AP BIO Unit 2 Released FRQs

2017 #8

2017 AP® BIOLOGY FREE-RESPONSE QUESTIONS

8. Estrogens are small hydrophobic lipid hormones that promote cell division and the development of reproductive structures in mammals. Estrogens passively diffuse across the plasma membrane and bind to their receptor proteins in the cytoplasm of target cells.

   (a) **Describe** ONE characteristic of the plasma membrane that allows estrogens to passively cross the membrane.

   (b) In a laboratory experiment, a researcher generates antibodies that bind to purified estrogen receptors extracted from cells. The researcher uses the antibodies in an attempt to treat estrogen-dependent cancers but finds that the treatment is ineffective. **Explain** the ineffectiveness of the antibodies for treating estrogen-dependent cancers.

2017 #8 Answer Key

AP® BIOLOGY
2017 SCORING GUIDELINES

Question 8

Estrogens are small hydrophobic lipid hormones that promote cell division and the development of reproductive structures in mammals. Estrogens passively diffuse across the plasma membrane and bind to their receptor proteins in the cytoplasm of target cells.

(a) **Describe** ONE characteristic of the plasma membrane that allows estrogens to passively cross the membrane. **(1 point)**

Description (1 point)

- Hydrophobic/nonpolar
- Space between phospholipids

(b) In a laboratory experiment, a researcher generates antibodies that bind to purified estrogen receptors extracted from cells. The researcher uses the antibodies in an attempt to treat estrogen-dependent cancers but finds that the treatment is ineffective. **Explain** the ineffectiveness of the antibodies for treating estrogen-dependent cancers. **(2 points)**

Explanation (2 points)

- Antibodies are unable to enter the cell.
- (Extracellular) antibodies will not bind to (intracellular) estrogen receptors.

2013 #6

6. The following data were collected by observing subcellular structures of three different types of eukaryotic cells.

RELATIVE AMOUNTS OF ORGANELLES IN THREE CELL TYPES

Cell Type	Smooth ER	Rough ER	Mitochondria	Cilia	Golgi Bodies
X	Small amount	Small amount	Large number	Present	Small amount
Y	Large amount	Large amount	Moderate number	Absent	Large amount
Z	Absent	Absent	Absent	Absent	Absent

Based on an analysis of the data, **identify** a likely primary function of each cell type and **explain** how the data support the identification.

2013 #6 Answer Key

Question 6

The following data were collected by observing subcellular structures of three different types of eukaryotic cells.

RELATIVE AMOUNTS OF ORGANELLES IN THREE CELL TYPES

Cell Type	Smooth ER	Rough ER	Mitochondria	Cilia	Golgi Bodies
X	Small amount	Small amount	Large number	Present	Small amount
Y	Large amount	Large amount	Moderate number	Absent	Large amount
Z	Absent	Absent	Absent	Absent	Absent

Based on an analysis of the data, **identify** a likely primary function of each cell type and **explain** how the data support the identification. (**3 points maximum**)

Cell Type	**Identify function**		**Explain how data support identification (1 point each correct pair). NOTE: No points for identification without explanation.**		
X	• Locomotion • Movement / surface transport	**AND**	Has cilia for movement and large amounts of mitochondria to provide energy for locomotion of cell itself (ciliated protist) or movement of particles (mucus /oocyte) along cell surface		
Y	• Secretion / exocytosis • Protein synthesis	**AND**	Has large amounts of rough ER and Golgi to produce and package proteins		
	• Lipid/hormone synthesis • Detoxification	**AND**	Has large amounts of smooth ER to produce lipids / hormones		
Z	• Transport	**OR**	• Oxygen transport in animal cells • Water transport in plant cells	**AND**	Does not require these organelles
	• Protection	**OR**	• Epidermal cells (stratum corneum, cork, nails)	**AND**	
	• Support	**OR**	• Ground tissue (schlerenchyma) • Vascular tissue (xylem)	**AND**	
	• Storage	**OR**	• Maximizes volume / space available (hemoglobin, oxygen)	**AND**	
	• No function	**OR**	• Is a dead cell/is undergoing apoptosis	**AND**	

2011 #1

1. During an investigation of a freshwater lake, an AP Biology student discovers a previously unknown microscopic organism. Further study shows that the unicellular organism is eukaryotic.

   (a) **Identify** FOUR organelles that should be present in the eukaryotic organism and **describe** the function of each organelle.

   (b) Prokaryotic cells lack membrane-bound organelles found in eukaryotes. However, prokaryotes must perform many of the same functions as eukaryotes. For THREE of the organelles identified in part (a), **explain** how prokaryotic cells carry out the associated functions.

   (c) According to the endosymbiotic theory, some organelles are believed to have evolved through a symbiotic relationship between eukaryotic and prokaryotic cells. **Describe** THREE observations that support the endosymbiotic theory.

2011 #1 Answer Key

Question 1

During an investigation of a freshwater lake, an AP Biology student discovers a previously unknown microscopic organism. Further study shows that the unicellular organism is eukaryotic.

(a) **Identify** FOUR organelles that should be present in the eukaryotic organism and **describe** the function of each organelle.
(5 points maximum)

Identify organelle (1 point for listing FOUR)	**Describe corresponding function (1 point for each function)**
Nucleus	Contains hereditary information/DNA/chromosomes or is the site of RNA synthesis.
Ribosomes	Site of protein synthesis.
ER (endoplasmic reticulum)	Internal transport or compartmentalization.
Rough ER	Protein synthesis/packaging/transport.
Smooth ER	Lipid synthesis or detoxification or transport.
Mitochondria	ATP synthesis or aerobic/cellular respiration.
Chloroplasts, plastids	Light absorption/photosynthesis/carbohydrate synthesis.
Vacuole, vesicles	Storage or transport.
Cilia/flagella	Motility.
Basal bodies	Support cilia/flagella.
Centrioles	Assist chromosome movement in mitosis.
Golgi bodies	Protein modification/packaging/transport.
Lysosomes	Enzymatic hydrolysis of wastes/metabolites/pathogens.
Peroxisomes	Catalase/peroxidase function or detoxification.

(b) Prokaryotic cells lack membrane-bound organelles found in eukaryotes. However, prokaryotes must perform many of the same functions as eukaryotes. For THREE of the organelles identified in part (a), **explain** how prokaryotic cells carry out the associated functions.
(3 points maximum)

Eukaryotic organelle	**Explain how prokaryote carries out function (1 point each)**
Nucleus	Hereditary information/DNA/chromosomes or RNA synthesis in cytosol.
Ribosomes	Site of protein synthesis.
ER (endoplasmic reticulum)	Diffusion of molecules in cytosol.
Rough ER	Protein synthesis/transport in cytosol; may be linked to transcription.
Smooth ER	Lipid synthesis or detoxification occurs in cytosol.
Mitochondria	Other membranes or cytosolic molecules function in ATP synthesis.
Chloroplasts	Other membranes or cytosolic molecules function in light absorption/photosynthesis/carbohydrate synthesis.
Plastids	Pigments are distributed throughout cytosol or are associated with membranes.
Vacuole, vesicles	Inclusion bodies/granules/large molecules in cytosol.
Cilia or flagella	Motility via bacterial flagella.

Basal bodies	Other structures support flagella.
Centrioles	Enzyme-mediated chromosome movement.
Golgi bodies	Protein modification/packaging/transport in cytosol.
Lysosomes	Secreted enzymes hydrolyze wastes/metabolites/pathogens.
Peroxisomes	Production/secretion of catalase or detoxification.

(c) According to the endosymbiotic theory, some organelles are believed to have evolved through a symbiotic relationship between eukaryotic and prokaryotic cells. **Describe** THREE observations that support the endosymbiotic theory.
(4 points maximum)

Describe three observations (1 point each)

- Mitochondria contain their own DNA.
- Chloroplasts contain their own DNA.
- Mitochondria can self-replicate.
- Chloroplasts can self-replicate.
- Mitochondrial chromosomes are circular.
- Chloroplast chromosomes are circular.
- Mitochondrial chromosomes lack histones.
- Chloroplast chromosomes lack histones.
- Mitochondria contain ribosomes that are similar to bacterial ribosomes.
- Chloroplasts contain ribosomes that are similar to bacterial ribosomes.
- Inner membrane of mitochondria is similar the membrane of prokaryotes.
- Inner membrane of chloroplasts is similar the membrane of prokaryotes.
- Mitochondria can perform transcription and translation.
- Chloroplasts can perform transcription and translation.
- First amino acid in the polypeptides in mitochondria is fMet (N-formylmethionine).
- First amino acid in the polypeptides in chloroplasts is fMet (N-formylmethionine).
- Mitochondria are approximately the size of bacteria.
- Chloroplasts are approximately the size of bacteria.
- Mitochondria use many prokaryote-like enzymes.
- Chloroplasts use many prokaryote-like enzymes.
- Many antibiotics (e.g., rifampicin) interfere specifically with mitochondrial protein synthesis.

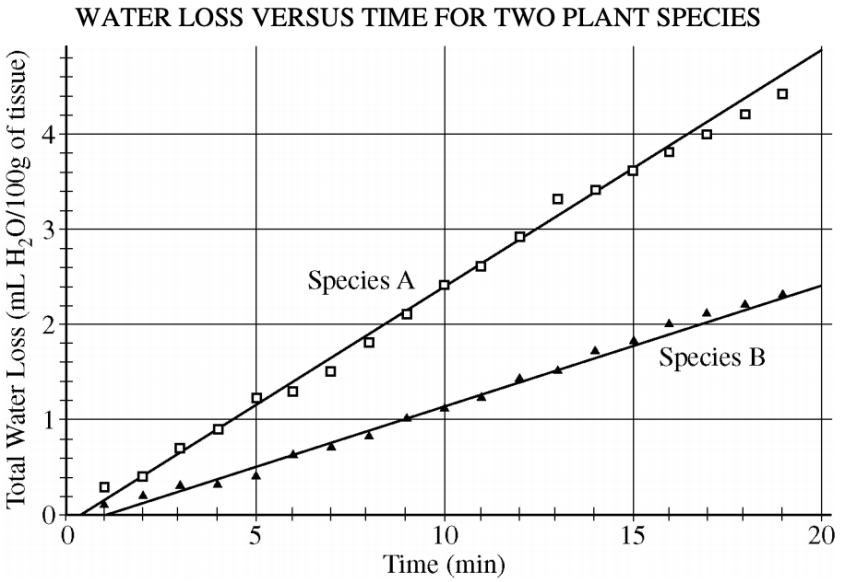
General description of endosymbiotic theory (1 point)

- Prokaryotic cells have been engulfed by and are living within ancestral/precursor eukaryotes.

2011 #4

4. The regulation of transpiration is an important homeostatic mechanism in plants.

   (a) Under controlled conditions, a transpiration experiment was conducted using two plant species. The data collected are shown in the figure below. Using the data from the experiment, **calculate** the rate of transpiration for species A and species B between the times of 5 and 15 minutes (show your work). **Summarize** the difference between the two transpiration rates.



   (b) **Identify** and **explain** THREE different structural or physiological adaptations that could account for the different transpiration rates of species A and B.

   (c) Water potential (Ψ) is described by the following formulas.

$$\Psi = \Psi_p + \Psi_s$$

$$\Psi = -iCRT$$

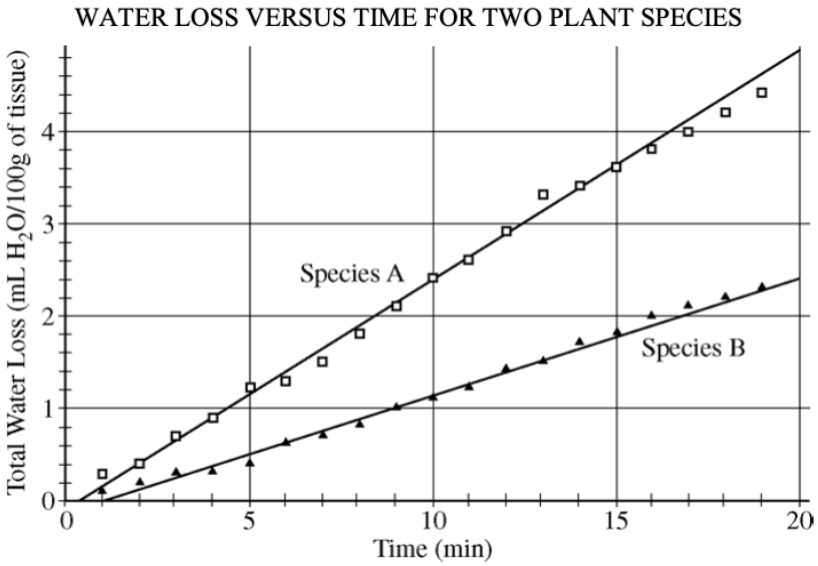
   Discuss the variables in both formulas and how they affect water potential.

2011 #4 Answer Key

Question 4

The regulation of transpiration is an important homeostatic mechanism in plants.

(a) Under controlled conditions, a transpiration experiment was conducted using two plant species. The data collected are shown in the figure below. Using the data from the experiment, **calculate** the rate of transpiration for species A and species B between the times of 5 and 15 minutes (show your work). **Summarize** the difference between the two transpiration rates.
(3 points maximum)



- Calculate transpiration rates, with units *(1 point each; 2 points maximum)*.
- Correct setups with incorrect results *(1 point maximum)*.

Species A
(1 point)

$\frac{3.6 \text{ mL } H_2O - 1.2 \text{ mL } H_2O}{15 \text{ minutes} - 5 \text{ minutes}} = 0.24 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

OR

$\frac{3.6 - 1.2}{15 - 5} = 0.24 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

OR equivalent

Question 4 (continued)

Species B
(1 point)

$\frac{1.8 \text{ mL } H_2O - 0.4 \text{ mL } H_2O}{15 \text{ minutes} - 5 \text{ minutes}} = 0.14 \text{ mL } H_2O/100g/min \ (\pm 0.02)$

OR

$\frac{1.8 - 0.4}{15 - 5} = 0.14 \text{ mL } H_2O/100g/min \ (\pm 0.02)$

OR equivalent

Summarize the difference between the rates *(1 point)*.

- Species A is losing water or transpiring faster than species B.

(b) **Identify** and **explain** THREE different structural or physiological adaptations that could account for the different transpiration rates of species A and B.
(6 points maximum)

Identify adaptation (1 point each; 3 points maximum)	**Explain effect and specify directionality (1 point each; 3 points maximum)**
Cuticle	Thicker cuticle decreases transpiration.
Stomata number	Increased number increases transpiration.
Stomata location	Underside location decreases transpiration.
Stomata size	Larger stomata increase transpiration.
Surface area of leaves	Increased surface area increases transpiration.
Root size or structure	Affects rate of water absorption, amount of water lost.
Root hairs	Increased number increases transpiration.
Leaf hairs	Presence decreases transpiration.
Stomatal crypts or recessed pits	Presence decreases transpiration.
C_3 photosynthesis	Requires more water than C_4.
C_4 photosynthesis: CO_2 concentrated as 4-carbon acid	Requires less water than C_3.
CAM photosynthesis: stomata open at night	Reduced water loss during day.
Abscissic acid	Closes the stomata, slows transpiration.
Guard cell regulation	Turgidity opens stomata, increasing transpiration.

Question 4 (continued)

(c) Water potential (Ψ) is described by the following formulas.

$$\Psi = \Psi_p + \Psi_s$$

$$\Psi = -iCRT$$

Discuss the variables in both formulas and how they affect water potential.
(4 points maximum)

Variables in $\Psi = \Psi_p + \Psi_s$		**Discussion of effect on water potential (1 point each; 2 points maximum)**
Ψ_p	Pressure potential	Water will move from the area of high pressure to the area of low pressure.
Ψ_s	Solute potential	Water will move from the area of high solute potential (low solute concentration) to the area of lower solute potential (higher solute concentration).

	Variables in $\Psi = -iCRT$	**Discussion of effect on water potential (1 point each; 2 points maximum)**
i	Ionization constant	Greater ionization decreases water potential/increases water movement, OR Decrease in ionization increases water potential/decreases water movement.
C	Concentration	Increase in concentration decreases water potential/increases water movement, OR Decrease in concentration increases water potential/decreases water movement.
R	Pressure constant	No change in water potential/movement.
T	Temperature	Increase in temperature decreases water potential/increases water movement, OR Decrease in temperature increases water potential/decreases water movement.

- Discussion stating that the formula allows osmotic potential or water movement to be calculated or predicted *(1 point)*.

2007 #1

1. Membranes are essential components of all cells.

   (a) **Identify** THREE macromolecules that are components of the plasma membrane in a eukaryotic cell and **discuss** the structure and function of each.

   (b) **Explain** how membranes participate in THREE of the following biological processes:

   - Muscle contraction
   - Fertilization of an egg
   - Chemiosmotic production of ATP
   - Intercellular signaling

2007 #1 Answer Key

Question 1

Membranes are essential components of all cells.

(a) **Identify** THREE macromolecules that are components of the plasma membrane in a eukaryotic cell and **discuss** the structure and function of each. **(6 points maximum; 1 point for each macromolecule + structure, 1 point for each macromolecule + function)**

NOTE: Only first three molecules mentioned will be scored.

Macromolecule	Structure	Function (must match selected macromolecule)
Phospholipids OR Lipid with phosphate	• Glycerol, two fatty acids, and polar head group w/phosphate • Amphipathic • Hydrophilic or polar (head) and hydrophobic or nonpolar (tails) • Forms a lipid bilayer	• Selectively permeable • Fluidity • Creates compartment/ separates cell from environment; barrier • Signals, inositol pathway (IP3) diacylglycerol (DAG)
Cholesterol	• Ring structure • Steroid • Amphipathic • Embedded in bilayer	• Moderates fluidity • Stabilizes membrane
Proteins OR <u>The following specific types must indicate that they are proteins</u> Integral Peripheral Pump Receptor Transport Recognition Tight junction Desmosomes Gap junctions Integrins Enzyme Channel	<u>General Structure</u> • Polypeptides; amino acids • 2°, 3°, 4° structure description <u>Specific Structure</u> • Integral, transmembrane, embedded; forms a channel • Peripheral, on surface • Structure fit to substrate or ligand	• Transport • Enzyme, catalysis • Signal transduction • Attachment: extracellular matrix (ECM)-cytoskeleton • Recognition • Cell junction
Glycolipid/Glycoprotein	• Carbohydrate (chains) linked to lipid/protein	• Cell recognition • Attachment to external molecule or another cell

Question 1 (continued)

(b) **Explain** how membranes participate in THREE of the following biological processes:
(6 points maximum; 2 points maximum per section)

Muscle contraction

- Motor neuron or axon terminal releases neurotransmitter or acetylcholine (ACh)
- ACh binds to receptors
- Depolarization or Na^+ moves in through membrane channels or membrane depolarizes
- Action potential propagates along cell membrane (sarcolemma) or T tubules
- Depolarization changes permeability of sarcoplasmic reticulum (SR) or Ca^{2+} released from SR
- Ca^{2+} active transport into SR (reuptake of Ca^{2+})
- Repolarization or maintenance of membrane potential (Na^+/K^+ pump)
- Smooth or cardiac muscle gap junctions directly transfer membrane potential between cells

Fertilization of an egg

- Part of the acrosomal reaction or sperm acrosome releases hydrolytic enzymes (by exocytosis)
- Sperm binds to receptors on egg
- Fusion of sperm and egg plasma membranes
- Change in membrane electrical charge or fast block (depolarization) to prevent further fertilization (polyspermy)
- Cortical reaction or slow block by exocytosis (prevents polyspermy) or "hardening" of membrane
- Separation of fertilization membrane (envelope)
- Fusion of egg and sperm nuclear membranes or nuclei

Chemiosmotic production of ATP

- Electron transport chain (ETC) in membrane pumps H^+ across membrane
- H^+ gradient established across membrane
- H^+ move through ATP synthase embedded in membrane to produce ATP
- Membrane infolding increases surface area

Intercellular signaling

- Release of chemical signals by exocytosis
- Receptors in membrane bind ligands or chemical signals or chemical signals pass through the membrane (examples: neurotransmitters, hormones, pheromones)
- Ligand-gated ion channels opening/closing
- Cascade of cellular events, including enzymatic reactions and second messengers (examples: G-proteins, cAMP, IP_3, Ca^{2+})
- Antibodies activate immune function
- Descriptions of gap junctions, plasmodesmata (communicating junctions)

2006 #1

1. A major distinction between prokaryotes and eukaryotes is the presence of membrane-bound organelles in eukaryotes.

   (a) **Describe** the structure and function of TWO eukaryotic membrane-bound organelles other than the nucleus.

   (b) Prokaryotic and eukaryotic cells have some non-membrane-bound components in common. **Describe** the function of TWO of the following and **discuss** how each differs in prokaryotes and eukaryotes.

   - DNA
   - Cell wall
   - Ribosomes

   (c) **Explain** the endosymbiotic theory of the origin of eukaryotic cells and **discuss** an example of evidence supporting this theory.

2006 #1 Answer Key

Question 1

A major distinction between prokaryotes and eukaryotes is the presence of membrane-bound organelles in eukaryotes.

(a) **Describe** the structure and function of TWO eukaryotic membrane-bound organelles other than the nucleus. **(4 points maximum)**

NOTE: One point is awarded for each bulleted item.

Organelle	Structure—1 point per box, Maximum—2 points	Function—1 point per box, Maximum—2 points
Mitochondria	• Indicate two membranes with either: - infolding of the inner membrane - cristae, or matrix	• cellular or aerobic respiration (Krebs, ETS) • production of ATP • release of chemical energy
Chloroplasts	• Indicate two membranes with either: - flattened sacs (thylakoids). - flattened stacks (grana). - stroma.	• photosynthesis or description of photosynthesis • production of 3-Carbon molecules (sugars, PGAL, glucose).
Endoplasmic Reticulum (ER)	• interconnected membranes, vesicles or sacs • rough ER has attached ribosomes and/or smooth ER without ribosomes	• synthesis of lipids (e.g., steroids) and/or proteins • detoxification of poisons, alcohol • transport • calcium signaling/storage If rough and smooth ER are the two named organelles • synthesis of proteins
Golgi apparatus	• series of flattened sacs	• modification of molecules • packaging molecules • processing molecules • vesicles (sacs) and their contents can be targeted for various locations in the cell and to its exterior
Lysosome	• vesicle (bag, sac) with enzymes	• digestion or breakdown of molecules waste materials and food with digestive enzymes (e.g., nucleases). • cell lysis • recycling organelles
Peroxisome (glyoxysomes)	• vesicle (bag, sac) with enzymes	• breakdown or detoxify free radicals or peroxides
Vacuoles	• vesicle (bag, sac)	• water balance • turgidity • storage water, ions, nutrients, or waste
Contractile vacuole	• vesicle (bag, sac)	• expulsion of water from cell
Vesicles	• sac (bag, sac)	• transporting materials to/from ER, Golgi, or cell membrane
Leucoplast	• Indicate two membranes with starch	• storing starch
Chromoplast	• Indicate two membranes with pigments	• storing pigments

2006 #1 Answer Key cont

Question 1 (continued)

(b) Prokaryotic and eukaryotic cells have some non-membrane-bound components in common. **Describe** the function of TWO of the following and **discuss** how each differs in prokaryotes and eukaryotes.

- DNA
- Cell wall
- Ribosomes

(4 points maximum)

Component	Function—1 point	Difference between Prokaryotes and Eukaryotes—1 point	
DNA	• contains, stores, or transmits genetic information • codes for proteins or traits	• single molecule • circular molecule • on avg. smaller number of base pairs (bp) • in cell's cytoplasm • few/no proteins* • no introns * *archaebacteria are an exception	vs. usually many molecules vs. linear molecule vs. 1,000 times the average number of prokaryote bp vs. within nucleus vs. histone proteins vs. introns
Cell wall	• protects • supports • maintains turgidity • maintains shape/ allows adherence	• Peptidoglycans (murein, amino acid, and sugar polymer)	vs. Cellulose and/or Chitin
Ribosome	• make protein • site of translation	• smaller • free in cytoplasm • simultaneous transcription/translation • contain different proteins, or RNAs • different antibiotic sensitivity	vs. larger vs. free and attached vs. non-simultaneous

(c) **Explain** the endosymbiotic theory of the origin of eukaryotic cells and **discuss** an example of evidence supporting this theory. **(2 points)**

Explain (1 point):
Prokaryotic cell was engulfed by another cell and formed a (symbiotic) relationship.

Evidence (1 point):

- Mitochondria and/or chloroplast contains own DNA.
- Mitochondria and/or chloroplast contains own ribosomes.
- Mitochondria and/or chloroplast contain double membrane.
- Mitochondria and/or chloroplast divides by binary fission.
- Mitochondria and/or chloroplast have a similar size to prokaryotic cells.

2006 B #2

2. The relationship of structure to function is one of the major themes in biology. For **three** of the following structure/function pairs, describe the structure and then explain how the function is related to the structure.
   (a) Enzyme structure/catalysis
   (b) mRNA structure/protein synthesis
   (c) Cell membrane structure/signal transduction
   (d) Membrane protein structure/active transport or facilitated diffusion

2006 B #2 Answer Key

Question 2

The relationship of structure to function is one of the major themes in biology. For **three** of the following structure/function pairs, describe the structure and then explain how the function is related to the structure.

(a) Enzyme structure/catalysis **(4 points maximum)**

Description (2 points)

- 3-D shape that results from folding of polypeptide chains
- Folding produces a pocket in which substrate may bind
- Levels of protein structure (primary, secondary, tertiary)

Explanation (2 points)

- Complementary 3-D shape of enzyme and substrate are required for proper interaction and catalysis in active site—reduction of activation energy; induced fit
- Allosteric modulation, effect of pH, temperature (or other environmental factors) on enzyme shape
- Elaboration points: competitive/non-competitive inhibition—effect on enzyme action; amino acid side groups in active site interact with substrate to stress bonds in substrate and reduce activation energy of reaction

(b) mRNA structure/protein synthesis **(4 points maximum)**

Description (2 points)

- Linear sequence of RNA nucleotides
- Details: 5' cap; poly-A tail; introns
- Description of origin and/or fate of mRNA (transcription, processing and translation)
- Fine details of RNA nucleotide structure

Explanation (2 points)

- The linear sequence of RNA nucleotides, read as codons (three at a time; contiguous; nonoverlapping)
- specify the sequence of amino acids incorporated in a new protein being constructed at a ribosome
- start codon and/or stop codon roles

(c) Cell membrane structure/signal transduction **(4 points maximum)**

Description (2 points)

- A phospholipid bilayer that incorporates malleable (and, often, mobile) integral or membrane associated proteins
- Membrane-embedded receptor molecules with transmembrane domains

Explanation (2 points)

- Receptor proteins undergo shape changes when proper stimulus is present—signal is communicated through membrane by allosteric shape change
- The altered proteins may then influence other cellular events or states: activation of G-proteins and/or tyrosine-kinase receptor protein auto- and heterophosphorylations leading to cellular response

Question 2 (continued)

(d) Membrane protein structure/active transport or facilitated diffusion **(4 points maximum)**

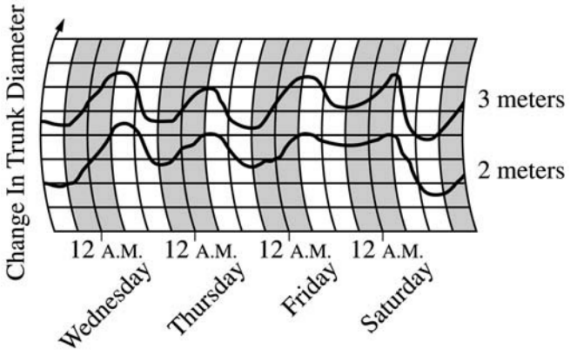
Description (2 points)

- Phospholipid bilayer (credited unless already described in c)
- Integral protein in membrane
- Protein's 3-D shape allows it to act as a channel, bind solutes, and/or bind ATP, as necessary

Explanation (2 points)

- Some solutes, like ions and larger hydrophobic molecules cannot cross phospholipid membranes unassisted.
- Integral proteins allow such substances to pass: hydrophilic channel; binding of solute leads to shape change in protein.
- Hydrolysis of ATP causes shape change in protein leading to shuttle of material from one side of membrane to the other.

2006 B #3



3. While studying transpiration, a scientist used a dendrometer to record the small daily changes in the diameter of a tree trunk at two different heights (2 meters and 3 meters) above the ground at the same time. The diameter decreased in the daytime. This decrease happened first at the higher location. Discuss the following in relation to water movement in plants.

   (a) Identify how **two** different environmental factors could be involved in the daily fluctuations shown above.

   (b) Discuss the mechanisms involved in the uptake and transport of water by vascular plants.

   (c) Discuss the role of water in the normal functioning of plants.

2006 B #3 Answer Key

Question 3

While studying transpiration, a scientist used a dendrometer to record the small daily changes in the diameter of a tree trunk at two different heights (2 meters and 3 meters) above the ground at the same time. The diameter decreased in the daytime. This decrease happened first at the higher location. Discuss the following in relation to water movement in plants.

(a) Identify how **two** different environmental factors could be involved in the daily fluctuations shown above. (**4 points maximum**; 2 points for each factor correctly associated with a mechanism)

Factor	How
Humidity	Humidity down ➔ Transpiration up ➔ Decreases diameter Humidity up ➔ Transpiration down ➔ Increases diameter
Sunlight	Sunlight up ➔ Transpiration up (stoma open) ➔ Decreases diameter Sunlight down ➔ Transpiration down (stoma close) ➔ Increases diameter
Temperature	Temperature up ➔ Transpiration up ➔ Decreases diameter Temperature down ➔ Transpiration down ➔ Increases diameter
Wind	Wind up ➔ Transpiration up ➔ Decreases diameter Wind down ➔ Transpiration down ➔ Increases diameter
Ground water	Transpiration removes water faster than roots pick it up ➔ Decreases diameter

(b) Discuss the mechanisms involved in the uptake and transport of water by vascular plants. **(4 points maximum)**

Uptake (2 points maximum)	Transport (2 points maximum)
• Root hairs or mycorrhizae increase surface area • Osmotic adjustment in roots, water flows in due to gradient • Aquaporin moves water in • Water potential moves water in	• Transpiration pull when water exits leaves • Creates negative pressure (tension) • Cohesion of water in xylem/column of water • Adhesion of water in xylem/column of water

Question 3 (continued)

(c) Discuss the role of water in the normal functioning of plants (**4 points maximum**; 2 points for each role correctly associated with a function, 1 point for function alone)

Role (2 points maximum)	Function (2 points maximum)
• Photosynthesis (photolysis) • Transport • Structure • Solvent • Reproduction • Change in guard cells • Growth	• e- in electron transport, H+ in ATP synthesis • movement of nutrients and ions • Turgor (vacuole)/support • Media of chemical reactions • Mosses/ferns fertilization by sperm • Water intake increases turgor ➔ guard cells open • Needed for cell elongation

2005 #2

2. The unit of genetic organization in all living organisms is the chromosome.

   (a) **Describe** the structure and function of the parts of a eukaryotic chromosome. You may wish to include a diagram as part of your description.

   (b) **Describe** the adaptive (evolutionary) significance of organizing genes into chromosomes.

   (c) How does the function and structure of the chromosome differ in prokaryotes?

2005 #2 Answer Key

Question 2

Part A (5 points maximum)		
Component	**Structure: 1 point/component**	**Function: 1 point/component**
Chromatids	2/sister/pair/identical DNA/genetic information	Distribution of one copy to each new cell
Centromere	Noncoding/uncoiled/narrow/constricted region/determines arm ratio	Joins/holds/attaches chromatids together
Nucleosome concept	Histones, DNA wrapped around special proteins	Packaging compacting
Chromatin form (heterochromatin/ euchromatin)	Condensed/supercoiled → Loosely coiled →	Proper distribution in cell division (not during replication) Gene expression during interphase/replication occurs when loosely packed
Kinetochores	Disc-shaped proteins	Spindle attachment/alignment
Genes or DNA	Brief DNA description	Codes for proteins or for RNA
Telomeres	Tips, ends, noncoding repetitive sequences	Protection against degradation/ aging, limits number of cell divisions

NOTE:

- No points for just naming the component.
- No points for stating that chromosomes are made of genes.
- A diagram alone will not suffice but can be used for clarification.

Question 2 (continued)

Part B (4 points maximum, 2 points per theme)	**Part C** (4 points maximum)

• allows for **genetic variation**
  o through independent assortment (brief description)
  o through crossing over (brief description)
  o leads to variation in gametes
• allows for **genetic stability**
  o efficiency of transfer of genetic information
  o prevents loss of genetic information
  o offspring get same number of chromosomes
  o maintains integrity of chromosomes
  o linked genes tend to be inherited together
• allows for **gene regulation**
  o increased complex structure
  o histone acetylating
  o methylation
• allows for **complexity**
  o allows for more genes
  o evolution of new genes can occur/transposons
  o intron/exon allows for alternate splicing
• allows for **diploid/polyploid**
  o genetic fitness
  o minimizes the effect of harmful alleles/backup copy
  o extra set(s) of alleles
  o heterozygosity
	• **shape** (circular/nonlinear/loop)
	• **less complex** (no histones/less elaborate structure/folding)
	• **size** (smaller size/less genetic information/fewer genes)
	• **replication method** (single origin of replication/theta replication)
	• transcription/translation may be coupled
	• generally few or no **introns** (noncoding)
	• majority of genome expressed
	• **operons**—gene regulation
	
	No points for plasmids—more common but not unique to prokaryotes/not part of prokaryote chromosome.

2005 B #4

4. Water potential in potato cells was determined in the following manner. The initial masses of six groups of potato cores were measured. The potato cores were placed in sucrose solutions of various molarities. The masses of the cores were measured again after 24 hours. Percent changes in mass were calculated. The results are shown below.

Molarity of Sucrose in Beaker	Percent Change in Mass
0.0 *M*	18.0
0.2	5.0
0.4	-8.0
0.6	-16.0
0.8	-23.5
1.0	-24.0

(a) Graph these data on the axes provided. From your graph, find the apparent molar concentration (osmolarity) of the potato core cells.

(b) What are the components of water potential, and why is water potential important for the movement of water in plants?

(c) Predict what would happen to typical animal cells placed in 0.0 *M* and 1.0 *M* sucrose solutions, and explain your prediction.

2005 B #4 Answer Key

Question 4

Part (a) (3 points maximum)

- Orientation of axes, labels, scales, units.
- Data points (one mistake permitted) and line drawn.
- Determine molar concentration of potato cells. (Note: This point must be read from graph. It should fall into the range of 0.25 to 0.4 *M*.)

Part (b) (4 points maximum)

Components of water potential (1 point maximum)

- Pressure potential AND solute/osmotic potential/($\psi = \psi_p + \psi_s$)

Importance of water potential/as related to water movement (3 points maximum)

- Ensures water moves into plant root.
- Helps movement of water within plant.
- Factor involved in transpiration.
- Cell wall allows for increased pressure (turgor pressure).
- Pressure might counteract osmolarity.

Part (c) (4 points maximum)

	Prediction	**Explanation**	
0.0 *M*	Gain water/mass Swell/burst/lyse	• Cell is hypertonic to sucrose solution. • Sucrose solution is hypotonic to cell. • Water potential is greater in 0.0 *M* environment. • No cell wall. • Cell moving toward equilibrium (isotonic).	2 points maximum
1.0 *M*	Lose water/mass Shrivel/crenate	• Cell is hypotonic to sucrose solution. • Sucrose solution is hypertonic to cell. • Water potential is greater inside animal cell. • Cell moving toward equilibrium (isotonic).	2 points maximum