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A maximum 4 points for each component.

Elaboration point: 1 point for either structure or function after the first 2 points have been earned

* = required element to receive elaboration point

<table>
<thead>
<tr>
<th>1 point</th>
<th>1 point</th>
<th>1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Describe structure</td>
<td>(a) Explain how structure is responsible for function (must be linked to structure described)</td>
<td>(b) Explain how the structure contributes to the function of the organ system to which it belongs</td>
</tr>
</tbody>
</table>

**Sarcomere**
* Thin-thick (i.e., actin-myosin or protein) filaments (i.e., myofilaments)
  - cross-bridges
  - troponin-tropomyosin complex/Ca^{2+} binding
  - detailed description of sarcomere (e.g., A-band, Z-line, etc.)

* Shortening of sarcomere (unit) causes contraction
  - sliding of actin filaments during contraction
  - number of groups of sarcomeres regulate strength of muscle contraction

* Cause a muscle fiber (muscle) to contract (shorten) in the muscular system (muscle) OR movement in muscle

**Neuron**
* Cell with dendrites and axon OR axon and dendrites and cell body OR nerve cell with cytoplasmic extensions
  - myelin sheath/Node of Ranvier
  - plasma membrane (neurilemma)
  - Na^{+}/K^{+} pump-gated channels
  - synaptic knobs/dendrite membrane receptors
  - axon hillock (i.e., neck of cell body)

* Generate/conduct/transmit impulses (electrical/chemical signals or messages)
  - speed of impulse transmission
  - change in membrane polarity
  - neurotransmitters
  - origin of depolarization

* Conduct impulses (electrical/chemical signals or messages) in the nervous system

**Nephron**
* (Renal) tubules and capillaries (glomerulus) OR Tubular excretory unit of the kidney
  - filtering unit
  - PCT, loop of Henle, DCT, collecting duct
  - epithelial cells
  - single layer of epithelial cells

* Filtration of materials from blood
  - (re)absorption of materials (e.g., HCO_{3}^{-}, NaCl, H_{2}O, glucose, amino acids, vitamins, K^{+}, urea)
  - tubular secretion of materials (H^{+}, NH_{4}^{+}, K^{+}, drugs, toxins)
  - counter-current multiplier

* Regulates osmolarity/waste removal/homeostasis in urinary (excretory) system
### Question 1 (cont.)

<table>
<thead>
<tr>
<th>Villus</th>
<th>Capillary</th>
<th>Alveolus</th>
</tr>
</thead>
</table>
| * Finger-like (hair-like) projections in small intestine*  
  • microvilli (brush border)  
  • capillary bed and lacteals  
  • single-cell layer/simple columnar epithelial  
  • tight junction  
  • goblet cells  
  * Also acceptable: Chorionic villus Finger-like projection in the placenta* | * Absorption of digested material (nutrients)*  
  • increase surface area  
  • secrete mucus | * Increases amount of surface area for absorption of nutrients in digestive system*  
  * Maternal-fetal exchange for nutrients, gases, etc.*  
  * Increases surface area for exchange in the reproductive system during fetal development* |
| * Movement of material (gases, nutrients, wastes, hormones, etc.) across capillary membrane*  
  • increases surface area  
  • blood cells moving through one at a time  
  • low pressure  
  • slowest velocity of blood  
  • allows passage (conduit) for white blood cells  
  • heat dissipation | | * Increases vessel contact with all body cells for the exchange of substances between body cells and blood in the circulatory system OR increases surface area in the circulatory system OR a description of a capillary network in the circulatory system* |
| * Allows gas diffusion (site to site)*  
  • surface area (High SA/V ratio)  
  • close association with capillaries  
  • reduces surface tension, prevents collapse of alveolus  
  • enhance diffusion | | * Increases amount of surface area which allows for the exchange of gases in respiratory system* |
Question 2

2. (a) A maximum of 6 points may be given for part (a). A single point may be awarded for each concept that follows. Beware of anything that sounds like a Lamarckian statement.

- Reproductive potential — the ability to over produce
- Variability — inheritable changes or mutations linked to variability
- Limited resources — biotic or abiotic
- Competition — intraspecific struggle for existence
- Differential Reproduction — reproductive success of variants
- Generations — time needed for evolution to occur
- Elaboration — expansion of Darwin’s ideas such as the effects of environmental change or artificial selection or good, linked example

2. (b) A maximum of 6 points can be scored in part (b).
A student may not receive a total score of ten without attempting to respond to three sections of part (b).
A single point may be awarded for each of the following:

(i)
1 point Different species exhibit adaptations as a result of the same environment
1 point Correct descriptive example linked to biome and survival value or linked to natural selection

(ii)
1 point An inherited characteristic enables the organism to resist the effect of the toxin
1 point Specific example, mechanisms of resistance, or extensive elaboration or link to natural selection

(iii)
1 point A single population divides into two reproductively isolated populations or equivalent (use of gene pools)
1 point Role of barriers in speciation or discuss gene pool separation or link to natural selection

(iv)
1 point Define or describe the behavior
1 point Give a clear example of how this behavior enhances survival or link to natural selection

(v)
1 point Survival value of heterozygote over both homozygotes
1 point An example of how the heterozygous enhances the survival of the organism or link to natural selection
Question 3

3. (a) 4 points possible

1 point for proper orientation of graph (independent variable on x-axis)

1 point for graph (all of the elements below must be present)
- Uniform spacing of units
- Correct labeling of axes
  - proper numbering (a minor error acceptable)
  - X-axis label: “Time”/ “Hour”/ a.m., p.m. labels/a conversion to integers requires unit label as well
  - Y-axis: oxygen label and mg/L Unit

1 point for correct plot of data points
- No connecting line necessary
- No point if more than one data point is misplotted
- No point if there is a solid extrapolation line beyond the 6:00 a.m. data point to the origin or the 12 midnight data point

1 point for drawing the cloudy day prediction Line/Curve (all of the elements below must be present)
- Distinguish between the two curves with a legend or direct labeling of one curve
- Position completely under the bright-day curve (may touch toward the tails)
- There must be some curve to the line (no flat lines)

3. (b) 5 points possible

1 point Photosynthesis: production of O₂ correlated with light changes (i.e., explains changes in shape of bright-day curve). The student must link photosynthesis to increase in light to increase in O₂ production. The student must use the term “photosynthesis” or an excellent replacement such as the chemical equation for the process.

1 point Respiration: consumption of O₂. Must link respiration to decrease in O₂. The student must use the term “respiration” or an excellent replacement such as the chemical equation for the process or the name of another appropriate process such as “decomposition.”

1 point Description of the interaction of the above: photosynthetic rate changes while respiration rate remains relatively constant.

1 point Overcast prediction curve explanation
- Reduced light leads to decreased photosynthetic O₂ production, etc.
- No point given if there is no prediction line/curve on the graph.

1 elaboration point (maximum) for any one of the above. Examples of elaboration may include, but are not limited to:
- Water split/photolysis to produce O₂ in the light phase, etc.
- Balanced equation for photosynthesis or respiration (unless used as a substitute for the term above)
- Description of “light phase” processes (photosystem II, etc.)
- Gross vs. net productivity
Question 3 (cont.)

3. (c) 3 points possible

1 point for describing (predicting) a change in lake conditions such as (must be related to the question)

- increased/decreased O₂
- increased/decreased biomass or numbers of organisms
- increased/decreased CO₂
- long-term or short-term changes
- no change

1 point for an explanation of the prediction above (may include toxic effects due to significant changes in pH, altered osmolarity, etc.)

1 elaboration point for the explanation of the prediction above or long term ecological consequences to lake.
Question 4

4. (a) **4 points maximum**

**Chemical composition — 2 points maximum**

1 point amino acids are the basic building blocks of proteins
1 point amino acids contain amino, carboxyl and R groups

* or *

correct structural formula showing amino, carboxyl, and R group attached to central carbon

* or *

proteins are composed of carbon, hydrogen, oxygen and nitrogen

1 point R group determines the identity/properties of the amino acid

**Elaboration**

1 point for a description of addition of lipids, carbohydrates, and/or prosthetic group

**Levels of structure — 3 points maximum** (Note: to obtain any points, response must name level or list in correct order.)

**Primary structure — 1 point**

- sequence (chain, string) of amino acids or the number and order of amino acids
- amino acids linked by peptide bonds
- amino acids bonded through dehydration synthesis

**Secondary structure — 1 point**

- helix and/or pleated sheet
- hydrogen bonds (between carboxyl and amino groups)

**Tertiary structure — 1 point**

- single polypeptide chain forms globular shape
- hydrogen, ionic, disulfide, and van der Waals bonds, and/or hydrophobic interactions (if hydrogen must have more than one)
- interaction between R groups

**Quaternary structure — 1 point**

- more than one polypeptide or subunit
- hydrogen, ionic, disulfide, and van der Waals bonds, and/or hydrophobic interactions (if hydrogen must have more than one)
- interaction between R groups

**Elaboration — 1 point**

- explanation of domains
- explanation of chaperones
4. (b) 4 points maximum

Global understanding of information flow — 1 point

- information in DNA is transcribed to mRNA which is translated into protein
- DNA contains the information that ultimately determines the sequence of amino acids in the protein

Roles

DNA — 1 point

- codes for RNA, mRNA, tRNA, or rRNA

mRNA — 1 point

- codes for amino acid sequence

tRNA — 1 point

- brings the correct amino acid to the ribosome/mRNA
- contains anticodon complementary to codon

rRNA — 1 point

- forms part of ribosome

Elaboration — 1 point

- intron removal by RNA/snRNP/snRNA
- alternative splicing provides protein diversity
- acts as ribozyme/involved in formation of peptide bond
- rRNA finds and binds start AUG of mRNA (in prokaryotes)

4. (c) 4 points maximum

Role in membrane structure — 2 points maximum

1 point — description of integral and/or peripheral proteins
1 point — membrane synthesis
1 point — defines membrane sidedness

Membrane function other than transport

1 point — receptors
1 point — enzymes
1 point — cell to cell communication
1 point — anchoring of cytoskeleton or extracellular matrix
1 point — spatial configuration of reaction pathways (e.g., electron transport system)
1 point — cell recognition
1 point — cell junctions
Role in transport — **3 points maximum**

1 point — transport proteins may be specific
1 point — process may require direct input of energy (e.g., use of ATP)
1 point — description of transport mechanisms (bind molecule, conformational change, release molecule) or description of how proteins form channels and move molecules through them

Elaboration — **1 point**

- **description** of a specific transport system (e.g., ATP synthase, Na⁺/K⁺ pump, receptor mediated endocytosis)
- **description** of chemiosmosis
- more than one molecule transported (e.g., symport, antiport)
- may be regulated by electrical or chemical stimuli (gated channels)