

- 1) The recent SARS virus is a:
 - a) Lentivirus
 - b) **Coronavirus**
 - c) Egtved virus
 - d) Baculovirus
 - e) Retrovirus

- 2) Which of the following cell organelles is typically identified by its sedimentation coefficient?
 - a) Golgi apparatus
 - b) Mitochondria
 - c) Nucleus
 - d) Nucleolus
 - e) **Ribosome**

- 3) Timber companies plant trees right after clear-cutting. Which of the following ecological and/or evolutionary processes would, in principle, take too long for timber companies to wait for, if nature just took its course?
 - a) Competitive exclusion
 - b) Coevolution
 - c) Decomposition
 - d) Mutualism
 - e) **Succession**

- 4) Bird migration is probably initiated by the effect of:
 - a) Changes in light intensity on wing muscles
 - b) **Changes in duration of darkness on endocrine glands**
 - c) The availability of food
 - d) The direction of the prevailing winds
 - e) The increased temperature of the springtime sun

- 5) Calico cats are 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**
 - e) Somatic hypermutation

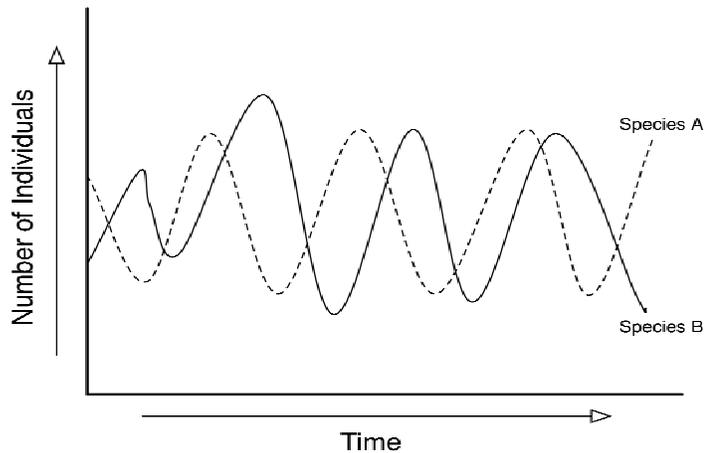
- 6) Which of these statements about plant hormones is correct?
 - a) Auxins, such as IAA, are only found in very young or just germinating plants
 - b) Auxins and cytokinins act synergistically to promote lateral growth at the apical meristem
 - c) Cytokinins do not occur naturally in plants
 - d) **Ethylene is a gas that plays a role in senescence**
 - e) Gibberellins, such as GA₃, play a predominant role in the generation of statoliths

- 7) In general, parasites tend to
 - a) become more virulent as they live within the host
 - b) become deactivated as they live within the host
 - c) **be only mildly pathogenic**
 - d) completely destroy the host
 - e) require large amounts of oxygen

- 8) The main function of the sinus glands of lobsters is:
- sensory
 - excretory
 - reproductive
 - endocrine
 - balance
- 9) Of the following parts of the vertebrate nephron, which consists of capillaries?
- Bowman's capsule
 - Distal tubule
 - Loop of Henle
 - Collecting tubule
 - Glomerulus
- 10) The Gram stain is one of the major tools used in the classification of bacteria. Which of the following statements is NOT true regarding the Gram stain?
- A gram-negative bacterium has peptidoglycan in its cell wall
 - A gram-negative bacterium has an inner lipid bilayer and an outer lipid bilayer
 - A gram-positive bacterium has peptidoglycan in its cell wall
 - A gram-positive bacterium has a periplasmic layer
 - None of the above
- 11) The carbon atom is one of the most important atoms in organic molecules. The carbon atom has all of the following properties EXCEPT:
- C has a valence of four electrons
 - C-C covalent bond is very stable; much more energy is required to break a C-C bond than to break an ionic bond
 - C can only form single or double bonds
 - C that has four different functional groups is called an asymmetric carbon
 - C can bond functional groups, which include hydroxyl, carbonyl, carboxyl, amino, sulfhydryl and phosphate
- 12) Carnivory in some plants appears to have evolved to compensate for soil that is relatively deficient in:
- Potassium
 - Calcium
 - Manganese
 - Nitrogen
 - Molybdenum
- 13) When the base composition of DNA from bacterium *Mycobacterium tuberculosis* was determined, 18% of the bases were found to be adenine. What is the G + C content?
- 18%
 - 32%
 - 36%
 - 64%
 - 72%

- 14) In order for a poinsettia plant to flower again, you would have to subject it to which of the following special treatments:
- Place it in a brown paper bag
 - Place it where the lights remain off at night
 - Give it a cold treatment, keeping it refrigerated
 - Give it plenty of light, so that it can photosynthesize
 - Provide plenty of water and essential elements
- 15) Which of the following bonds/interactions involved in folding a protein into its proper 3D shape is INCORRECTLY matched with its description?
- Hydrogen bond: a bond formed by the attraction of a hydrogen atom to an electronegative atom
 - Hydrophobic effect: the attraction between a hydrophobic molecule and a hydrophilic molecule
 - Electrostatic interaction (ionic bond): the bond between a positively charged ion and a negatively charged ion
 - Van der Waals force: an attractive force that occurs due to resonating dipole moment when atoms or groups of atoms are very close together
 - All of the above are correctly matched with their description
- 16) Which organism could have aposematic coloration?
- A tree snake
 - A barnacle
 - A hawkmouth larva
 - A poison-arrow frog
 - A zebra
- 17) During agarose gel electrophoresis, DNA molecules move from the _____ to the _____.
- cathode ... anode
 - left ... right
 - anode ... cathode
 - right ... left
 - none of the above
- 18) What provides the best evidence for the independent origin of microphylls and megaphylls?
- Microphylls have a single unbranched vein, while megaphylls have a branching vascular system
 - Microphylls are small, while megaphylls are larger
 - Both are vascularized
 - Both appear as lateral appendages of the stem
 - Both are photosynthetic organs
- 19) If the nucleoli in a eukaryotic cell were destroyed, the cellular activity that would be most affected is:
- The formation of the nuclear lamina
 - The appearance of the middle lamella
 - The activity of the nuclear membrane
 - The synthesis of ribosomes
 - The storage of RNA

20) Populations of two different species were studied over time and the following results were plotted.



The best interpretation of these data would be:

- They represent interspecific competition for a limited resource
- They represent a predator/prey relationship
- They indicate habitat diversification
- They show a habitat with limited carrying capacity
- They show a complex interrelationship between abiotic and biotic factors

21) Physical and chemical agents, called mutagens, interact with DNA to cause mutations. X-rays are considered to be mutagens because they cause:

- Chromosomal translocations
- Deletions
- Insertions
- Missense mutations
- Point mutations

****ALL answers were marked correct for question #21. If the answer was left blank, it also was marked correct.**

22) A scientist notes that the leaves of a plant have become flaccid during the middle of the day. If s/he could isolate and test the following cell types for potassium ions (K^+), in which would you expect the highest concentration?

- Bundle sheath cells
- Guard cells
- Palisade cells
- Sieve tube cells
- Tracheids

23) The relationship of the three bones in the human inner ear to the jawbones of some fishes is a case of:

- Analogy
- Convergence
- Homology
- Symbiosis
- Vestigialism

- 24) Signal transduction is the process by which cells convert chemical signals delivered extracellularly into altered gene expression within the cell. In some pathways, signal transduction is accomplished by covalently linking serine and threonine residues in signaling proteins to phosphate. What is the name of the enzyme that carries out this process, and what is one reactant required for the reaction?
- Hydrolases, ATP
 - Kinases, ATP
 - Lyases, ATP
 - Mutases, ATP
 - Phosphatases, NADH
- 25) A keystone predator:
- is typically present in large numbers
 - may exert its influence by preying on a major competitor
 - usually only works in a bottom-up model
 - must be very specific in its prey
 - is normally a top predator
- 26) People are susceptible to influenza infection each year because of a process called:
- Antigenic drift
 - Horizontal transmission
 - Negative selection
 - Peripheral tolerance
 - Reverse transcription
- 27) Stem cells are most abundant in which of the following tissues?
- Bone marrow
 - Thymus gland
 - Liver
 - Thyroid gland
 - Spleen
- 28) These materials are assembled at your laboratory station: frozen spinach, methyl alcohol, a hot plate, filter paper strips, a beaker, a large test tube with a cork, petroleum ether, a metric ruler, and a capillary tube. It is most likely that the goal of this laboratory exercise is to:
- Determine the amount of chlorophyll in spinach leaves
 - Measure the rate at which chlorophyll dissolves in a solvent
 - Measure the dissolving power of methyl alcohol
 - Separate plant pigments
 - Study the effect of chlorophyll in a closed system
- 29) All enzymes that bind and hydrolyze ATP, under normal physiological conditions, require which of the following cations:
- Calcium (Ca^{2+})
 - Iron (Fe^{2+})
 - Magnesium (Mg^{2+})
 - Manganese (Mn^{2+})
 - Zinc (Zn^{2+})

- 30) A cross between a horse and a zebra results in a sterile zebroid. The reason for sterility of this hybrid is BEST explained by:
- The failure of chromosomes from the parent species to align properly during meiosis
 - The appearance of the fragile X chromosome in the zygote of the zebroid
 - Incomplete fertilization caused by a time lag of the sperm penetrating the ovum
 - Species incompatibility of endocrine secretions
 - The increased rate of nondisjunction during mitosis
- 31) A newborn experimental animal is fed for one month with normal levels of only 19 amino acids. Which of the following is characteristic of what can happen to the animal?
- Secretion of excessive enzymes in the digestive tract
 - Increase in basal metabolic rate
 - No change in the animal
 - Swelling of the liver
 - Physical underdevelopment
- 32) Which of the following fungi have sexual spores borne externally on club-shaped structures?
- Ascomycota
 - Basidiomycota
 - Chytridiomycota
 - Masonomycota
 - Zygomycota
- 33) Some compound microscopes utilize a third lens, in addition to the eyepiece and ocular lenses. The use of this lens is to:
- Decrease the visible light wavelength
 - Increase the resolution
 - Invert the image
 - Increase the depth of focus
 - Magnify the image further
- *Answers C and E were marked as correct; Answers A, B and D were not marked correct.**
- 34) CAM plants initially fix CO₂ into _____ during the _____.
- three-carbon compounds; day
 - three-carbon organic acids; day
 - four-carbon organic acids; night
 - six-carbon compounds; day
 - six-carbon compounds; night
- 35) You have discovered a new bug! You know it is an insect based on the number of legs. You are having difficulty classifying its mouthparts. However, you can clearly see that it has only one pair of wings. What order does your new insect most likely belong to?
- Odonata
 - Lepidoptera
 - Diptera
 - Hymenoptera
 - Siphonaptera

USABO Semifinal Exam – Part B

[Please note: Questions 1 - 11 were negatively graded. All correct answers were given positive point values; all incorrect answers were given negative points equal to the positive point value; all blanks were given zero points.]

[1] (2.5 points) Match the vitamin with the symptom of deficiency or extreme excess:

- | | |
|---------------------------------|-----------------------------|
| <u>c</u> Vitamin C | a. bone deformities |
| <u>d</u> Vitamin B ₁ | b. defective blood clotting |
| <u>a</u> Vitamin D | c. scurvy |
| <u>e</u> Vitamin A | d. beri beri |
| <u>b</u> Vitamin K | e. problems with vision |

[2] (2.5 points) Match the disorder with the symptom it generates:

- | | |
|---------------------------------------|--|
| <u>c</u> high thyroid hormone | a. loss of muscle tissue, increased blood glucose, decreased inflammatory response |
| <u>e</u> high parathyroid hormone | b. low blood pH, increased urine |
| <u>a</u> high adrenal corticosteroids | c. weight gain, tiredness, sensitivity to cold |
| <u>d</u> high anti-diuretic hormone | d. decreased urine volume, high urine osmolarity |
| <u>b</u> loss of insulin | e. loss of bone density |

[3] (2 points) Choose a phrase or term from the right, which describes each behavioral scenario on the left. [NOTE: Behavioral scenarios may be used more than once]

- | | |
|--|---------------------------|
| <u>d</u> a bird pecks at a button in its cage and receives a sunflower seed | a. imprinting |
| <u>a</u> a mouse, raised by a gerbil, prefers to play with to play with gerbils, not mice, as an adult | b. habituation |
| <u>b</u> a monkey is undisturbed by a rubber snake it has seen on multiple occasions | c. classical conditioning |
| <u>c</u> a fish swims to the surface whenever red light is flashed on the aquarium | d. operant conditioning |
| | e. maturation |

[4] (6 points) Match the characteristic or function of the immunoglobulin on the right, with its class on the left. [Some answers may fit in more than one class of immunoglobulins. Classes will have more than one answer.]

- | | |
|-------------------|--|
| ___c, g, j___ IgA | a. functions as a monomer |
| ___a, i___ IgD | b. when activated, causes cells to release histamine and other chemicals that cause an allergic response |
| ___a, b___ IgE | c. functions as a dimer |
| ___a, f, h___ IgG | d. the first circulating antibodies to appear in response to the initial antigen exposure |
| ___d, e___ IgM | e. functions as a pentamer |
| | f. the most abundant circulating antibody |
| | g. produced by cells in mucus membranes |
| | h. confers passive immunity to the fetus in a pregnant woman |
| | i. do not activate complement, cannot cross the placenta; found on surfaces of B cells |
| | j. found in many body secretions such as saliva and tears |

[5] (3 points) Match the molecular biology technique on the left with the corresponding definition on the right:

- | | |
|--|---|
| ___d___ PCR (polymerase chain reaction) | a. technique to introduce holes in plasma membranes |
| ___e___ Restriction fragment length analysis | b. technique to separate molecules by size or other physical property |
| ___c___ DNA microarray analysis | c. technique to measure expression of thousands of genes at one time |
| ___f___ RNA interference | d. technique to make thousands of copies of a nucleotide sequence |
| ___a___ electroporation | e. technique to detect differences in two alleles |
| ___b___ electrophoresis | f. technique to silence the expression of a gene |

[8] (5 points) Currently there are two competing classification schemes used by biologists; the older five-kingdom system and the more recent three-domain system. In the chart below, indicate with an “X” whether each statement on the right describes the 3-domain system, the 5-kingdom system, or both.

<u>3-Domain System</u>	<u>5-Kingdom System</u>	<u>STATEMENT</u>
<u> x </u>	<u> x </u>	i. A human construction, not simply a fact of nature
<u> x </u>	<u> </u>	ii. Implies that one group of prokaryotes is much closer to eukaryotes than to other prokaryotes
<u> </u>	<u> x </u>	iii. Is comprised of four major groups of eukaryotes and one major group of prokaryotes
<u> x </u>	<u> </u>	iv. Is a classification scheme composed of three fundamentally different groups of organisms
<u> x </u>	<u> x </u>	v. Represents an attempt to classify life in a useful way that reflects evolution
<u> x </u>	<u> </u>	vi. Is composed of two major groups of prokaryotes and one major group of eukaryotes
<u> </u>	<u> x </u>	vii. Implies that prokaryotes are more closely related to each other than to eukaryotes
<u> </u>	<u> x </u>	viii. Is a classification scheme based primarily on structure and nutrition
<u> </u>	<u> x </u>	ix. Is composed of two fundamentally different groups of organisms
<u> x </u>	<u> </u>	x. Is a classification scheme based more on molecular studies

[9] (5 points) The three domains of life and several kingdoms are presented below. Match each statement with the domain(s) and/or kingdom(s) to which it applies.

- | | |
|--|---|
| a. Domain Bacteria
b. Domain Archaea
c. Domain Eukarya
g. protists (several kingdoms) | d. Kingdom Plantae
e. Kingdom Fungi
f. Kingdom Animalia |
|--|---|

	DOMAIN	KINGDOM
i. Single-celled organisms such as Amoeba	c _____	g _____
ii. Spider, flying fox, and sloth	c _____	f _____
iii. Protozoa and algae	c _____	g _____
iv. Multicellular eukaryotes that eat other organisms	c _____	f (and d, if answered with f)
v. Prokaryotes	a or b	N/A
vi. <i>Magnoliopsida</i> or <i>Liliopsida</i>	c _____	d _____
vii. Another domain of prokaryotes	a or b	N/A
viii. Mushrooms, molds, and yeasts	c _____	e _____
ix. Organisms the cells of which lack a nucleus	a or b	N/A
x. Photosynthetic multicellular organisms	c _____	d _____

[Please note: For parts i, ii, iii, iv, vi, viii and x, positive points were given if the domain or the kingdom was answered correctly. If both the domain and kingdom were given, both must be answered correctly in order to receive positive points. If one was answered correctly and the other incorrectly, then the answer was graded negatively.]

[10] (5.5 points) [Please note: Point value was changed from 6 to 5.5 points due to part xii.] Complete the following table. The first column lists the names of elements important to living things. The second column lists their chemical symbols. The third should indicate whether the elements are used in trace (T), moderate (M), or large (L) amounts in living things.

<i>Element</i>	<i>Symbol</i>	<i>Amount</i>
i. Iron	Fe	T
ii. Nitrogen	N	L
iii. Calcium	Ca	M
iv. Iodine	I	T
v. Hydrogen	H	L
vi. Oxygen	O	L

<i>Element</i>	<i>Symbol</i>	<i>Amount</i>
vii. Sodium	Na	M
viii. Phosphorous	P	M
ix. Carbon	C	L
x. Copper	Cu	T
xi. Zinc	Zn	T
xii - M represents a non-existence element. This was a typo. Section xii was not graded.		

[11] (5 points) Nucleic acids, a group of macromolecules, are characterized by distinctive structures and functions. Match the phrases on the left with the appropriate word or phrase on the right. [NOTE: Answers may be used more than once]

- | | |
|--|---------------------|
| i. <u>i</u> Monomer of nucleic acids | a. Phosphate group |
| ii. <u>d</u> A nucleotide is a sugar, a phosphate, and a _____. | b. Deoxyribose |
| iii. <u>b</u> Sugar in DNA | c. RNA |
| iv. <u>f</u> Passed on from parent to offspring | d. Nitrogenous base |
| v. <u>h</u> Overall structure of DNA | e. A, T, C, G |
| vi. <u>a</u> Sugar of one nucleotide bonds to _____ of the next nucleotide | f. DNA |
| vii. <u>c</u> DNA is expressed through this intermediary | g. Ribose |
| viii. <u>e</u> Nitrogenous bases of DNA | h. Double Helix |
| ix. <u>j</u> Nitrogenous bases of RNA | i. Nucleotide |
| x. <u>g</u> Sugar in RNA | j. A, U, C, G |

[12] (2 points) To determine the population size of carp (the fish) in a pond, you catch and tag 15 carp. One week later, you catch 50 carp; only two are tagged. What is the size of the carp population the pond?

375 carp

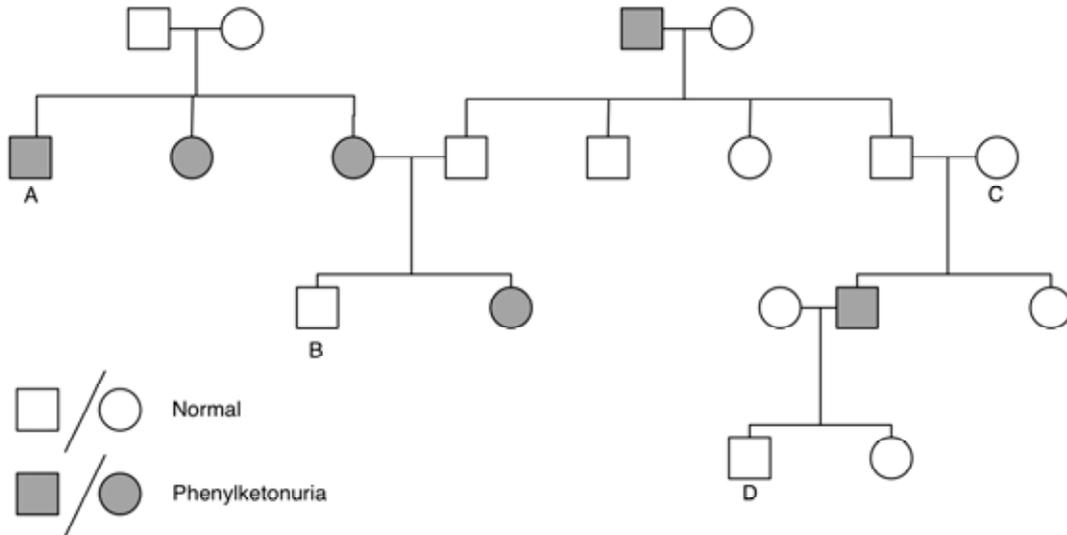
[13] (5 points) Using the genetic code table above, list the first five amino acids encoded by the open reading frame below. [NOTE: Amino acids should be listed by either their three-letter or capital letter abbreviation.]

3'-TACCATCGTTAAGAAACTACCCTACTT-5'

M V A I L or Met-Val-Ala-Ile-Leu

[14] (3.5 points) The life history traits of some populations are characterized by *K-Selection*, while others exhibit *r-Selection*. In the following table, compare these contrasting life histories by filling the lettered blank spaces with one or more words.

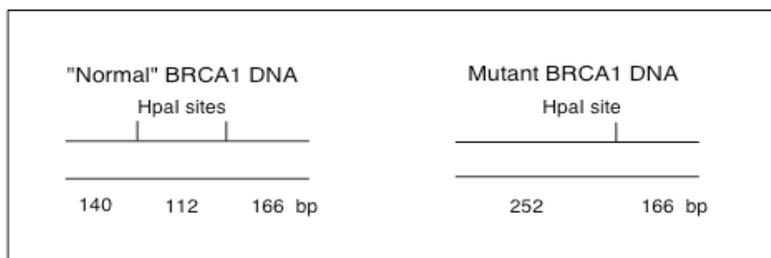
Characteristic	<i>r-Selection</i>	<i>K-Selection</i>
Life history emphasis	Rapid population growth when conditions are favorable	a. Stability near carrying capacity
Relative body size	b. Small	c. Large
Number of offspring per reproduction	d. Many	e. Few
Relative age at first reproduction	f. Younger	Older
Emphasis on ____ of offspring	Quantity	g. Quality and care; quality and survival; quality
Examples	Insects and weeds	Many large land vertebrates, such as polar bears



[15] (4 points) Use the above pedigree to solve this problem. Phenylketonuria is caused by a homozygous recessive gene. Indicate the genotypes of the four individuals labeled A, B, C, and D, using *T* to indicate the dominant allele and *t* to indicate the recessive allele.

A = *tt*; B = *Tt*; C = *Tt*; D = *Tt*

[16] (3.5 points) You have joined a team of scientists that are developing diagnostic tests for genetic defects. You have developed a method for detection of specific mutations in the BRCA1 gene, which is involved in some breast and ovarian cancers. The method relies on PCR amplification of a 428bp fragment, which is then digested with the restriction enzyme *HpaI*. This enzyme cleaves normal DNA twice within the amplified fragment. There is only one *HpaI* site in the DNA of the individuals containing the specific BRCA1 mutations that you are trying to detect. This is illustrated in the schematic below:



In the boxes provided, write the size(s) of restriction fragments of a DNA sample you would detect in an agarose gel from an individual who was:

[NOTE: Not all the boxes may be used]

112	166	140	252
-----	-----	-----	-----

i. Heterozygous at BRCA1

112	140	166
-----	-----	-----

ii. Homozygous “normal” at BRCA1

[Please note: The fragment sizes sequences (in parts i and ii) were not part of the grading process.]

[17] (4 points) The following genotype frequency data were accumulated for five separate loci, A through E.

Gene A	Gene B	Gene C	Gene D	Gene E
AA .36	BB 0	CC 1.0	DD .70	EE .25
Aa .48	Bb .03	Cc 0	Dd .20	Ee .50
aa .16	bb .97	cc 0	dd .10	ee .25

i. Which loci are monomorphic? Which loci are dimorphic?

Monomorphic – C Dimorphic – A, B, D, E

ii. What is the average heterozygosity across all five loci?

Average H = (.48 + .03 + 0 + .20 + .50)/5 = 24.2 %

iii. What are the allele frequencies at each locus?

$F(A) = .36 + \frac{1}{2}(.48) = 0.6$ $F(a) = 0.4$
 $F(B) = 0 + \frac{1}{2}(0.03) = 0.015$ $F(b) = 0.085$
 $F(C) = 1$ $F(c) = 0$
 $F(D) = 0.7 + \frac{1}{2}(0.2) = 0.8$ $F(d) = 0.2$
 $F(E) = 0.25 + \frac{1}{2}(0.5) = 0.5$ $F(e) = 0.5$

[Please note: For part iii, credit was give if either one of the two allele frequencies was answered correctly, or if both alleles frequencies were answered correctly. If one allele frequency was answered correctly and the other incorrectly, then credit was not given for that allele frequency. Each allele frequency was worth 0.2 points, totally 1.0 point if all parts were answered correctly.]

[18] (2 points) Fill-in the empty table cells below with the appropriate characteristics of Ernst Mayr’s fundamental distinction between functional biology vs. evolutionary biology:

	Functional Biology	Evolutionary Biology
Kind of questions addressed: ‘How’ or ‘why’	a. How	b. Why
Kind of causes identified: proximate or ultimate	c. Proximate	d. Ultimate
Focus of investigation: decoding of genetic program or origin of genetic program	e. Decoding of genetic program	f. Origin of genetic program
Nature of explanation: reductionistic vs. historical	g. Reductionistic	h. Historical

[19] (2 points) Suppose we cross a trihybrid with purple flowers and yellow, round seeds with a plant with purple flowers and green, wrinkled seeds. The second plant is heterozygous for the flower color. What is the probability of getting a plant with at least two recessive traits?

$$6/16 = 3/8 = 0.375 = 37.5 \%$$

[20] (4 points) The Bubblegumose operon contains the genes involved in the catabolism of bubblegumose in the bacteria *Ficticus*. Sodapopose is the preferred sugar for generating energy in *Ficticus*, but the bacteria can also catabolize bubblegumose. Indicate with a (+) or a (-) if the bubblegumose operon is expressed when *Ficticus* cells are grown in the presence or absence of the sugars bubblegumose and sodapopose. [For operon expression, use (+) symbol; for lack of expression, use (-) symbol.]

Bubblegumose operon expression	Bubblegumose	Sodapopose
-	Absent	Absent
-	Absent	Present
+	Present	Absent
-	Present	Present

[21] (5.5 points) Animal bodies are covered by epithelial tissue, which also lines the organs of the body. The chart below compares the following four kinds of epithelium:

- Stratified Squamous Epithelium
- Simple Cuboidal Epithelium
- Simple Squamous Epithelium
- Simple Columnar Epithelium

Fill in the blanks with the appropriate term(s) and/or phrase(s).

<i>Epithelial Tissue Type</i>	<i>Description: of cells; in layer(s)</i>	<i>Representative Functions</i>	<i>Typical Body Locations</i>
Simple Squamous	a. thin, flattened cells; in single layer	Exchange of materials by diffusion	b. linings of lungs and blood vessels
c. Simple Cuboidal	Cube-shaped cells in single layer	d. absorbs and secretes fluid in kidneys, or thyroid glands; endocrine secretions	e. tubular passage-ways where urine forms in kidneys, and/or liver, and/or pancreas, and/or thyroid gland, and/or endocrine glands
f. Stratified Squamous	g. flattened cells; in multiple layers	h. covers and protects surfaces subject to abrasion	Lining of esophagus; epidermis of skin
i. Simple Columnar	j. elongated; cylindrical cells; single layer	Secretion and absorption via the digestive tract wall	k. forms mucous membrane that lines digestive tract and/or reproductive tract

[Please note: For parts a, g and j, credit was only given if the correct description of cells was given and the correct description of cell layers. If only one description was given, the answer was not receive credit.]

[22] (2 points) Two black mice are crossed. The resulting offspring demonstrate a phenotypic ratio of 9 black, 3 brown, and 4 white mice.

- i. The number of genes involved is 2.
- ii. The resulting phenotypic ratio is due specifically to epistatic interaction, epistasis, or definition of epistasis.

[23] (7 points) We are told that: “Despite changes in the external environment, an animal can keep its internal environment remarkably constant.” For human beings, this process is called homeostasis. It maintains body temperature and the fluctuation of blood sugar within a narrow range.

In the chart below, fill-in the spaces with the appropriate homeostatic control system components as they are listed in the left-hand column.

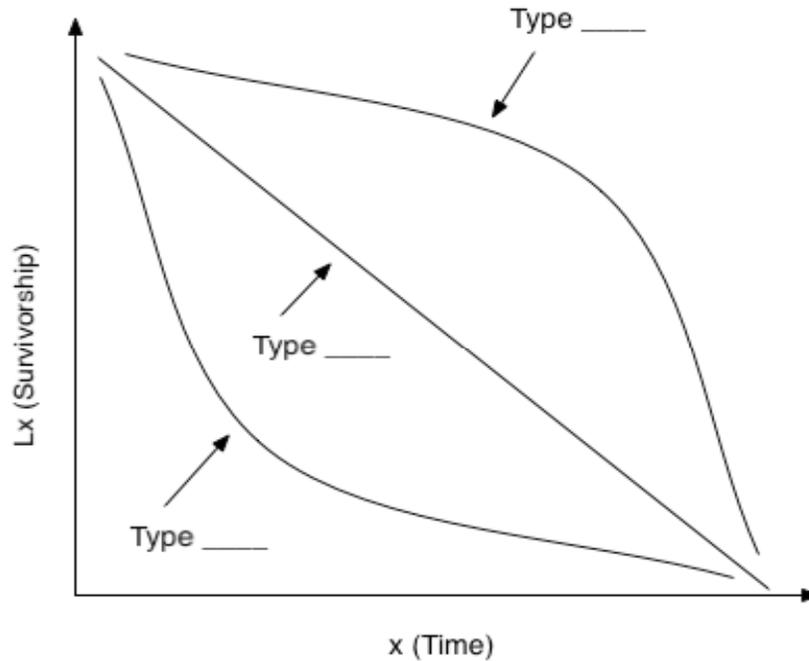
	BLOOD SUGAR	BODY TEMPERATURE
Type of change in external environment	Eating a meal; fasting	Increase in ambient temperature; change in temperature
Control center	Pancreas	Hypothalamus; brain
Stimulus	Increase in blood sugar level; change in glucose level; fasting	Increase in blood temperature; increase in temperature
Kind of signal sent by control center to effector	Hormone; insulin; endocrine	Nerve impulses; neurochemical; electrochemical
Effector	Cells; liver cells; liver and glucogen breakdown	Sweat glands and blood vessels in skin; skeletal muscles
Response	Cells take-up sugar; increase or decrease in blood sugar level; glycogen breakdown	Sweat glands secrete sweat; blood vessels dilate and fill with warm blood; cooling method of body; shivering; goose bumps
Set Point	70 – 110 mg of sugar per 110 mL of blood	37°C; 98.6°F; approximately 98°F

[Please note: If question #23 was misread and/or misunderstood, but was logically answered correctly with reasoning, the proper answer was given credit.]

[24] (2 points) Read the “Explanations” column, then complete the table below with the appropriate phrase.

<u>Costs and/or Benefits to Helpers</u>	<u>Costs and/or Benefits to Breeders</u>	<u>Explanation</u>
a. Decrease in fitness	increase in fitness	helpers are altruistic
b. Increase in fitness	c. Decrease in fitness	helpers are selfish
increase in fitness	d. Increase in fitness	both helpers and breeders benefit

[25] (4.5 points) There are three general classes of survivorship curves. [See illustration below]



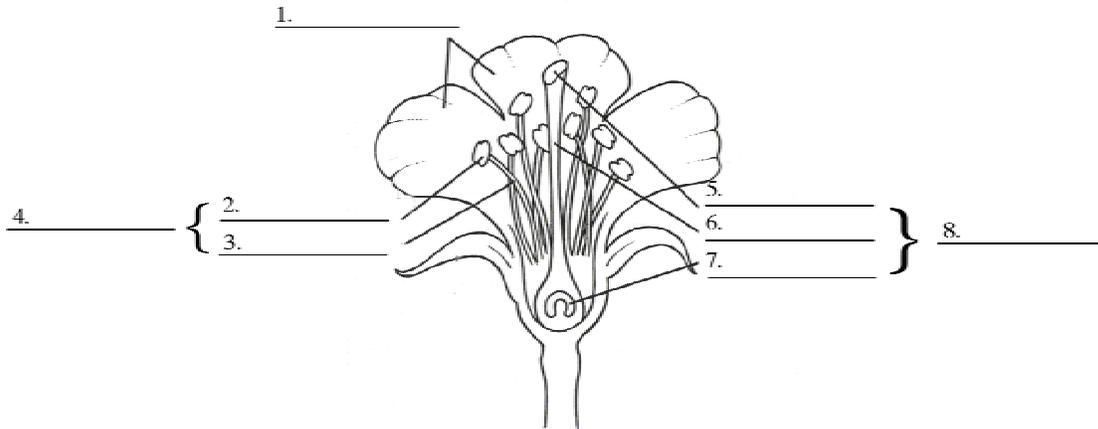
[a] (1.5 points) Indicate on the figure above if the survivorship curve is: Type I, Type II, or Type III.

Top type – Type I; middle type – Type II; bottom type – Type III

[b] (3 points) In spaces below, match each survivorship type curve with its description. [Examples are provided in the last column]

	a...c	i...iii	Description of Type	Example of Type
Type I curve	b	ii	a. Occurs when juvenile mortality is extremely high in type III populations; It is often true that $e_{i+1} > e_i$ for small i ; Life expectancy increases for individuals who survive their risky juvenile period.	i. e.g.) many species of large birds and fish
Type II curve	c	i	b. Typical of populations in which most mortality occurs among the elderly.	ii. e.g.) humans in developed countries
Type III curve	a	iii	c. Occurs when mortality is not dependent on age. This can hold for an infinite population, $e_0 = e_1 = \dots$, but cannot hold for a finite population	iii. e.g.) plant and animal species produce many offspring; few survive.

[26] (4 points) On the diagram below label the flower structures in the blanks provided.



- | | |
|----------------------|---------------------|
| 1. Petals or Corolla | 5. Stigma |
| 2. Anther | 6. Style |
| 3. Filament | 7. Ovule |
| 4. Stamen | 8. Carpel or Pistil |

[27] (6 points) In supplying oxygen to a [human] mother’s fetus, a molecule of O₂ must follow a circuitous path. In the list below, order from first (notation: 1st) to last (notation: 11th) the route O₂ takes from the mother to her fetus.

- 8th a. Oxygen attaches to hemoglobin in fetal blood.
- 7th b. Oxygen diffuses through the wall of a capillary in the placenta and into the blood of the fetus.
- 4th c. The mother’s blood, now loaded with oxygen, returns from her lungs to the heart.
- 11th d. Oxygen leaves the blood of the fetus and diffuses into a growing cell in the fetus’ brain.
- 6th e. Oxygen diffuses out through the walls of capillaries in the uterus.
- 10th f. The fetus’ heart pumps the oxygen-rich blood out to its tissues.
- 5th g. The mother’s heart pumps the oxygen-rich blood to her uterus.
- 1st h. The mother takes a deep breath of fresh air.
- 2nd i. Oxygen diffuses across the thin wall of an alveolus in the mother’s lung and into a capillary.
- 9th j. Oxygen-rich fetal blood flows into the fetus through a vein in the umbilical cord.
- 3rd k. Oxygen attaches to hemoglobin in the mother’s blood.

[28] (3.5 points) The following chart lists examples of innate animal behaviors. Fill-in the appropriate spaces in the species column, sign stimulus column, and fixed action pattern column.

<u>Species</u>	<u>Sign Stimulus</u>	<u>Fixed Action Pattern</u>
Cuckoo chick	Host eggs	Ejects eggs from nest
Chicken	Flying shape	a. runs for cover
Bird	Open mouth of chick	b. stuffs food into mouth;
Red-winged blackbird	Red wing patches	c. threatens and attacks intruders
d. Frog; chameleon; gecko	Habituation (probably association too)	Catches insect with tongue
e. Infant; adult human	f. adult face; mother; sees someone smile; laughter; gets into USABO National Finals	Smiles
Gull or Graylag Goose	Egg near nest	g. rolls egg into nest