BRVGS AP Biology Review Packet 5.4.20

Dear BRVGS AP Biology Students,

As we head into the last 2 weeks prior to the May 18 AP Biology test, you have 2 final review assignments that **need to be completed by Sunday, May 17th.**

Assignment 1

The first assignment is to complete the Science Practices - AP Test Review Sheet.

Assignment 2

For your second assignment, you need to complete whichever ONE of the following assignments below that you have NOT yet done. (As a reminder, these were the choice activities that were sent out in the first AP Biology packet on April 3rd)

Option 1: **FRQ Activity**: Part 1: Long FRQ and Part 2: Short FRQs

(Note: this counts as ONE activity)

Option 2: **Unit 1-6 Cheat Sheet Competition** (this can be used for the AP test)

Option 3: **Tying Evolution To All Six Units**

If you need a printed copy of the formula sheet for the AP Biology Exam, please contact Ms. Bunovich at kbunovich@brvgs.k12.va.us or by phone at 804-787-0886 to have one mailed to you.

Please contact your BRVGS AP Biology teacher and Mr. Carraway at mcarraway@brvgs.k12.va.us for any questions.

BRVGS AP Biology Review Packet 5.4.20

AP Biology - Science Practices Review

Directions: A huge part of being able to succeed in AP Biology (as well as being a scientifically literate person!) involves being able to analyze data and apply critical-thinking skills. The following questions will help you prepare for the upcoming AP exam by applying the skills you have acquired this year.

Please use ***complete sentences*** to answer each question. Answer them the same way you would on the Free Response section of the AP exam -- outlines, bulleted lists, or diagrams alone are not acceptable.

Part 1 - Experimental Scenarios

Scenario #1

A student investigated whether ants dig more tunnels in the light or in the dark. She thought that ants used the filtered light that penetrated the upper layers of earth and would dig more tunnels during the daytime.

Ten ant colonies were set up in commercial ant farms with the same number and type of ants per ant farm. The same amount of food was given to each colony, and the colonies were at the same temperature. Five of the colonies were exposed to normal room light and five were covered with black construction paper so they did not receive light. Every other day for three weeks the length of the tunnels was measured in millimeters using a string and a ruler. Averages for the light and dark groups were calculated and can be found in **Figure 1** below.

Figure 1. Length of Tunnels (mm) Constructed by Ants in Different Light Conditions

Day	Light - Average Tunnel Length (mm)	Dark - Average Tunnel Length (mm)
1	5	7
3	10	15
5	20	25
7	26	32
9	32	47
11	50	62
13	61	93
15	66	110
17	90	115
19	95	120
21	103	136

BRVGS AP Biology Review Packet 5.4.20

Scenario #1 Questions

a) Identify the problem being studied.

b) List three observations based on the data.

c) Come up with a question that describes the experiment.

d) Construct a hypothesis and a null hypothesis (look up the definition if needed!).

e) Write a short procedure as to how this experiment was conducted.

f) Identify the independent variable and dependent variable.

g) Describe the control group. Why is this important to the validity of the experiment?

h) List the experimental group(s).

Scenario #2

A student investigated the effect of aged-grass compost (fertilizer made from decaying plant material) on the growth of bean plants. She thought that the compost would provide extra nutrients and make plants grow faster.

Thirty bean seeds were divided into three groups and planted in different flats (boxes). All seeds germinated after 12 days and were allowed to grow for five days. The flats were all given the same amount of water and the same amount of light. Flat A was then fertilized with 3-month old compost; Flat B was given 6-month old compost; and Flat C was given no compost. At the end of 14 days the height of each plant was measured in centimeters.

Figure 2. Final Heights of Bean Plants (cm)

Final Plant Heights (cm) - Flat A	Final Plant Heights (cm) - Flat B	Final Plant Heights (cm) - Flat C
7.6	10.1	6.5
5.4	9.5	7.2
8.2	12.1	8.4
9.3	13.0	11.0
8.2	8.5	6.9
6.9	13.1	6.8
7.3	12.4	6.3
9.4	11.6	10.7
10.2	14.8	9.9
12.0	10.8	10.6

Scenario #2 Questions

a) Identify the problem being studied.

b) List three observations based on the data.

c) Come up with a question that describes the experiment.

d) Construct a hypothesis and a null hypothesis (look up the definition if needed!).

e) Write a short procedure as to how this experiment was conducted.

f) Identify the independent variable and dependent variable.

g) Describe the control group. Why is this important to the validity of the experiment?

h) List the experimental group(s).

Part 2 - Scientific Analysis

Scientific Analysis #1

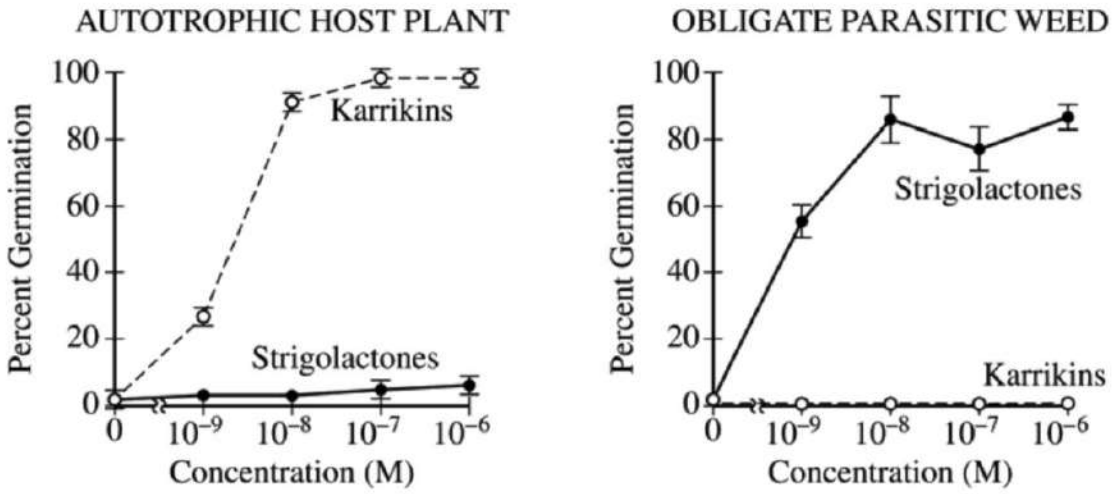


Figure 1. Effect of karrikins and strigolactones on seed germination in an autotrophic host plant and its obligate parasitic weed

Background: Karrikins and strigolactones are two groups of chemical compounds that can affect seed germination in certain species of plants. After their seeds germinate, many species of autotrophic plants also release strigolactones from their roots into the soil, which promotes the uptake of nutrients.

The graphs above represent the results of a laboratory experiment to test the effect of different concentrations of strigolactones or karrikins on the seed germination of two types of plants: an autotrophic host plant and an obligate parasitic weed that infects the host plant.

a) **Identify** the independent and dependent variables of this experiment.

b) **Identify** the concentration of karrikins that will lead to 50% seed germination in autotrophic host plants.

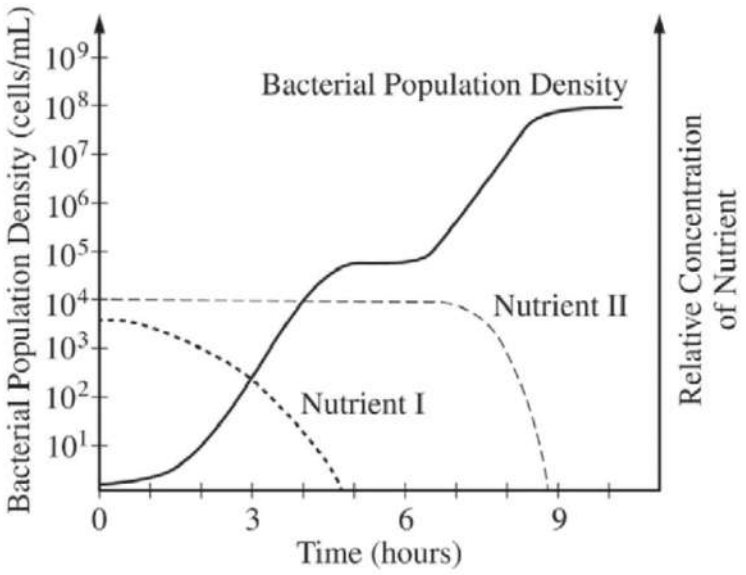
c) **Describe** how each of the two types of plants respond as the concentration of karrikins increases.

d) **Describe** how each of the two types of plants respond as the concentration of strigolactones increases.

e) **Identify** the plant that seems to have had the most variability in their germination rates above 80%, and **support** your response with specific examples from the graphs. (HINT: look at the error bars)

f) A researcher proposes that the obligate parasitic weed requires exposure to a signal from the host plant before it can germinate. Using specific examples from the data in the graphs, either **support** or **refute** this researcher's claim.

Scientific Analysis #2



Background: Bacteria can be cultured successfully if the right concentrations of nutrients are present. The graph above shows the population density of bacteria in a medium with two types of nutrients, I and II.

a) **Explain** why there are labels on both the left and right sides of the graph.

b) **Identify** the independent and dependent variables of this experiment.

c) **Propose** a title for the above graph.

d) **Predict** the bacterial population density if the experiment was allowed to continue to hour 15. **Justify** your prediction.

e) **Calculate** the average population growth rate in cells/mL/hour from hour 2 to hour 4 (hint: you don't really need a calculator to answer this question!).

f) A researcher claims that the bacterial species being studied does not show a preference for either nutrient I or II and will grow equally under either condition. Using specific examples from the data in the graphs, either **support** or **refute** this researcher's claim.

Scientific Analysis #3

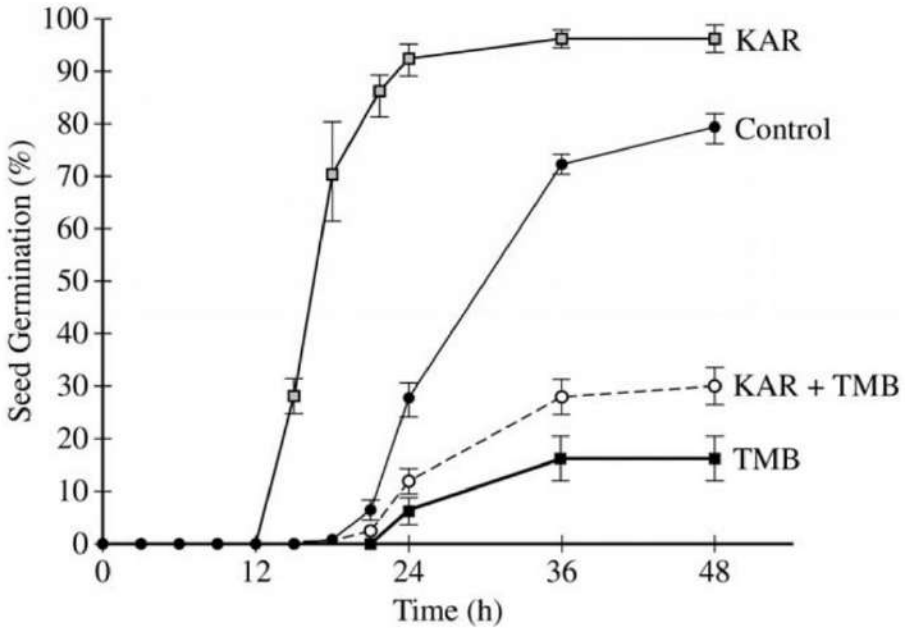


Figure 1. The effect of karrikins (KAR) and trimethylbutenolides (TMB) on seed germination in *Lactuca* plants. Error bars represent $\pm 2SE_{\bar{x}}$.

Background: Fires frequently occur in some ecosystems and can destroy all above-ground vegetation. Some plants, including those in the *Lactuca* genus (lettuce is an example), can respond to chemical compounds in smoke in order to recover after a fire. Karrikins (KAR) and trimethylbutenolides (TMB) are chemicals found in the smoke given off from burning vegetation, and can bind to receptors in plant seeds.

A study to see how plants grow after a major fire was conducted. Researchers recorded the timing and percent of seed germination in the presence of different combinations of KAR and TMB. These results are showing in the graph above (Figure 1).

a) **Identify** the conditions that were mostly likely used as a control group in this experiment.

b) **Estimate** the ratio of the maximum seed germination % of seeds exposed to control conditions compared to the maximum seed germination of seeds exposed to KAR + TMB.

c) Using the data in Figure 1 above, **provide** specific support for each of the following claims:

i) KAR alone affects timing of seed germination

ii) KAR alone affects percentage of seeds that germination

iii) TMB alone affects timing of seed germination

iv) TMB alone affects percentage of seeds that germination

d) **Propose** and **justify** a claim about how *both* KAR and TMB affect the timing and percentage of seed germination. Use the data in Figure 1 to support your answer.

e) In Figure 1, the second KAR data point (at 18 hours, 70% germination) has much higher error bars than any other data point. Is this a problem? **Justify** your response based on your analysis of the data.

Scientific Analysis #4

Background: Feline High-Rise Syndrome (FHRS) is the term used in medical cases of cats falling from balconies or windows of high-rise buildings in urban areas. The cause of the fall in most cases happens during play, when the animal jumps from the window or over the balcony, when chasing a bird or insect, or it slips while walking on the edge of the balcony, railing or window.

This begs the essential question:

How do the number of injuries per cat relate to the number of stories a cat falls?

Good news, we have data:

Number of Stories Fallen	Number of Total Injuries Per Cat	Number of Cats Per Stories Fallen
1	0.00	0
2	0.75	8
3	1.00	14
4	1.60	27
5	2.00	34
6	2.30	21
7-8	2.40	9
9-32	1.10	13

a) Make a scientific **claim** that answers the essential question (see background).

b) Support your claim with **evidence** from biological concepts, processes, and/or data.

c) Provide **reasoning** to justify why it supports your claim.

d) Explain the **relationship** between the results shown and larger biological concepts, processes, or theories. In other words, what is the relationship between the experimental data and our broader understanding of biology (specifically feline biology!).

Scientific Analysis #5

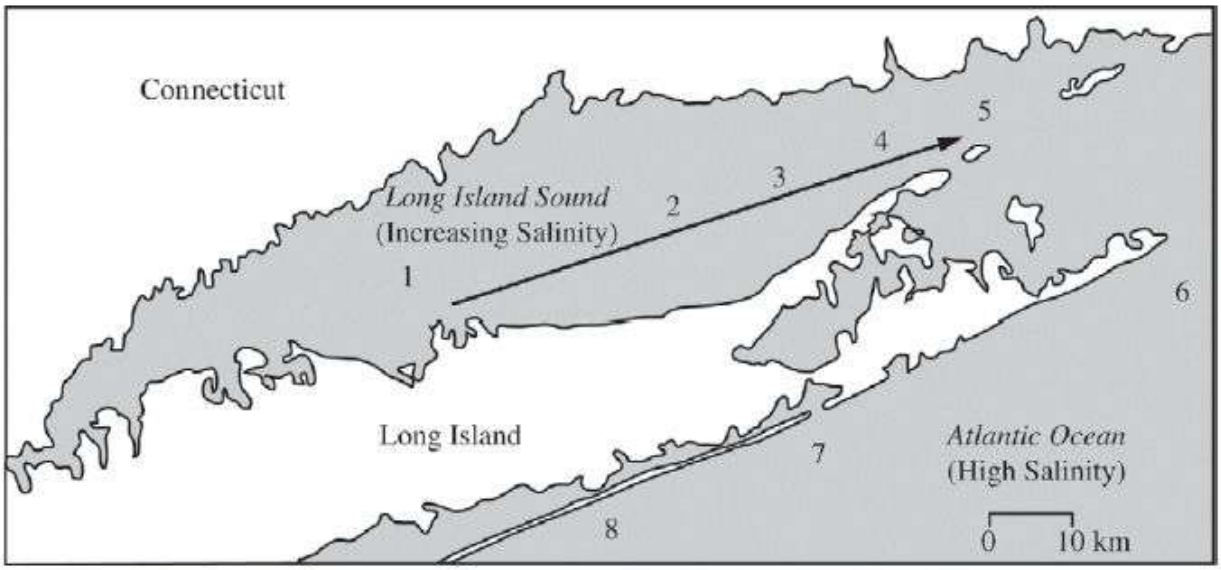


Figure 1. Sampling sites of marine mussels at various locations (1–8) in Long Island Sound and the Atlantic Ocean

TABLE 1. PERCENT OF INDIVIDUALS POSSESSING *lap*^{94} ALLELE

	Long Island Sound					Atlantic Ocean		
Site	1	2	3	4	5	6	7	8
lap^{94} frequency (%)	13	16	25	37	55	59	59	59
Salinity	Low →				High	High		

Background: Leucine aminopeptidases (LAPs) are found in all living organisms and have been associated with the response of the marine mussel, *Mytilus edulis*, to changes in salinity. LAPs are enzymes that remove N-terminal amino acids from proteins and release the free amino acids into the cytosol. To investigate the evolution of LAPs in wild populations of *M. edulis*, researchers sampled adult mussels from several different locations along a part of the northeast coast of the United States, as shown in Figure 1. The researchers then determined the percent of individuals possessing a particular lap allele, *lap*^{94}, in mussels from each sample site (table 1).

a) Based on the data, **describe** the most likely effect of salinity on the frequency of the *lap*^{94} allele in the marine mussel populations in Long Island Sound.

b) **Predict** the likely *lap*^{94} allele frequency at a sampling site between site 1 and site 2 in Long Island Sound and **justify** your prediction.

c) **Propose** a null hypothesis and an alternative hypothesis that explains the relationship between salinity and expression of the *lap*^{94} allele.

d) Calculate the average *lap*^{94} frequency % marine mussel populations in Long Island Sound.

e) Would we expect to see similar data for *lap*^{94} allele frequency if freshwater mussels were being tested instead of saltwater mussels? **Justify** your prediction (it might help to look back to your answer for part a or c).

Assignment 2 - Option 1 - Part 1 of 2

The Long FRQ

1) On a piece of paper, brainstorm all the information you should put in your answer in relation to this question. 2) Time yourself: Allow for a maximum of nine minutes. (Roughly two minutes to read and seven to brainstorm a response)

Question 1 (#1 in image)

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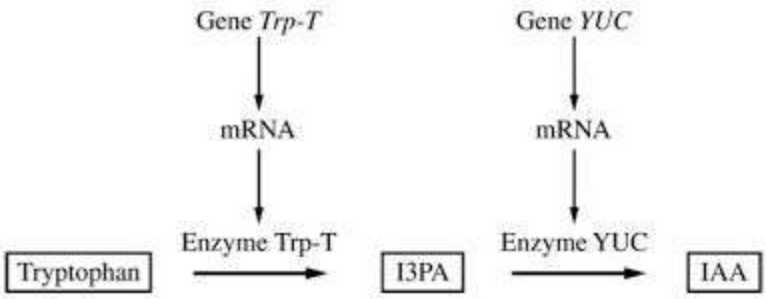

Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan

1. Auxins are plant hormones that coordinate several aspects of root growth and development. Indole-3-acetic acid (IAA) is an auxin that is usually synthesized from the amino acid tryptophan (Figure 1). Gene *Trp-T* encodes an enzyme that converts tryptophan to indole-3-pyruvic acid (I3PA), which is then converted to IAA by an enzyme encoded by the gene *YUC*.

   (a) **Circle** ONE arrow that represents transcription on the template pathway. **Identify** the molecule that would be absent if enzyme YUC is nonfunctional.

   (b) **Predict** how the deletion of one base pair in the fourth codon of the coding region of gene *Trp-T* would most likely affect the production of IAA. **Justify** your prediction.

   (c) **Explain** one feedback mechanism by which a cell could prevent production of too much IAA without limiting I3PA production.

   (d) Rhizobacteria are a group of bacteria that live in nodules on plant roots. Rhizobacteria can produce IAA and convert atmospheric nitrogen into forms that can be used by plants. Plants release carbon-containing molecules into the nodules. Based on this information, **identify** the most likely ecological relationship between plants and rhizobacteria. **Describe** ONE advantage to the bacteria of producing IAA.

   (e) A researcher removed a plant nodule and identified several "cheater" rhizobacteria that do not produce IAA or fix nitrogen. **Describe** the evolutionary advantage of being a bacterial cheater in a population composed predominantly of noncheater bacteria. Plants can adjust the amount of carbon-containing molecules released into nodules in response to the amount of nitrogen fixed in the nodule. **Predict** the change in the bacterial population that would cause the plant to reduce the amount of carbon-containing molecules provided to the nodule.

Before going to the next step: Answer the question of "Did you do all the words in BOLD in the question?"

2) Take the attached Scoring Guidelines and take three minutes to score yourself.

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2019 SCORING GUIDELINES

Question 1

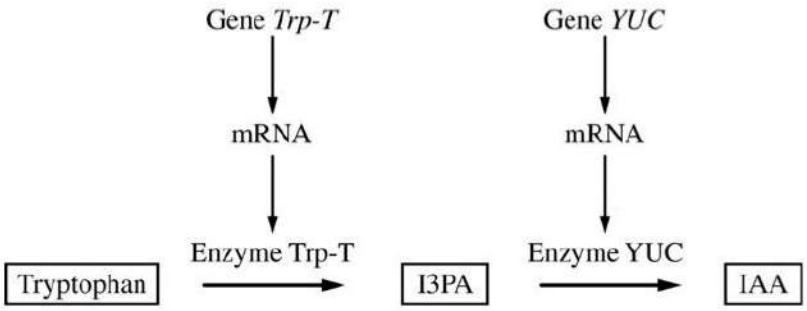

Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan

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(a) **Circle** ONE arrow that represents transcription on the template pathway. **Identify** the molecule that would be absent if enzyme YUC is nonfunctional.

Circle (1 point)

- Circle around either arrow pointing from a gene (*Trp-T* or *YUC*) to mRNA

Identification (1 point)

- IAA

(b) **Predict** how the deletion of one base pair in the fourth codon of the coding region of gene *Trp-T* would most likely affect the production of IAA. **Justify** your prediction.

Prediction (1 point)

- Reduction in IAA production OR No production of IAA

Justification (1 point)

- The mutation will result in the translation of an inactive/nonfunctional Trp-T enzyme.
- The mutation will result in no translation of the Trp-T enzyme.
- The mutation will result in no/reduced production of I3PA.

(c) **Explain** one feedback mechanism by which a cell could prevent production of too much IAA without limiting I3PA production.

Explanation (2 points)

- Negative feedback/feedback inhibition/increasing amounts of IAA inhibits the pathway.
- Production of YUC enzyme is inhibited OR YUC enzyme activity is inhibited.

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2019 SCORING GUIDELINES

Question 1 (continued)

(d) Rhizobacteria are a group of bacteria that live in nodules on plant roots. Rhizobacteria can produce IAA and convert atmospheric nitrogen into forms that can be used by plants. Plants release carbon-containing molecules into the nodules. Based on this information, **identify** the most likely ecological relationship between plants and rhizobacteria. **Describe** ONE advantage to the bacteria of producing IAA.

Identification (1 point)

- Mutualism

Description (1 point)

- Increases habitat/number of nodules for the rhizobacteria.
- The bacteria receive carbon/carbon-containing molecules (as a result of increased plant growth).

(e) A researcher removed a plant nodule and identified several "cheater" rhizobacteria that do not produce IAA or fix nitrogen. **Describe** the evolutionary advantage of being a bacterial cheater in a population composed predominantly of noncheater bacteria. Plants can adjust the amount of carbon-containing molecules released into nodules in response to the amount of nitrogen fixed in the nodule. **Predict** the change in the bacterial population that would cause the plant to reduce the amount of carbon-containing molecules provided to the nodule.

Description (1 point)

- Cheaters/bacteria that benefit without producing IAA/fixing nitrogen have more energy for reproduction.

Prediction (1 point)

- Decrease in the nitrogen-fixing/noncheater bacteria
- Decrease in the amount of nitrogen fixed (by bacteria)

3) What score did you give yourself?

4) Give yourself a total of 12 minutes and Score the three students sample work. Write the scores you gave them down on your piece of paper.

STUDENT A

PAGE FOR ANSWERING QUESTION 1

1A1

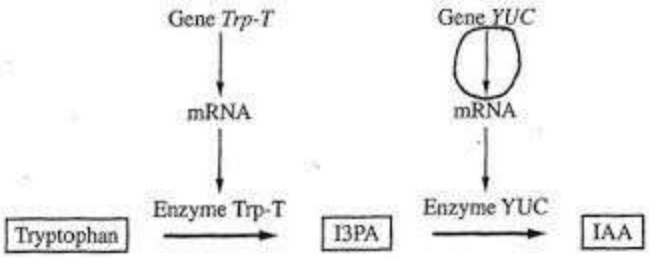

Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan

a) See diagram for circled arrow. If Enzyme YUC is nonfunctional, IAA will be absent.

b) The described deletion would likely significantly reduce IAA production. This is because a deletion of a base pair in a gene often causes a frame shift, which alters all subsequent codons in the gene. As the corresponding mRNA is translated, the altered codons append different amino acids than intended, resulting in a Trp-T Enzyme that is non-functional due to a differing primary structure.

c) To limit IAA production without limiting I3PA production, a cell would need a negative feedback loop that prevents Enzyme YUC availability in the presence of excess IAA. An example could consist of epigenetic markers produced in the presence of IAA that prevent transcription of the YUC gene, temporarily halting Enzyme YUC production.

d) The most likely ecological relationship between the plants & the rhizobacteria is mutualism. An advantage for the bacteria producing IAA is that the host roots will grow & develop in the presence of the IAA auxin, expanding the bacteria's habitat & ensuring the survival of the plant on which it depends.

e) Bacterial cheaters have an evolutionary advantage because they expend less energy

STUDENT B

1B1

PAGE FOR ANSWERING QUESTION 1

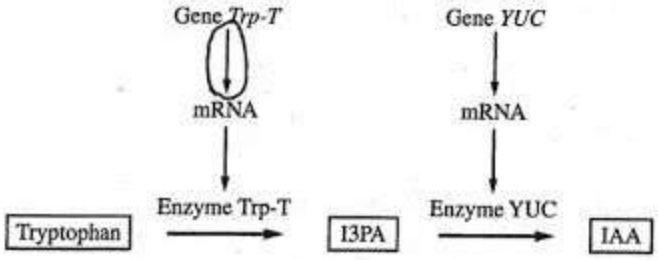

Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan

a.) The molecule that would be absent would be IAA.

b.) The deletion of one base pair could lead to the enzyme Trp-T to not be produced properly or at all blc the deletion would affect the coding region of the gene, which would change the amino acid sequence, which would alter the protein that is produced after translation. IAA would not be produced blc the Enzyme Trp-T would not be usable or produced, so tryptophan cannot become I3PA which cannot be converted to IAA.

c.) The cell could turn of the Gene YUC which would not create the Enzyme YUC which would mean I3PA could not be converted to IAA.

STUDENT C

1C1

PAGE FOR ANSWERING QUESTION 1

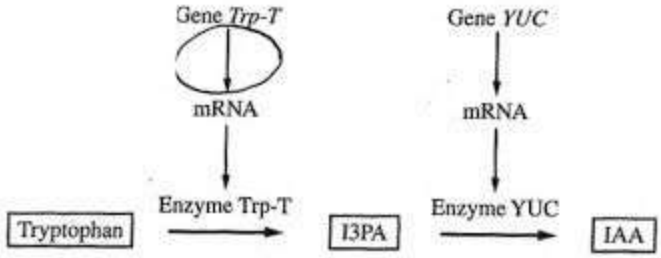

Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan

a) The molecule that would be absent if enzyme YUC is nonfunctional is indole-3-acetic acid (IAA).

b) The deletion of one base pair in the fourth codon of the coding region of gene Trp-T could stop the production of IAA. This is because a deletion of one base-pair can lead to a frameshift mutation, causing a different enzyme to probably be produced. If enzyme Trp-T is no longer produced by gene Trp-T, then I3PA cannot be made, which means nothing is available to be converted into IAA.

c) One feedback mechanism could be limiting the production of enzyme YUC. Without enough enzymes YUC, I3PA will not be able to be converted to IAA even if there are many (a lot of) of I3PA.

5) Use the Scoring document below to compare how you scored the student responses with College Board scored them. Answer the question below on your paper.

- **Student A: How did your score compare? If yours was different, why?**
- **Student B: How did your score compare? If yours was different, why?**
- **Student C: How did your score compare? If yours was different, why?**

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2019 SCORING COMMENTARY

Question 1

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

This question is based on a two-step enzymatic pathway in plants for the synthesis of the growth hormone indole-3-acetic acid (IAA) from the amino acid tryptophan. Students were provided with a model showing this pathway, including transcription and translation leading to production of the two enzymes needed for this pathway. The students were asked to interpret the model by circling an arrow on the diagram that represented the process of transcription and to identify the molecule that would be absent if one of the enzymes was nonfunctional. Students were then asked to apply concepts of gene mutation to predict the outcome of a specific mutation in the gene encoding one of the enzymes. The students were also asked to justify their prediction. Next, the students were asked to use their understanding of gene expression to explain a feedback mechanism that could lead to a reduction of one of the products of the pathway without affecting the production of an intermediate in the pathway. Students then considered ecological interactions involving populations of bacteria that live in root nodules of plants and produce IAA and fix nitrogen. Students were told that the plants release carbon-containing compounds into the nodule. Based on this information, students were asked to describe the type of symbiosis that occurs between the plant and bacterial species. Lastly, students were asked to describe the evolutionary advantage to "cheater" bacteria that did not produce IAA or fix nitrogen and to predict conditions in the bacterial population that would cause the plants to reduce the amount of carbon compounds released in the root nodules.

Sample: 1A
Score: 10

The response earned 1 point in part (a) for circling the arrow pointing from Gene *YUC* to mRNA. The response earned 1 point in part (a) for identifying that IAA would be absent. The response earned 1 point in part (b) for predicting that the deletion would "reduce IAA production." The response earned 1 point in part (b) for justifying that the deletion would result in a "Trp-T enzyme that is non-functional." The response earned 1 point in part (c) for explaining that a cell could limit IAA production with "a negative feedback loop." The response earned 1 point in part (c) for explaining that the feedback "prevents Enzyme YUC availability" and further clarifies that the feedback would "prevent transcription of the YUC gene, temporarily halting Enzyme YUC production." The response earned 1 point in part (d) for identifying that the ecological relationship is mutualism. The response earned 1 point in part (d) for describing that IAA would stimulate root growth, "expanding the bacteria's habitat." The response earned 1 point in part (e) for describing that bacterial cheaters "expend less energy on producing IAA & fixing nitrogen than non-cheaters, giving them more energy to … reproduce." The response earned 1 point in part (e) for predicting that "the bacterial population will exhibit a hire cheating frequency … This results in less nitrogen fixation."

Sample: 1B
Score: 8

The response earned 1 point in part (a) for circling the arrow pointing from Gene *Trp-T* to mRNA. The response earned 1 point in part (a) for identifying that the molecule that would be absent would be IAA. The response earned 1 point in part (b) for justifying that the deletion "could lead to the enzyme Trp-T to not be produced properly or at all." The response earned 1 point in part (b) for predicting that "IAA would not be produced." The response earned 1 point in part (c) for explaining that the feedback mechanism could "turn of the Gene YUC which would not create the Enzyme YUC." The response earned 1 point in part (d) for identifying that the relationship is mutualistic. The response earned 1 point in part (d) for describing that the plant "gives the

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Question 1 (continued)

bacteria more shelter." The response earned 1 point in part (e) for describing that "the bacteria that 'cheat' … do not have to expend energy … this would give the 'cheaters' more energy to reproduce."

Sample: 1C
Score: 6

The response earned 1 point in part (a) for circling the arrow pointing from Gene *Trp-T* to mRNA. The response earned 1 point in part (a) for identifying that the molecule that would be absent is indole-3-acetic acid (IAA). The response earned 1 point in part (b) for predicting that the deletion could "stop the production of IAA." The response earned 1 point in part (b) for justifying that "[i]f enzyme Trp-T is no longer produced … then I3PA cannot be made." The response earned 1 point in part (c) for explaining that "[o]ne feedback mechanism could be limiting the production of enzyme YUC." The response earned 1 point in part (d) for identifying that "[p]lants and Rhizobacteria most likely have a mutualistic relationship."

Assignment 2 - Option 1 - Part 2 of 2
The Short FRQ

1) On a piece of paper, brainstorm all the information you should put in your answer in relation to each question.
2) Time yourself: Allow for a maximum of nine minutes. (Roughly two minutes to read each one and 3.5 minutes for brainstorming each response)

Question 1 (#3 in image)

2019 AP® BIOLOGY FREE-RESPONSE QUESTIONS

3. The pyruvate dehydrogenase complex (PDC) catalyzes the conversion of pyruvate to acetyl-CoA, a substrate for the Krebs (citric acid) cycle. The rate of pyruvate conversion is greatly reduced in individuals with PDC deficiency, a rare disorder.

   (a) **Identify** the cellular location where PDC is most active.

   (b) **Make a claim** about how PDC deficiency affects the amount of NADH produced by glycolysis AND the amount of NADH produced by the Krebs (citric acid) cycle in a cell. **Provide reasoning** to support your claims based on the position of the PDC-catalyzed reaction in the sequence of the cellular respiration pathway.

   (c) PDC deficiency is caused by mutations in the *PDHA1* gene, which is located on the X chromosome. A male with PDC deficiency and a homozygous female with no family history of PDC deficiency have a male offspring. **Calculate** the probability that the male offspring will have PDC deficiency.

Question 2 (#4 in image)

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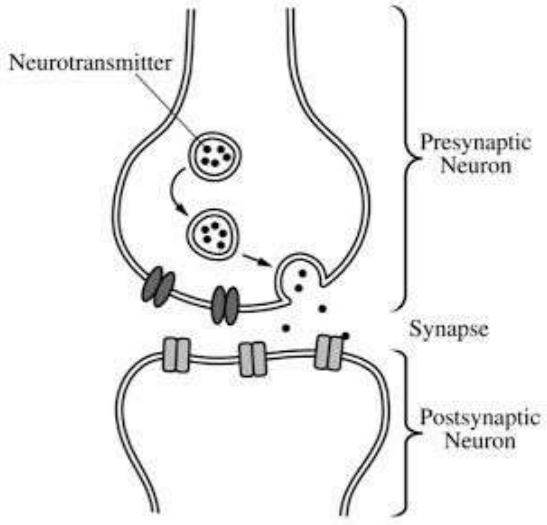

Figure 1. Release of neurotransmitters into the synapse in response to an action potential

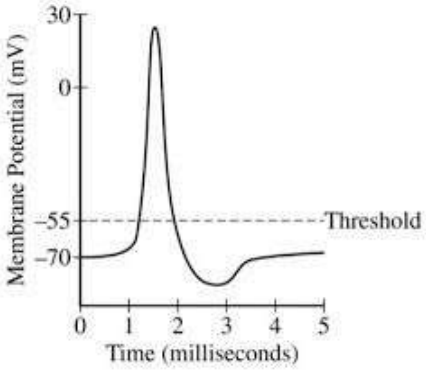

Figure 2. Model of a typical action potential in a neuron

4. Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

   (a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

   (b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

3.) Take the attached Scoring Guidelines and take 4 minutes (2 per question) to score yourself.

AP® BIOLOGY
2019 SCORING GUIDELINES

Question 3

The pyruvate dehydrogenase complex (PDC) catalyzes the conversion of pyruvate to acetyl-CoA, a substrate for the Krebs (citric acid) cycle. The rate of pyruvate conversion is greatly reduced in individuals with PDC deficiency, a rare disorder.

(a) **Identify** the cellular location where PDC is most active.

Identification (1 point)

- Mitochondria
- Mitochondrial matrix

(b) **Make a claim** about how PDC deficiency affects the amount of NADH produced by glycolysis AND the amount of NADH produced by the Krebs (citric acid) cycle in a cell. **Provide reasoning** to support your claims based on the position of the PDC-catalyzed reaction in the sequence of the cellular respiration pathway.

(1 point per row; 2 points max.)

	Claim	Reasoning
Glycolysis	No change	• Glycolysis continues; PDC is not needed. • Glycolysis occurs before conversion of pyruvate to acetyl-CoA.
Krebs cycle	Decrease	• The Krebs cycle is greatly reduced/slowed down if there is no/less acetyl-CoA. • The Krebs cycle occurs after conversion of pyruvate to acetyl-CoA.

(c) PDC deficiency is caused by mutations in the *PDHA1* gene, which is located on the X chromosome. A male with PDC deficiency and a homozygous female with no family history of PDC deficiency have a male offspring. **Calculate** the probability that the male offspring will have PDC deficiency.

Calculation (1 point)

- The probability of inheritance is 0.
- The offspring cannot/will not have PDC deficiency.

What score did you give yourself?

BRVGS AP Biology Review Packet 5.4.20

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2019 SCORING GUIDELINES

Question 4

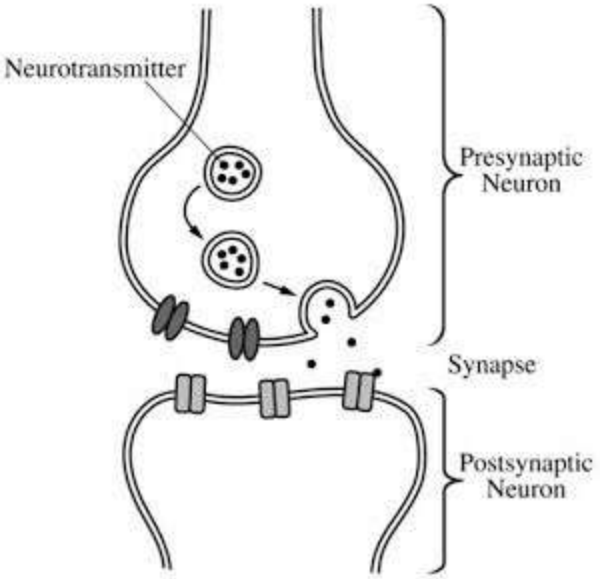


Figure 1. Release of neurotransmitters into the synapse in response to an action potential

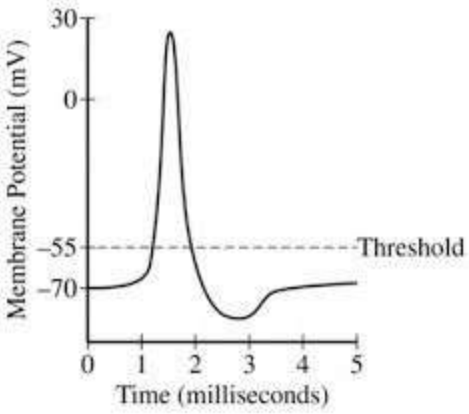


Figure 2. Model of a typical action potential in a neuron

Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

(a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

Description (1 point)

- It will increase the number of action potentials.

Prediction (1 point)

- It will stay the same.

(b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

(1 point per row; 2 points max.)

	Prediction	Reasoning
Model A	Effective	Acetylcholine is in the synapse.
Model B	Not effective	Acetylcholine is not in the cytoplasm of the postsynaptic cell.

What score did you give yourself?

BRVGS AP Biology Review Packet 5.4.20

Give yourself 6 minutes and Score the three students' sample work. Write the scores you gave them down on your piece of paper.

5) Use the Scoring Document for each question to compare how you scored the student responses with how College Board scored them. Answer the questions below on your paper.

- **Student A: How did your scores compare? If yours was different, why?**
- **Student B: How did your scores compare? If yours was different, why?**
- **Student C: How did your scores compare? If yours was different, why?**

Question 1 (#3 in image)

STUDENT A

3A

3. The pyruvate dehydrogenase complex (PDC) catalyzes the conversion of pyruvate to acetyl-CoA, a substrate for the Krebs (citric acid) cycle. The rate of pyruvate conversion is greatly reduced in individuals with PDC deficiency, a rare disorder.

   (a) **Identify** the cellular location where PDC is most active.

   (b) **Make a claim** about how PDC deficiency affects the amount of NADH produced by glycolysis AND the amount of NADH produced by the Krebs (citric acid) cycle in a cell. **Provide reasoning** to support your claims based on the position of the PDC-catalyzed reaction in the sequence of the cellular respiration pathway.

   (c) PDC deficiency is caused by mutations in the *PDHA1* gene, which is located on the X chromosome. A male with PDC deficiency and a homozygous female with no family history of PDC deficiency have a male offspring. **Calculate** the probability that the male offspring will have PDC deficiency.

PAGE FOR ANSWERING QUESTION 3

a. PDC is most active in a cell's mitochondria.

b. A PDC deficiency does not change the amount of NADH produced [redacted] by glycolysis, but it decreases the amount of NADH produced in the Krebs cycle. This occurs because the PDC-catalyzed reaction (to make acetyl CoA) occurs after glycolysis, leading to no impact, and before the Krebs cycle. Without acetyl CoA, the Krebs cycle cannot occur, so a PDC deficiency would halt all NADH production in this step.

c. Male - X^mY, where m = mutation

Female - XX

X	X	
X^m	X^mX	X^mX
Y	XY	XY

There is a 0% probability that a male offspring will have PDC deficiency.

Student B

3B1

3. The pyruvate dehydrogenase complex (PDC) catalyzes the conversion of pyruvate to acetyl-CoA, a substrate for the Krebs (citric acid) cycle. The rate of pyruvate conversion is greatly reduced in individuals with PDC deficiency, a rare disorder.

   (a) **Identify** the cellular location where PDC is most active.

   (b) **Make a claim** about how PDC deficiency affects the amount of NADH produced by glycolysis AND the amount of NADH produced by the Krebs (citric acid) cycle in a cell. **Provide reasoning** to support your claims based on the position of the PDC-catalyzed reaction in the sequence of the cellular respiration pathway.

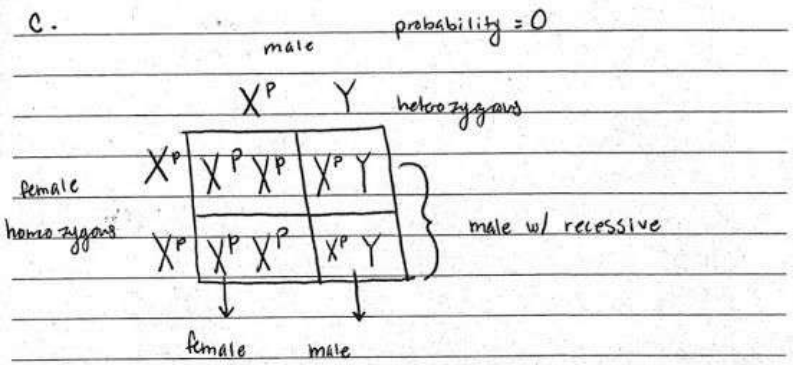
   (c) PDC deficiency is caused by mutations in the *PDHA1* gene, which is located on the X chromosome. A male with PDC deficiency and a homozygous female with no family history of PDC deficiency have a male offspring. **Calculate** the probability that the male offspring will have PDC deficiency.

PAGE FOR ANSWERING QUESTION 3

a. It is most active in the cytoplasm of eukaryotic cells.

b. The PDC catalyzed reaction occurs at the end of glycolysis, prior to entering the Krebs cycle so a deficiency would not affect the amount of NADH produced by glycolysis. However, a deficiency would decrease the amount of NADH produced by the Krebs cycle because it would prevent the conversion, or significantly decrease, the ~~the~~ amount of acetyl-CoA which is a necessary substrate to trigger the Krebs cycle. If the Krebs cycle is not activated, the production of NADH during cellular respiration would be reduced, though it would not affect the existing amounts produced by glycolysis earlier in the overall process.

c.



X^P = dominant sex-linked trait for PDHA1 mutation

X^p = recessive

Y = y-chromosome

STUDENT C

3C

3. The pyruvate dehydrogenase complex (PDC) catalyzes the conversion of pyruvate to acetyl-CoA, a substrate for the Krebs (citric acid) cycle. The rate of pyruvate conversion is greatly reduced in individuals with PDC deficiency, a rare disorder.

   (a) **Identify** the cellular location where PDC is most active.

   (b) **Make a claim** about how PDC deficiency affects the amount of NADH produced by glycolysis AND the amount of NADH produced by the Krebs (citric acid) cycle in a cell. **Provide reasoning** to support your claims based on the position of the PDC-catalyzed reaction in the sequence of the cellular respiration pathway.

   (c) PDC deficiency is caused by mutations in the *PDHA1* gene, which is located on the X chromosome. A male with PDC deficiency and a homozygous female with no family history of PDC deficiency have a male offspring. **Calculate** the probability that the male offspring will have PDC deficiency.

PAGE FOR ANSWERING QUESTION 3

A: PDC is most active in the mitochondria.

B: PDC deficiency will cause NADH production to decrease because there will be less energy.

C: X^h Y The male offspring have a 0% chance of having a PDC deficiency.

X^H X^HX^h X^HY

X^H X^HX^h X^HY

How did your score compare to College Board?

AP® BIOLOGY
2019 SCORING COMMENTARY

Question 3

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

Students were asked to consider the cellular location of pyruvate dehydrogenase complex (PDC), the enzyme that converts pyruvate to acetyl-CoA, and describe the consequences in the cell when the activity of the enzyme is greatly reduced in the genetic disorder PDC deficiency. Students used their understanding of cellular organelles to identify the location of the enzyme. They also used their understanding of glycolysis and aerobic respiration to make a claim (and justify it) about how PDC deficiency affects the amount of NADH produced by these two processes. Lastly, they used their knowledge of the inheritance of X-linked traits to determine the probability of a child inheriting PDC deficiency given information about the genotypes of the parents. Within the question, students needed to provide claims and reasonings as well as calculate a probability.

Sample: 3A
Score: 4

The response earned 1 point in part (a) for identifying the mitochondria. The response earned 1 point in part (b) for making a claim that PDC deficiency does not change the amount of NADH produced by glycolysis and providing reasoning that "the PDC-catalyzed reaction occurs after glycolysis." The response earned 1 point in part (b) for making a claim that PDC deficiency decreases the amount of NADH produced in the Krebs cycle and providing reasoning that the PDC-catalyzed reaction occurs before the Krebs cycle. The response earned 1 point in part (c) for calculating that "[t]here is a 0% probability."

Sample: 3B
Score: 3

The response earned 1 point in part (b) for providing reasoning that the PDC-catalyzed reaction occurs at the end of glycolysis and making a claim that deficiency would not affect the amount of NADH produced by glycolysis. The response earned 1 point in part (b) for making a claim that a deficiency would decrease the amount of NADH produced by the Krebs cycle and providing reasoning that "it would prevent the conversion, or significantly decrease, the amount of acetyl-CoA which is a necessary substrate to … the Krebs cycle." The response earned 1 point in part (c) for calculating that the "probability = 0."

Sample: 3C
Score: 2

The response earned 1 point in part (a) for identifying that PDC is most active in the mitochondria. The response earned 1 point in part (c) for calculating that "[t]he male offspring have a 0% chance of having a PDC deficiency."

Give yourself 6 minutes and Score the three students' sample work. Write the scores you gave them down on your piece of paper.

6) Use the Scoring Document for each question to compare how you scored the student responses with how College Board scored them. Answer the questions below on your paper.

- **Student A: How did your scores compare? If yours was different, why?**
- **Student B: How did your scores compare? If yours was different, why?**
- **Student C: How did your scores compare? If yours was different, why?**

Question 2 (#4 in image)
STUDENT A

4A1

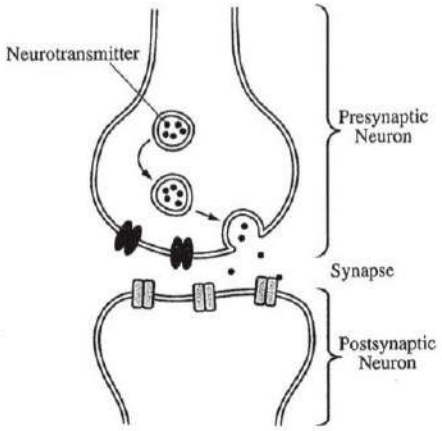


Figure 1. Release of neurotransmitters into the synapse in response to an action potential

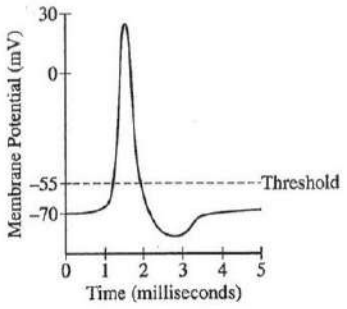


Figure 2. Model of a typical action potential in a neuron

(4) Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

(a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

(b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

PAGE FOR ANSWERING QUESTION 4

a) The number of action potentials will increase as a result of the neurotoxin as Acetylcholine will be increased and thus, bind to the receptors more frequently. The maximum membrane potential should remain the same, however.

4A2

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

b) Model A will be effective in preventing the effects of the neurotoxin, as AChE will degrade the Acetylcholine in the synaptic cleft, where it affects the action potential cascade. Model B will be ineffective as there is no Acetylcholine in the post-synaptic cell, so the AChE will not prevent the effects of the neurotoxin.

STUDENT B

4B1

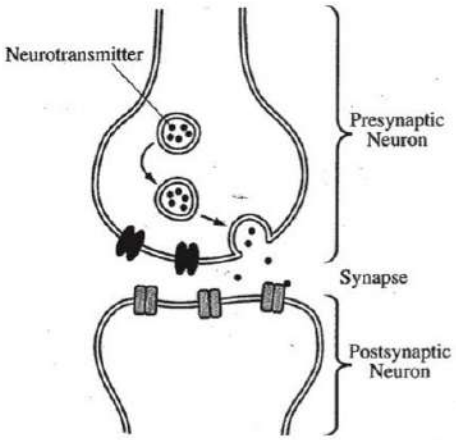


Figure 1. Release of neurotransmitters into the synapse in response to an action potential

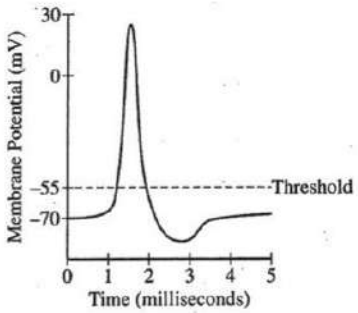


Figure 2. Model of a typical action potential in a neuron

4. Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

   (a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

   (b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

PAGE FOR ANSWERING QUESTION 4

A) The neurotoxin will increase the number of action potentials because more neurotransmitters will be available in the synapse to bind to the postsynaptic neuron receptors and start an action potential.

4B2

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

B) Model A would be effective because it would break down some acetylcholine in the synapse to bring the number of neurotransmitters down to normal levels. Model B would be ineffective because it does nothing to the number of neurotransmitters because the acetylcholine will leave the presynaptic neuron ~~and~~, go into the synapse, bind to the receptors on the outside of the postsynaptic neuron, then return to the presynaptic neuron through reuptake so if ~~the~~ acetylcholinesterase is in the cytoplasm of the postsynaptic cell, it won't come into contact with the acetylcholine being released.

STUDENT C

4C

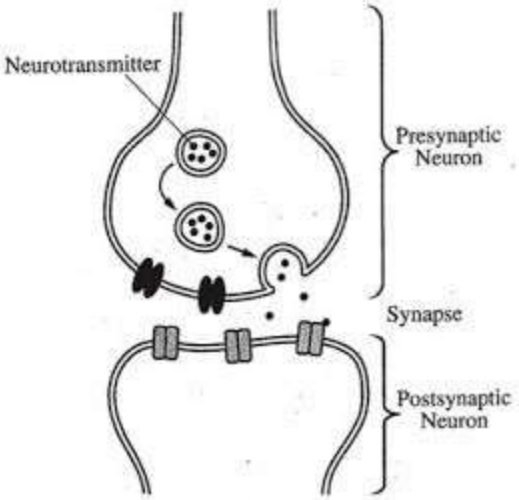


Figure 1. Release of neurotransmitters into the synapse in response to an action potential

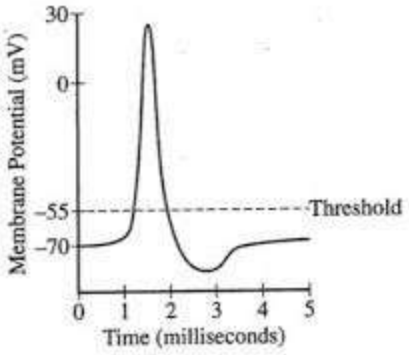


Figure 2. Model of a typical action potential in a neuron

4. Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

   (a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

   (b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

PAGE FOR ANSWERING QUESTION 4

a) there will be more action potentials and the maximum membrane potential will stay the same

b) for the AChE added to the synapse is going to be more effective in having less action potentials while if it is added to the post synaptic neuron there will be no effect on the action potentials

How did your score compare to College Board?

AP® BIOLOGY
2019 SCORING COMMENTARY

Question 4

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

Students were provided with a figure showing the release of a neurotransmitter into a synapse and a graph showing a model of a typical action potential in a neuron. Information was provided that researchers were investigating the effect of a neurotoxin that causes the amount of the neurotransmitter, acetylcholine, released from presynaptic neurons to increase. Students were asked to describe the effect of the neurotoxin on the number of action potentials and to predict the effect of the neurotoxin on the maximum membrane potential of the postsynaptic neuron. Then students were asked to consider two models where acetylcholinesterase (AChE—an enzyme that degrades acetylcholine) was added to the system: In model A, AChE was added to the synapse, and in model B the enzyme was added to the cytoplasm of the post-synaptic neuron. Students were asked to predict the effectiveness of each model to prevent the effects of the neurotoxin and to provide reasoning for their predictions. This question required basic knowledge of the nervous system at the cellular level, specifically how signals are passed from cell to cell to cause action potentials. Students also needed to predict the effects of changes to the system.

Sample: 4A
Score: 4

The response earned 1 point in part (a) for describing that the number of action potentials will increase "as a result of the neurotoxin." The response earned 1 point in part (a) for predicting that the maximum membrane potential should remain the same. The response earned 1 point in part (b) for predicting that Model A will be effective and reasoning that "AChE will degrade the Acetylcholine in the synaptic cleft." The response earned 1 point in part (b) for predicting Model B will be ineffective and reasoning that "there is no Acetylcholine in the post-synaptic cell."

Sample: 4B
Score: 3

The response earned 1 point in part (a) for describing that the neurotoxin will increase the number of action potentials. The response earned 1 point in part (b) for predicting that Model A will be effective and reasoning that "it would break down some acetylcholine in the synapse." The response earned 1 point in part (b) for predicting that Model B will be ineffective and reasoning that acetylcholinesterase in the cytoplasm of the postsynaptic cell "won't come into contact with the acetylcholine being released."

Sample: 4C
Score: 2

The response earned 1 point in part (a) for describing that there will be more action potentials. The response earned 1 point in part (a) for predicting that the maximum membrane potential will stay the same.

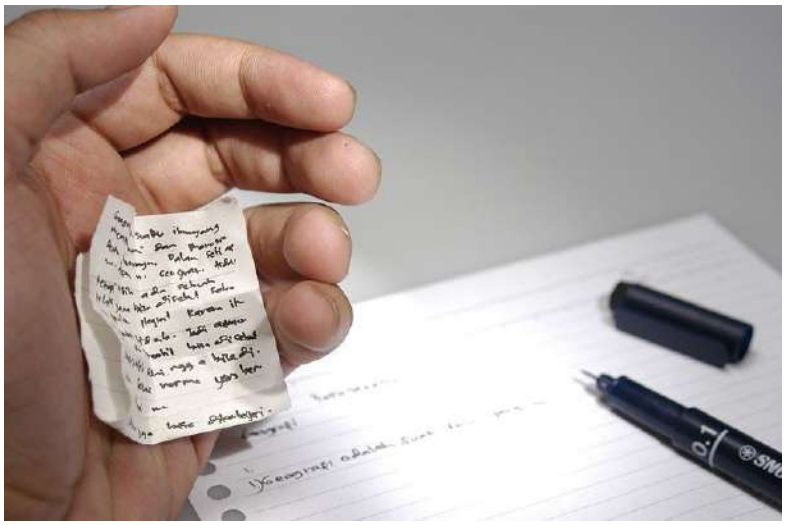
Assignment 2 - Option 2

Unit 1-6 Cheat Sheet Competition (This MAY be used on the AP Exam)

BRVGS Class Cheat Sheet Competition

Spring 2020

Who can make the BEST Cheat Sheet?



THE RULES!!

Format Choices: Drawn Images only (may include small captions/labels) OR Shortcuts to Remembering OR Old School (get as much info on a page as possible)

Font Size: You will NOT have a magnifying glass, so must be size 10-12 font

One normal 8x11 page front and back AND must be submitted digitally by taking pictures and emailing to your teacher OR a copy can be mailed to BRVGS at 14455 James Madison Hwy., Palmyra, VA 22963

Content: The main focus should be on **College Board AP Bio Units 1-6**.

Cheat Sheets will be judged on: accuracy, amount of information and creativity

Assignment 2 - Option 3
Tying Evolution To All Six Units

AP Biology Review - Natural Selection

"Nothing in biology makes sense except in the light of evolution." - Theodosius Dobzhansky (1973)

What similarities do organisms have in common? How do their differences help them survive in different environments? How do we explain all of the diversity of life on this planet, while at the same time explaining the basic similarities that all living things share?

Instructions: While the AP test will not specifically focus on Unit 7 (Natural Selection), the topics of evolution and natural selection tie in with every other concept covered in AP Biology.

For **each** of the six topics/units listed below:

- Write a 75-100 word summary on how the topics of evolution/natural selection relate to the unit/topic

  -OR-

- Provide 4 specific examples of how the topics of evolution/natural selection relate to the unit/topic.

Example: A specific example for Unit 1- Chemistry of Life - *All organisms are mostly made of the same elements (CHONPS), and these elements can be combined into chemicals that all living things require (carbohydrates, lipids, proteins, and nucleic acids). This provides evidence of the interrelatedness/common descent of all organisms.*

Possible Ideas to Consider:

- Similarities and differences between prokaryotes and eukaryotes
- Similarities and differences between animals/plants/fungi/microorganisms in terms of structure (overall anatomy, cell structure, etc)
- Similarities and differences between animals/plants/fungi/microorganisms in terms of function (reactions, metabolism, etc.)
- Basic similarities of all animals (or plants, fungi, prokaryotes, etc), as well as specific differences between types of animals (or plants, fungi, prokaryotes, etc)

Your answers can focus on specific examples, along with more "big picture" ideas. Feel free to email your teacher if you need any help!

IMPORTANT NOTE: The unit numbers refer to the specific units outlined by the College Board for AP Biology, and may be different from specific units covered in your AP Biology class.

BRVGS AP Biology Review Packet 5.4.20

1. How does evolution/natural selection relate to Unit 1 - Chemistry of Life?

- Potential topics include: macromolecule structure and function, chemical bonding, water chemistry

2. How does evolution/natural selection relate to Unit 2 - Cell Structure and Function?

- Potential topics include: cell structure and function (prokaryotic vs eukaryotic), membrane transport, cellular responses to changes in the environment

3. How does evolution/natural selection relate to Unit 3 - Cellular Energetics?

- Potential topics include: photosynthesis, cellular respiration, enzymes

4. How does evolution/natural selection relate to Unit 4 - Cell Communication and Cell Cycle?

- Potential topics include: signal transduction pathways, feedback loops, cell division

5. How does evolution/natural selection relate to Unit 5 - Heredity?

- Potential topics include: genetic diversity, reproduction, genetics

6. How does evolution/natural selection relate to Unit 6 - Gene Expression and Regulation?

- Potential topics include: transcription and translation, DNA/RNA structure and function, regulation of gene expression