decrease in the amount of vegetation
- b) decrease in the number of herbivores, increase in the amount of vegetation
- c) increase in the number of herbivores, increase in the amount of vegetation
- d) increase in the number of herbivores, decrease in the amount of vegetation
- e) decrease in the number of omnivores, increase in the amount of vegetation

21. The inspiratory phase of mammal respiration is characterized by:

- a) collapse of the rib cage and contraction of the diaphragm
- b) collapse of the rib cage and relaxation of the diaphragm
- c) expansion of the rib cage and contraction of the diaphragm
- d) expansion and the rib cage and relaxation of the diaphragm
- e) expansion of the rib cage only

22. Correctly identify the tissue types A, B, and C in the images below.



Type A

Type B

Type C

- a) sclerenchyma, parenchyma, collenchyma
- b) collenchyma, parenchyma, sclerenchyma
- c) collenchyma, sclerenchyma, parenchyma
- d) parenchyma, collenchyma, sclerenchyma
- e) parenchyma, sclerenchyma, collenchyma

23. Compared to an uncatalyzed reaction, all of the following are characteristics of an enzyme-catalyzed reaction EXCEPT:

- a) smaller activation energy
- b) no change in equilibrium value
- c) rate of the reaction is accelerated
- d) maximal velocity can be achieved
- e) free energy for the reaction is reduced

24. Which of the following is the most important missing evidence in Darwin's theory of natural selection when it was published in 1859?

- a) evidence of the overproduction of offspring

- b) evidence that some organisms became extinct
- c) knowledge of the source of genetic variation
- d) observation that even members of the same species are variable
- e) observation that environmental resources can be a limiting factor to population growth

25. The equilibrium model of island biogeography suggests all of the following EXCEPT:

- a) larger islands have more species than smaller islands
- b) smaller islands have lower rates of extinction
- c) species richness of an island is determined by colonization and extinction
- d) islands closer to the mainland have higher colonization rates
- e) colonial populations become genetically divergent from their parent population over time, due to natural selection, mutation, and/or genetic drift.

26. The inner ear of humans, and most other mammals, is sensitive to body position and balance. What organ(s) is/are responsible for this?

- a) cochlea
- b) cochlea and basilar membrane
- c) semicircular canals
- d) semicircular canals and cochlea
- e) semicircular canals, utricle, and saccule

27. A researcher is interested in identifying a gene or genes whose expression pattern is altered in response to temperature fluctuations. Which laboratory technique would be most appropriate for addressing this question?

- a) PCR of genomic DNA
- b) Southern blotting
- c) gel electrophoresis
- d) sucrose gradient centrifugation
- e) microarray analysis

28. A plant cell with a solute potential of -0.8 MPa maintains a constant volume when bathed in a solution that has a solute potential of -0.25 MPa and is in an open container. From this information, we know that:

- a) the cell has a pressure potential of +0.25 MPa
- b) the cell has a pressure potential of +0.55 MPa
- c) the cell has a pressure potential of +0.80 MPa
- d) the cell has a water potential of -0.8 Mpa
- e) none of the above

29. K^+ secretion into the nephron tubule takes place at the:

- a) ascending loop of Henle
- b) descending loop of Henle
- c) collecting duct
- d) distal tubule
- e) proximal tubule

30. Which of the following is/are not evolutionary advantage(s) provided by operons to bacterial cells?

- a) genes may be regulated together by a single operator sequence
- b) intron sequences may be more easily spliced from operon mRNA sequences
- c) multiple proteins may be encoded by a single mRNA
- d) multiple proteins may be translated simultaneously by a single mRNA
- e) both b and d

31. A beaver eats the bark, both inner and outer bark, all the way around a tree trunk. Why does this always cause the tree to eventually die?

- a) the tree is more susceptible to insect and fungal diseases
- b) cells of the apical meristem can no longer divide

- c) the transport of sugars between leaves and twigs is interrupted
- d) the transport of sugars between leaves and roots is interrupted
- e) the supply of water and minerals to the leaves is no longer possible

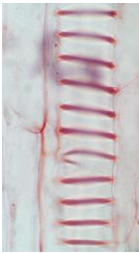
32. Which of the following statements is false?

- a) The first living cells were prokaryotes.
- b) The cyclic pathway of photosynthesis first appeared in some eubacterial species.
- c) Oxygen began accumulating in the atmosphere after the noncyclic pathway of photosynthesis evolved.
- d) In the Proterozoic, increasing levels of atmospheric oxygen enhanced the spontaneous formation of organic molecules.
- e) all are correct

33. Where in the cell are disulfide bonds primarily made?

- a) cytoplasm
- b) endoplasmic reticulum
- c) lysosome
- d) nucleus
- e) nucleoplasm

34. The cell shown in the image below is most likely a:



- a) companion cell
- b) fiber
- c) sclerid
- d) sieve tube element
- e) vessel element

35. Plasmodesmata in plant cells are MOST SIMILAR in function to which of the following structure in animals cells?

- a) desmosomes
- b) gap junctions
- c) glycocalyx
- d) peroxisomes
- e) tight junctions

For questions 1 through 7 on Part B of the 2005 USABO Semifinal Exam, fill-in the appropriate bubble(s) on your Scantron sheet that indicate your response. Scantron sheet numbers are placed adjacent to the space, blank, or box of each question.

1. (6 points) In the evolution of ‘organismic’ from simpler, single ‘cell’ organization, there appears to have been a selective advantage to being part of the more complex form, rather than ‘going it alone’.

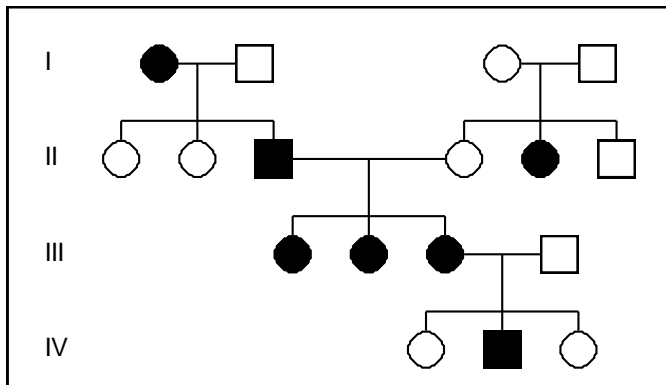
In the table below, match each term with its appropriate phrase.

<i>Cell Behavior</i>	<i>Single Cell</i>	<i>Organism</i>
Cooperation: (Scantron #51) [_____]	Negative: (Scantron #53) [_____]	Positive: (Scantron #55) [_____]
Defection: (Scantron #52) [_____]	Positive: (Scantron #54) [_____]	Negative: (Scantron #56) [_____]

- a. cell abandons function in order to reproduce
- b. lowers cell reproductive rate
- c. increases cell reproductive rate
- d. improves organism function and reproduction
- e. cell assumes specialized function
- ab. decreases organism function and reproduction

2. (4 points) For the following pedigree, indicate whether the inheritance of the trait could be caused by the following:

NOTE: On your Scantron sheet, fill-in [a] for ‘yes’ or [b] for ‘no’



_____ a recessive autosomal gene
(Scantron #57)

_____ a dominant autosomal gene
(Scantron #58)

_____ a recessive X-linked gene
(Scantron #59)

_____ a dominant X-linked gene
(Scantron #60)

3. (4 points) Match the gastrointestinal organ on the left with the chemical or protein it produces to aid in digestion on the right.

_____ stomach (Scantron #61)

_____ pancreas (Scantron #62)

_____ liver (Scantron #63)

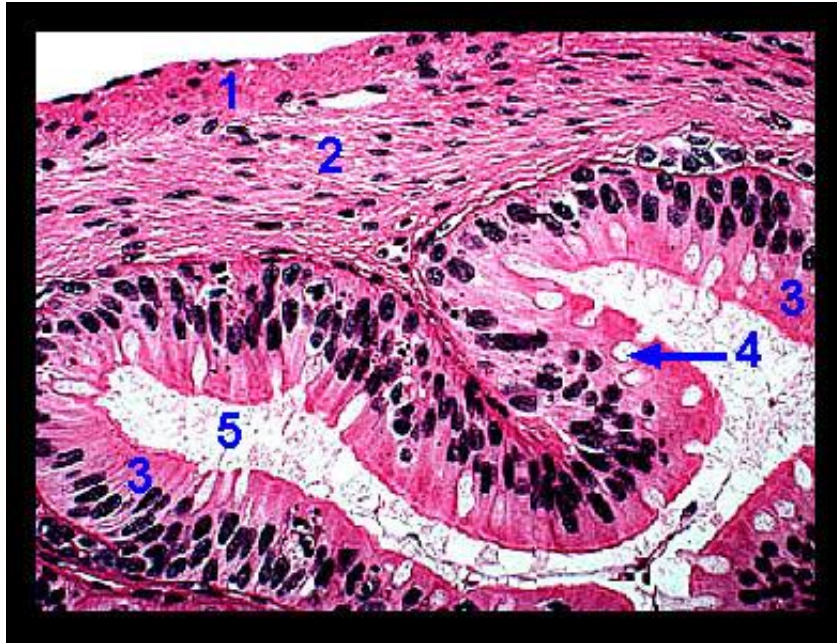
_____ small intestine (Scantron #64)

a. lipase

b. maltase

c. pepsid

d. bile



4. (5 points) Match the numbers from the photo above with the appropriate definition below.

- | | |
|-------------------------------|--|
| _____ Number 1 (Scantron #65) | a. simple columnar epithelium |
| _____ Number 2 (Scantron #66) | b. longitudinal layer of smooth muscle |
| _____ Number 3 (Scantron #67) | c. lumen of the intestine |
| _____ Number 4 (Scantron #68) | d. circular layer of smooth muscle |
| _____ Number 5 (Scantron #69) | e. a goblet cell |

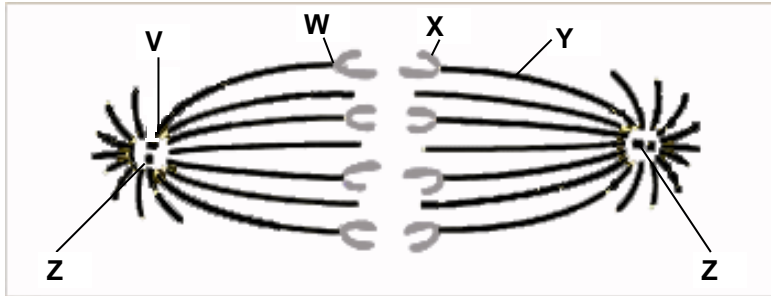
5. (5 points) Match the function on the right with the appropriate cell type on the left.

- | | |
|------------------------------------|----------------------|
| macrophages (Scantron #70) _____ | a. viral defenses |
| neutrophils (Scantron #71) _____ | b. phagocytosis |
| platelets (Scantron #72) _____ | c. hemostatis |
| T lymphocytes (Scantron #73) _____ | d. a and b |
| B lymphocytes (Scantron #74) _____ | e. none of the above |

6. (10pts) Match each item on the right with the term it is most closely associated with on the left.

- | | |
|--------------------------------------|---|
| _____ golgi apparatus (Scantron #75) | a. krebs cycle |
| _____ leucoplasts (Scantron #76) | b. digestive enzymes |
| _____ smooth ER (Scantron #77) | c. fiber of actin |
| _____ genome (Scantron #78) | d. complete set of genetic instructions |
| _____ microfilament (Scantron #79) | e. starch storage |
| _____ microtubule (Scantron #80) | ab. lipid synthesis |
| _____ centriole (Scantron #81) | ac. secreted protein synthesis |
| _____ lysosome (Scantron #82) | ad. spindle fiber |
| _____ mitochondria (Scantron #83) | ae. microtubule-organizing center |
| _____ rough ER (Scantron #84) | bc. protein modification and targeting |

7. (6 points) Match the description on the left with the appropriate term on the right using the figure below.

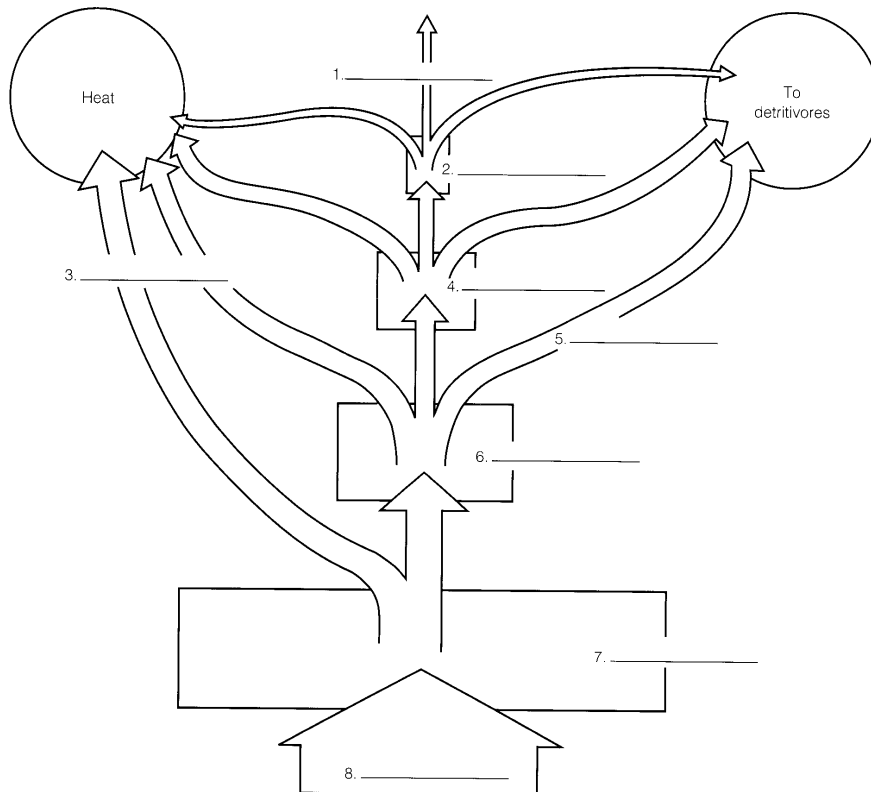


- | | | |
|---|------------------|-----------------|
| _____ stage of mitosis (Scantron #85) | a. centrioles | ad. microtubule |
| _____ structures at Z (Scantron #86) | b. metaphase | ae. anaphase |
| _____ structure at Y (Scantron #87) | c. microfilament | bc. site V |
| _____ structure at X (Scantron #88) | d. prophase | bd. site W |
| _____ structure at W (Scantron #89) | e. chromosome | be. site X |
| _____ site of disassembly of structure Y (Scantron #90) | ab. telophase | cd. site Y |
| | ac. kinetochore | ce. site Z |

For questions 8 through 24, WRITE your response(s) in the space, blank, or box provided. You WILL NOT need your Scantron sheet for questions 8 through 26.

8. (8 points) Trophic levels are indicated below with numbered lines in the flowchart. Write the appropriate trophic level name in the space provided next to its number. Write ONLY the letter of the trophic characteristic.

NOTE: Left-hand circle in flowchart is *Heat*; right-hand circle in flowchart is *To detritivores*.



- 1. _____
- 2. _____
- 3. _____
- 4. _____

- 5. _____
- 6. _____
- 7. _____
- 8. _____

- a. energy used in cellular respiration
- b. sunlight
- c. tertiary consumers
- d. energy in wastes
- e. primary producers
- f. primary consumers
- g. production energy
- h. secondary consumers

9. (14 points) Match the following word with its definition or function. Answers may be used more than once.

pits	_____	a. thin regions with only a primary wall
tracheids	_____	b. water migrates laterally between neighboring vessels
secondary wall	_____	c. long, thin cells with tapered ends
xylem vessel	_____	d. contain lignin
sieve-tube member	_____	e. wide, short, and thin-walled; aligned end-to-end to form micropipes
companion cell	_____	f. perforated ends
plasmodesmata	_____	g. chains of cells that conduct organic compounds
sieve tube	_____	h. lack nucleus, vacuole, and ribosomes
stele	_____	i. does not conduct flow of fluid from cell to cell
		j. connects photoplasts of neighboring cells
		k. continuous ER in structures called desmotubules
		l. sits alongside sieve-tube members
		m. porous walls between cells
		n. surrounded by a casparian strip

10. (2 points) Assume for a particular plant that small flower blossoms are dominant to large flower blossoms, yellow seeds are dominant to green seeds, and round seeds are dominant to wrinkled seeds. If you cross a triple heterozygote with a plant that has green wrinkled seeds and is heterozygous for small flower blossoms, what is the fraction of the offspring that will have at least two recessive traits?

11. (2 points) The human genome contains several types of repetitive DNA. One of these is called the Alu sequence (it is cleaved by the restriction enzyme Alu I). Alu I sequence elements are about 300bp in length. If the human genome is 3×10^9 bp in size and Alu I elements comprise 15% of the human genome, approximately how many Alu elements are in the human genome (round to nearest hundred)?

12. (7 points) Match the phrase on the right with the appropriate ethological term on the left. Write ONLY the letter of the ethological term in the space provided.

- | | |
|---|------------------------|
| _____ signaling or exchange of information | a. cognition |
| _____ may reinforce genetically inherited social behavior in humans | b. search image |
| _____ helps an animal look for food | c. dominance hierarchy |
| _____ help or sacrifice that is repaid later | d. territory |
| _____ interaction between individuals, usually of same species | e. social behavior |
| _____ self-sacrifice on behalf of other(s) | f. kin selection |
| _____ the ability to use, process, and store sensory information | g. optimal foraging |
| _____ ranking by social interactions | h. reciprocal altruism |
| _____ area defended against members of same species | i. sociobiology |
| _____ minimizes agonistic behavior before mating | j. courtship ritual |
| _____ most efficient feeding behavior | k. culture |
| _____ when self-sacrifice, on part of relatives, leads to altruism | l. agonistic behavior |
| _____ threat or combat | m. altruism |
| _____ study of the biological basis of social behavior | n. communication |

13. (6 points) Calculate the partial pressures of O₂ and CO₂ in the below table. Round your answer to the nearest one-hundredth.

	Partial Pressure of O ₂ (in mmHg)	Partial Pressure of CO ₂ (in mmHg)	Composition of air:
Sea level: 760mmHg			O ₂ : 20.93%
1,000ft above sea level: 733mmHg			CO ₂ : 0.03%
15,00ft above sea level: 429mmHg			N ₂ : 79.04%

14. (5 points) Identify the patterns of leaf venation (6-8) and root types (9-10):



6. _____ 7. _____ 8. _____ 9. _____ 10. _____

15. (8 points) You have discovered a series of mutations in the A locus, which governs the distribution of pigment in the coat of horses. The alleles, their associated phenotypes, and frequencies in a certain population are:

Allele	Associated phenotype	Frequency
A ⁺	bay (wild type)	0.4
A	dark bay (black mane and tail)	0.2
a ^t	seal brown	0.1
a	recessive black	0.3

*The order of dominance of the alleles is: A⁺ > A > a^t > a

What are the expected frequencies of the four possible phenotypes, assuming this population is in Hardy-Weinberg equilibrium?

NOTE: Indicate your answers to only two decimal places.

- _____ bay
- _____ dark bay
- _____ seal brown
- _____ black

16. (4 points) Complete the following table by writing the number of the energy and carbon source(s) listed below for the appropriate mode of nutrition in the table:

1. organic compounds 2. inorganic chemicals 3. CO₂ 4. light

Mode of Nutrition	Energy Source	Carbon Source
Chemoautotroph		
Chemoheterotroph		
Photoautotroph		
Photoheterotroph		

17. (8 points) The enzyme polynucleotide phosphorylase was used by M. Nirenberg and others to synthesize artificial, random sequence RNAs in the absence of a template. The RNA was then used as a template in a cell-free system for protein synthesis. [Assume that an RNA was synthesized using polynucleotide phosphorylase from a mixture of ribonucleotides that consisted of 90% ATP and 10% CTP.]

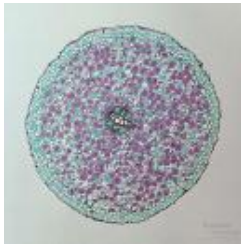
Use the table below to answer the following questions:

a. Which amino acid(s) could possibly appear in the synthetic protein?

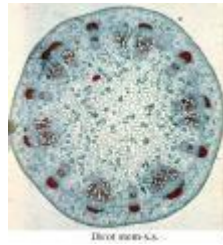
b. Which amino acid(s) would be the most prevalent and which would be least prevalent? State the amino acid and give the percent to the nearest tenth for both the most prevalent and the least prevalent.

1st position (5' end)	2cd position				3rd position (3' end)			
	U	C	A	G				
U	Phe - F	Ser - S	Tyr - Y	Cys - C	U	Alanine	Ala	A
	Phe - F	Ser - S	Tyr - Y	Cys - C	C	Arginine	Arg	R
	Leu - L	Ser - S	Stop	Stop	A	Asparagine	Asn	N
	Leu - L	Ser - S	Stop	Trp - W	G	Aspartic acid	Asp	D
C	Leu - L	Pro - P	His - H	Arg - R	U	Cysteine	Cys	C
	Leu - L	Pro - P	His - H	Arg - R	C	Glutamic acid	Glu	E
	Leu - L	Pro - P	Gln - Q	Arg - R	A	Glutamine	Gln	Q
	Leu - L	Pro - P	Gln - Q	Arg - R	G	Glycine	Gly	G
A	Ile - I	Thr - T	Asn - N	Ser - S	U	Histidine	His	H
	Ile - I	Thr - T	Asn - N	Ser - S	C	Isoleucine	Ile	I
	Ile - I	Thr - T	Lys - K	Arg - R	A	Leucine	Leu	L
	Met - M	Thr - T	Lys - K	Arg - R	G	Lysine	Lys	K
G	Val - V	Ala - A	Asp - D	Gly - G	U	Methionine	Met	M
	Val - V	Ala - A	Asp - D	Gly - G	C	Phenylalanine	Phe	F
	Val - V	Ala - A	Glu - E	Gly - G	A	Proline	Pro	P
	Val - V	Ala - A	Glu - E	Gly - G	G	Serine	Ser	S
					Threonine	Thr	T	
					Tryptophan	Trp	W	
					Tyrosine	Tyr	Y	
					Valine	Val	V	

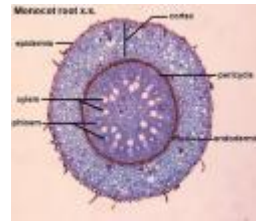
18. (4 points) Fill-in the blanks provided for each cross-section. State whether the cross-section is a monocot or dicot, and if it is a root or a stem.



a. _____



b. _____

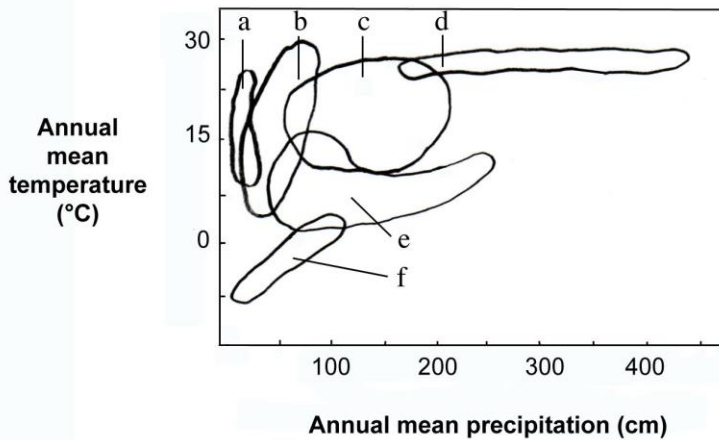


c. _____



d. _____

19. (6 points) Match the biome in the figure below with the appropriate plotted area (a, b, c, d, e, and f) in the climograph.



- _____ arctic and alpine tundra
- _____ coniferous forest
- _____ desert
- _____ grassland
- _____ temperate forest
- _____ tropical forest

20. (10 points) Match the endocrine activity on the left with the appropriate hormone on the right. Answers may be used once, more than once, or not at all.

- _____ lowers level of glucose in the blood
- _____ stimulates contraction of uterus
- _____ stimulates calcium deposition in bones
- _____ promotes reabsorption of sodium ions in kidney
- _____ its secretion is directly regulated by light-dark cycles
- _____ secreted by the alpha cells of the islets of Langerhans
- _____ secretion is increased when blood calcium levels are low
- _____ promotes the growth of uterine lining
- _____ stimulates contraction of mammary gland cells
- _____ secreted by pineal gland

- a. progesterone
- b. aldosterone
- c. melatonin
- d. progesterone
- e. insulin
- f. epinephrine
- g. oxytocin
- h. thymosin
- i. calcitonin
- j. parathyroid hormone
- k. none of the above

21. (5 points) Match the term on the left with its definition on the right. Write ONLY the letter of the ethological term in the space provided.

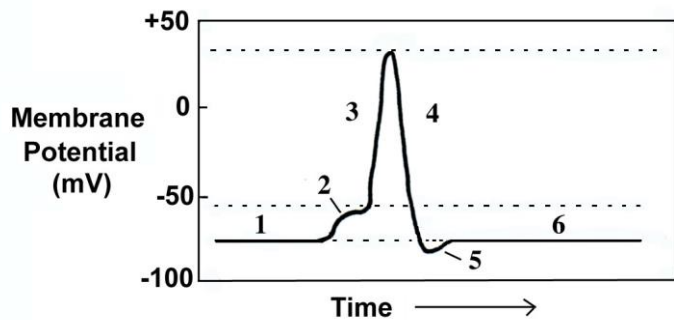
Terms

- _____ niche
- _____ habitat fragmentation
- _____ extinction
- _____ threatened species
- _____ ecological restoration
- _____ metapopulation
- _____ endangered species
- _____ extirpation
- _____ endemic
- _____ deme

Definitions

- a. the dividing of contiguous blocks of habitat into two or more fragments
- b. where there is no member of a given species left alive anywhere in the world
- c. where clusters of a single species intermittently occupying discrete sites whose populations exchange breeders (A.K.A. a population of populations)
- d. a species that is found naturally in a single geographic area and in no other place
- e. rehabilitation or re-creation of an ecosystem in which the natural functions have been destroyed or impaired
- f. where no member of a species is found in an area that it once inhabited, but is found elsewhere in the wild
- g. collection of individuals that are sufficiently close genetically and geographically that they mate with one another
- h. ecological role or relationship between a species and various ecosystem components
- i. species likely to go extinct as a result of human activity
- j. species likely to become endangered in the near future

22. (5 points) Referring to the action potential graph below, write the number (from the graph) that corresponds with the appropriate action potential action on the right of what is occurring at that stage of the action potential.



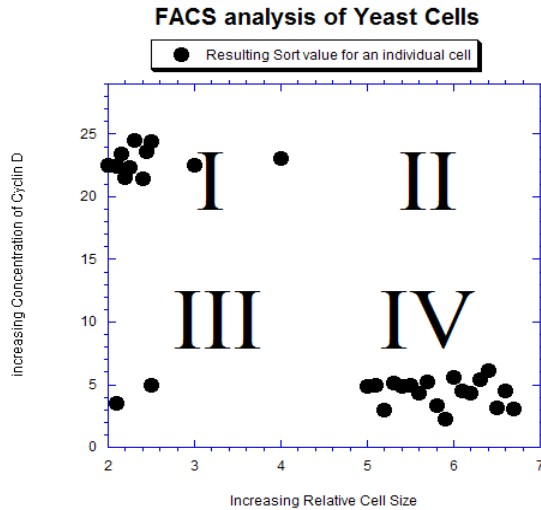
_____ the membrane is unable to respond to any further stimulation regardless of intensity

_____ sodium gates close, and potassium gates re-open

_____ both sodium and potassium voltage-gated channels are closed

_____ stimulus opens some sodium channels

23. (3 points) Below is an example of data collected from FACS (fluorescence activated cell sorting) analysis of dividing yeast cells analyzed on the basis of their size and the amount of Cyclin D they are expressing. Cyclin D is a cell cycle regulatory protein that accumulates in G₁ phase and is broken down before the cells enter the next phase of the cell cycle. The accumulation and destruction of Cyclin D must occur for cells to successfully progress through the cell cycle.



NOTE: Y-axis reads *increasing concentration of Cyclin D*; X-axis reads *increasing relative cell size*

Individual cells sorting to quadrant I are likely to be in the middle of G₁ phase. Answer the following questions based on the information provided.

a. Individual cells sorting to which quadrant(s) are the smallest by volume?

b. Cells in late M phase are most likely in which quadrant?

c. If the gene encoding Cyclin D underwent a mutation rendering it nonfunctional, the resulting yeast cells would most likely sort to which quadrant(s)?

24. (5 points) In the table below, write the letter to match the adult brain regions with the 4-week embryonic brain regions from which they arise. Some 4-week embryonic brain regions give rise to more than one region of the adult brain.

Regions present in adult:

- a. cerebrum
- b. diencephalons
- c. medulla oblongata
- d. midbrain
- e. pons

4-week embryonic brain regions	Adult brain regions
Forebrain	
Midbrain	
Hindbrain	

Student ID Number: _____