



WEST VIRGINIA STATE UNIVERSITY

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Academic Affairs Assessment of Student Learning Report for Academic Year: 2022-2023

Department/Program: Biology

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- 1. Which learning outcomes did you measure this past year?** [Please indicate whether any of these measures were conducted as follow-up to a previous year's issues or in response to Program Review. Be specific.]

PLO #1: Demonstrate field knowledge (of Biology)

PLO #2: Apply the scientific method to answer a biologically-relevant question

- 2. In which course(s) were assessments conducted?**

PLO #1: Biology 250, 411

PLO #2: Biology 120

- 3. How did you assess the selected program learning outcomes?** (i.e., what did you assess – group project, skills demonstration, presentation, performance, debate, lab experiment, online discussion, etc. *and*- what tool (measure) did you use - rubric, nationally or state-normed exam, item analysis, pre-posttest design, skills inventory, survey, etc.)

PLO #1:

ETS Biology Major Field Test (nationally normed exam)

Department of Biology Faculty-developed questions embedded in the final exam.

PLO #2:

Departmental faculty-developed rubric designed to assess various aspects of the scientific method

4. How many students were included in the assessment(s) of each PLO in a course?

Course	PLO Assessed	Number of Students
Biology 120	2	36
Biology 250	1	13
Biology 411	1	10

5. How were students selected to participate in the assessment of each outcome (Helpful details might include- whether this assessment represents all students, a sample of students in a class, or a sample of students across sections)?

PLO #1:

Biology 250: all students taking the final exam in spring sections were assessed

Biology 411: all students taking senior seminar in fall and spring were assessed.

PLO #2:

Biology 120: a subset students enrolled in spring sections of Biology 120 were assessed

6. In general, describe how each assessment tool (measure) was constructed (i.e. in-house, national, adapted).

PLO #1 is assessed with faculty developed questions embedded in the final exam the and the Biology Major Field Test

PLO #2 is assessed with a faculty-developed rubric designed using the framework of our General Education assessment rubric to assess student's knowledge and ability to utilize the scientific method

7. Who analyzed results and how were they analyzed?

ETS analyzes the Major Field test and the data are downloaded from their website. The Assessment Coordinator uses a statistical analysis to analyze the other data collected.

8. Provide a summary of the results/conclusions from the assessment of each measured Program Learning Outcome. Report scores for this assessment, as well as students' strengths and weaknesses relative to this learning outcome.

PLO

#1

Scores in Biology 250 program assessment tool (see Table 3) showed that students improved their performance on 2 of the 3 subjects (succession, and conservation) compared to the prior

year's final exam. Students did not perform as well on the productivity question as they had in the previous year (45.6% vs 90%, respectively). That being said, for comparison, in 2015 only 13% of students were able to answer the question on productivity correctly. Scores were slightly better in 2016 and 2017 (16% and 10% respectively). Additionally, a fourth question, testing students' knowledge of ecological niches was added (see Appendix II). Just under 80% of students answered that question correctly. Future assessments of Biology 250 will be based on students' performance on 10 questions administered during their final exam.

Major Field Test assessment data show that WVSU students have a scaled average score of 145.2 (see Table 10). Subsection scores (for Spring 2023) revealed that students did best in the subcategory of Molecular Biology and Genetics (48.1), followed by Cell Biology (47.1), Organismal Biology (44.6) and Population Biology, Evolution and Ecology (43.6). Each of these means fit within the appropriate ranges for performance in each of the subject areas. While this is consistent with our faculty – developed assessment results showing acceptable student performance in Molecular Genetics (Biology 270) and improvement in Ecology (Biology 250), there is still room for improvement.

PLO #2

The Scientific Method is defined as a series of steps that scientists use to answer a question based on an observation. This process is essential to biology and other scientific disciplines. Since it is so important to the discipline, proper and meaningful use of the scientific method was identified by the faculty as an appropriate outcome for assessment.

This Program Learning Outcome is assessed at the beginning of the BS Biology program in Biology 120, the first core course of the major and near the end of the program in Cell Biology. Although WVSU Catalog Suggested Course Sequence for the BS Biology program indicates Cell Biology be taken in the junior year, many students wait to take the course in the first or second semester of the senior year. Unfortunately, because the former instructor for Biology 385 retired, the new instructor did not assess the scientific method for academic year 2022-2023. Our assessment outcomes for Biology 385 will be changed with the new assessment procedure we will be following beginning in Fall 2024.

By using either a survey tool or standard experimental approach, groups of students in Biology 120 are given the assignment of designing, and implementing an activity and analyzing the results. Student groups are then required to present the findings in class. In Cell Biology, the activity is more refined, less open-ended. After receiving some basic information and techniques about enzymes and enzyme assays, groups of students are asked to design, implement, analyze and present findings on some aspect of enzyme kinetics. A rubric designed by the Departmental Assessment Committee is used to evaluate group achievement in the following assessment areas: ability to clearly identify a problem, measure observations, organize data, analyze the observations (data), apply a model and communicate the results. Students were scored as follows: advanced = 4, proficient = 3, satisfactory = 2, poor = 1 in the categories specified above.

- 9. What are next steps?** (e.g., will you measure this same learning outcome again? Will you change some feature of the classroom experience and measure its impact? Will you try a new tool? Are you satisfied?)

Although we had intended to collect another year of data on the current two PLOs, this is the final year of collecting data on the PLOs indicated above. We are developing new assessment outcomes, rubrics and in-house final exam embedded questions to be implemented beginning in Fall 2024 (see Appendix IV), with a pilot in Spring 2023. One of the issues that has concerned me with regard to assessment is that we don't know our students' level of Biology understanding when they enter our department. One of the changes to our new assessment procedure will be to determine a baseline of our new majors' level of understanding and assess their knowledge based on those assessments and test them again in each of the core courses, then the Major Field Test can assess their understanding of Biology against students from other universities. In addition, we plan to develop new learning outcomes that specifically address scientific writing and oral communication.

- 10. Please attach an example of the assessment tool used to measure your PLO(s).** These can be added as an appendix, a link to the assessment, or sent separately in email with your report.

Those assessment tools are included in Appendices II and III.

APPENDIX I

Table 1. PLO #1 Demonstrate Field Knowledge (Ecology):

Faculty – Developed final exam – embedded questions. Spring 2023 Biology 250; N = 13

Subject	% of students answering correctly	Number of students answering correctly
Succession	84.6	11
Productivity	46.2	6
Conservation	92.3	9
Ecological Niche	79.9	10

Students performed best on the assessment questions on conservation and productivity. However, it is worth noting that students performed well on all embedded questions. Only one student failed to answer at least 2 of the 4 questions correctly and 9 of the 13 students answered 3 of 4 or all 4 of 4 questions correctly. Looked at another way, across all students and questions, 39 of 52, or 75% of questions were answered correctly. As was mentioned in the previous year’s assessment report, a different cohort of students were given these same questions on the Spring 2020 final exam that was proctored virtually because of COVID-19 restrictions and thus was open book. On that exam (N=12), 58% of students answered the succession question correctly, 83% answered the productivity question correctly and 83% answered the conservation question correctly. The Fall 2021 Final exam included 2 of the 3 embedded questions (conservation and productivity) and 71.4% and 85.7% of students answered those questions correctly, respectively. Students’ strong performances on these questions make their weak Major Field Test scores on the Population Biology, Evolution, and Ecology subsection all the more perplexing.

Table 2. PLO #1 Demonstrate Field Knowledge: Biology Major Field Test. Total Test Results from Fall Spring 2023, N=10

Spring 2022

Student	Total Biology	Cell Biology	Mol. Biol. Gen.	Org. Biology	Pop. Eco. Evo.
1	142	38	53	46	33
2	152	54	60	46	50
3	134	27	44	39	33
4	148	54	41	58	38
5	138	35	53	32	38
6	139	54	31	37	41

7	144	48	44	46	41
8	145	42	50	46	43
9	159	57	55	54	65
10	151	62	50	42	54
WVSU Mean	145.2 (+/- 11.6)	47.1	48.1	44.6	43.6
Nat'l. Mean	152	53	54	53	52

For the academic year 2022-2023, Biology majors scored a mean of 145.2 on the Major Field Test in Biology (composite) taken during the Spring semester 2023.

For comparison, here are mean composite scores from other institutions (and WVSU) from previous years:

UT-Chattanooga 2020-2021: 146.8

Wiley College 2020-2021: 134

WVSU 2020-2021: 148.2

Our students' performance on the Major Field Test in Biology indicates that our students' mastery of Biology is comparable to that of students from other universities. On the subject-specific areas, our students performed best in the Molecular Biology, and Cell Biology areas. Students performed least well on the Organismal Biology and Population Biology, Evolution and Ecology subsections. Comparison data for those subject areas was not readily available.

Table 3. PLO #2 Apply the scientific method to answer a biologically relevant question: Mean scores from Biology 120.

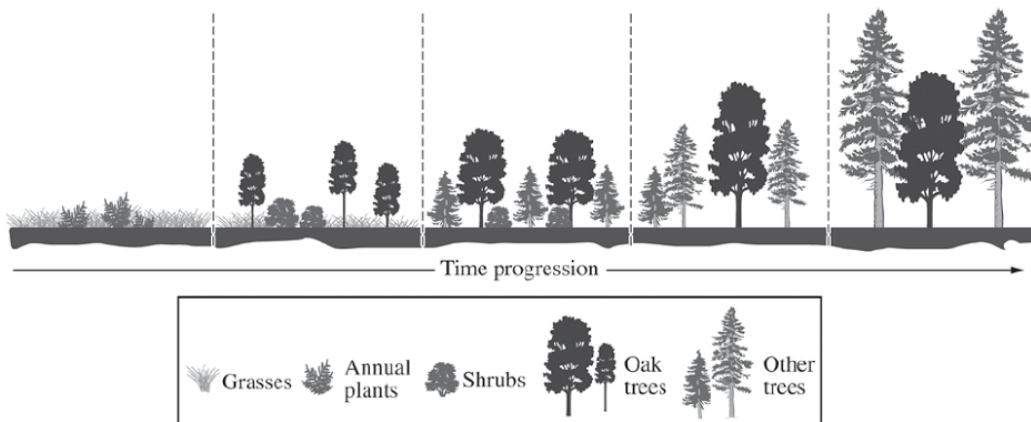
Components assessed	N=36
Identify problem	2.8
Measure observations	3.0
Organize data	2.8
Analyze observations	2.6
Apply model	2.3
Communicate results	2.7

From our rubric (Appendix III), the students in Biology 120 all scored at least "satisfactory" on the Scientific Method exercise and scored Proficient for their organization of data. They scored least well on their ability to apply the model to their observations.

APPENDIX II

Sample Assessment Tool: Faculty – Developed final exam-embedded assessment of PLO#1:
Demonstrate Field Knowledge (Ecology) in Biology 250.

The diagram below shows the progression of ecological events after a fire in a particular ecosystem. *Based on the diagram*, which of the following best explains why oak trees are later replaced by other tree species?



- A- Eventually other trees grow taller than the oak trees, forming a dense canopy shading the understory
- B- Oak trees alter the pH of the soil, making the forest better suited for shrubs and other trees
- C- Roots of shrubs proliferate in the soil of the forest and prevent the oak trees from obtaining water
- D- Oak trees succumb to environmental pollutants more readily than do either shrubs or other trees

In an Asian rice paddy, carp eat decaying material from around the base of rice plants while a snail scrapes algae from the leaves, stems, and roots of the same plant. They can survive at the same time in the same rice paddy because they

- A- Belong to different phyla.
- B- Occupy the same habitat but different niches
- C- Occupy different habitats and different niches
- D- Occupy the same habitat and the same niche



Tigers are an endangered species, with fewer than 7,500 individuals left in the wild. Tigers are solitary and secretive, and each tiger needs at least 10 square miles of habitat. Female tigers mature at 3 years of age, usually produce 2 cubs per year, and may live up to 20 years. Which of the following is the best conservation measure for these animals?

- A- Introduce exotic prey for tigers to eat.
- B- Use a captive breeding program to reduce genetic diversity
- C- Increase carrying capacity by protecting large tracts of high-quality habitat.
- D- Promote hunting to remove the sick and old from the population



If we have a habitat with 10,000 units of energy fixed in primary productivity each year, we would expect about how many units of energy to make it to the first level of carnivores?

- A- 1,000 units
- B- 500 units
- C- 100 units
- D- 10 units

APPENDIX III

Sample Assessment tool; faculty – developed rubric for assessment of PLO#2: Apply the scientific method to answer a biologically relevant question

Biology Program Scientific Method Assessment Rubric

Year ____ Term ____ Class ____ Project _____ Student _____ Evaluator _____

Scientific method components	4 = Advanced (excellent, next level)	3 = Proficient (good)	2 = Satisfactory/Basic (OK but weak)	1 = Not satisfactory / Below basic (significant problems)	Score	Comm
Identify relevant properties of the system / problem / observation	Identifies the role of specific parts of relevant concepts and how they interact to create the outcome of the system / problem / observation.	Identifies what specific parts of relevant concepts contribute to the outcome of the system/ problem/ observation, but doesn't distinguish the role of their contributions or how they interact.	Identifies relevant concepts, which contribute to outcome of system /problem / observation.	Needs to identify concepts of system / problem / observation, which contribute to outcome.		
Measure/Assess quantified observations in a reproducible manner in standard units of measurement	Objective-quantified observations are made through reproducible measurements of the relevant quantities contributing to the system, while minimizing error and using standard units of measurement	Objective-quantified observations are made through reproducible measurements of the relevant quantities contributing to the system, using standard units of measurement	Objective-quantified observations are made of the relevant quantities contributing to the system, using standard units of measurement.	Observations are made of the relevant quantities contributing to the system but are neither quantified nor objective.		
Organize collected observations	Selects and applies an appropriate method for organizing quantitative or qualitative data, including, when applicable: a database, graphs, tables or images. Data are ranked, grouped or tabulated in a manner for clear interpretation. Appropriate units are included.	Selects or applies an appropriate method for organizing quantitative or qualitative data, including, when applicable: a database, graphs, tables or images. Data need to be ranked, grouped or tabulated in a manner for clear interpretation.	Quantitative or qualitative data is collected, but is not arranged in an organized manner. Data need to be ranked, ordered or grouped according to variables of interest. Units need to be	Neither quantitative nor qualitative data was collected or organized.		

		Units are included.	included.			
Analyze collected observations	<p>Correctly selects and applies an appropriate method for analysis of observations, including, when applicable: pattern recognition, measures of central tendency (mean, median, and mode), standard deviation, and other statistical analysis (Chi-Squared, student T- test), and error analysis appropriate for the course, discipline and/or question.</p> <p>Discusses the factors that contributed to the outcome, & any sources of error.</p> <p>Strong, valid connections are drawn between outcome & theoretical or conceptual understandings in the field</p>	<p>Selects or applies an appropriate method for analysis of observations, such as, including, when applicable: pattern recognition, measures of central tendency (mean, median, and mode), standard deviation, and other statistical analysis (Chi-Squared, student T- test), error analysis as is expected for the course, discipline and/or question.</p> <p>Discusses the factors OR sources of error which have contributed to the outcome.</p> <p>Connects the outcome to theoretical or conceptual understandings in the field.</p>	<p>Selects or applies a method for analysis of observations.</p> <p>Needs to discuss factors that may have contributed to the outcome.</p> <p>Needs to connect the outcome to theoretical or conceptual understandings in the field</p>	<p>Needs to select or apply a method for analysis of observations</p> <p>Needs to discuss factors that may have contributed to the outcome.</p> <p>Needs to connect the outcome to theoretical or conceptual understandings in the field.</p>		
Apply model based on results to predict future outcomes/explain/interpret the initial system/ problem/ observation	<p>Summarizes and explains results.</p> <p>Draws inferences that are consistent with the data and scientific reasoning</p> <p>Explains expected results & offers explanations/ suggestions for further research of unexpected results</p> <p>Distinguishes between raw data & inferences, avoids overgeneralization, and accepts/rejects hypothesis (if appropriate)</p>	<p>Summarizes and explains the results.</p> <p>Draws inferences that are consistent with the data and scientific reasoning.</p> <p>Explains expected results but needs to acknowledge unexpected results.</p> <p>Distinguishes between raw data and inferences.</p>	<p>Results summarized, but not interpreted or explained.</p>	<p>Results need to be summarized.</p>		

Communicate & defend results	Conveys detailed, specific information, orally, in writing, and visually describing results of investigation of system/problem/observation	Conveys specific information, orally and in writing, describing results of investigation of system /problem/observation.	Conveys general information describing results of investigation in system/problem/observation	Needs to describe results of investigation		
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APPENDIX IV

Questions demonstrating field knowledge to be administered to students in Biology 120 (entry-level majors course) and then embedded in Department of Biology core courses (beginning Fall 2024). The classes to be assessed using these questions are Biol 121 (Biodiversity), Biol 250 (General Ecology), Biol 270 (Genetics) and Biol 385 (Cell Biology). Tentatively, performance will be evaluated and assessed as follows (based on number of correct answers out of 10): 0-4 = Unsatisfactory, 5-6 = Satisfactory, 7-8 = Proficient, 9-10 = Advanced.

Biology 121 Assessment Questions

What feature of angiosperms is unique relative to other members of the kingdom Plantae?

- A- Pollen
- B- Flowers
- C- Roots
- D- Leaves

The success of land plants is largely due to their mutualism with mycorrhizae. What type of organism is/are mycorrhizae?

- A- Animals
- B- Other plants
- C- Bacteria
- D- Fungi

What plant feature enabled them to escape moist habitats as well as grow taller?

- A- Roots
- B- Leaves
- C- Chlorophyll
- D- Vascular tissue

What is a unique defining characteristic for animals in the class Mammalia?

- A- Warm bloodedness
- B- Feathers
- C- Teeth with different shapes
- D- Parental care

What is the largest animal phylum?

- A- Vertebrata
- B- Arthropoda
- C- Mollusca
- D- Eubacteria

On a phylogenetic tree, what animals would be located on the most basal branch (i.e., is most primitive)?

- A- Sponges
- B- Arthropods
- C- Vertebrates
- D- Flatworms

What is the most inclusive (largest) taxonomic unit of the ones listed below?

- A- Class
- B- Species
- C- Family
- D- Genus

What feature of viruses suggests that they are not living organisms?

- A- They cannot evolve or undergo natural selection
- B- They cannot perform biological activities independent of a host cell
- C- They neither respire nor photosynthesize
- D- None, viruses are considered living organisms

What shape or form does a bacterium in the genus *Bacillus* have?

- A- Spherical
- B- Oblong
- C- Spiral
- D- Circular

What organism is a prokaryote?

- A- Apple tree
- B- Amoeba
- C- Bacterium
- D- Fungus

Biology 250 Assessment Questions (in addition to the 4 already in use)

Invasive populations of the red imported fire ant, *Solenopsis invicta* differ from native populations in that they form super colonies that may have evolved due to changes in odorant receptors. What evolutionary process is most likely to account for the fixation of neutral or even maladaptive alleles or allele combinations in small populations such as this?

- A- Recombination
- B- Lamarckian selection
- C- Mutation
- D- Genetic drift

Wallace's sphinx moth (*Xanthopan praedicta*) is the only insect that can pollinate Darwin's orchid (*Angraecum sesquipedale*), mainly because the latter's 12 inch nectar spur (tube) can only be accessed by the former's 12 inch tongue. What term is used to describe evolutionary change in both a pollinator and a flower resulting from their mutualistic interaction like the one represented by this example?

- A- Divergent evolution
- B- Parallel evolution
- C- Coevolution
- D- Convergent evolution

When comparing eutrophic and oligotrophic lakes, what tends to be greater in an oligotrophic lake relative to a eutrophic one?

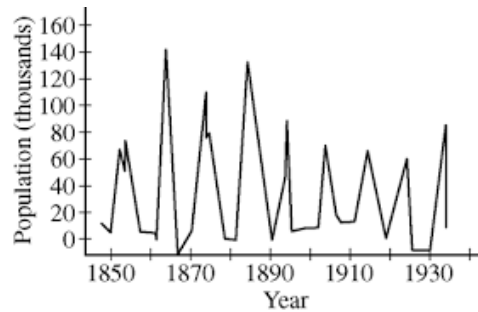
- A- The supply of oxygen
- B- The number of blue-green algae
- C- Biological oxygen demand
- D- The amount of degradable organic matter

An area was recently destroyed by a raging wildfire. Which of the following events would allow or enable secondary succession to take place?

- A- Animals that survive migrate to surrounding areas
- B- Plant life that survives begins to die out as a result of the lack of available nutrients
- C- The decomposition of the carcasses of animals that did not survive the fire return nutrients to the soil
- D- Omnivores that survive outcompete and thus create a decline of both herbivore and carnivore populations

Many conservation efforts are geared toward organisms that are endemic. What are endemic species?

- A- Organisms that suffer from some genetic abnormality
- B- Organisms that freely hybridize with other species
- C- Organisms that are only found in one location
- D- Organisms that are at a high risk of extinction



The data in the graph above represent the population size of the snowshoe hare—a prey species in northern Canada and Alaska—between 1850 and 1940. If one assumes that a predator and its prey have mutual density-dependent effects on one another, how would a curve for the simultaneous population size of lynx, a predator of the snowshoe hare, compare to it?

- A- Have peaks simultaneously with the peaks for the prey
- B- Have peaks slightly before the peaks for the prey
- C- Have peaks slightly after the peaks for the prey
- D- Be essentially a horizontal line

Biology 270 Assessment Questions

What is the test that is used to validate segregation ratios?

- A- F-test
- B- Z-test
- C- T-test
- D- Chi square test

What term is used to describe genes located on the same chromosome?

- A- Linked
- B- Epistatic
- C- Coupled
- D- Repulsed

Interphase occurs at the onset of what process?

- A- Meiosis
- B- Mitosis
- C- Mating
- D- Transcription

Electrophoresis is a gel separation of DNA based on what characteristic?

- A- Density
- B- Molecular weight
- C- Shape
- D- Helical structure

What are Beadle and Tatum known for?

- A- One gene, one enzyme hypothesis
- B- Complementation test
- C- Mutation screen
- D- All the above

What term or term can be used to describe human blood groups?

- A- Multi-allelic
- B- Polymorphic
- C- Codominant
- D- All of these

What does deaminated cytosine produce?

- A- Uracil
- B- Adenine
- C- Stop codon
- D- Start codon

In what organisms are polycistronic mRNAs common in?

- A- Eukaryotes
- B- Prokaryotes
- C- Both
- D- Neither

Heterozygotes of sickle cell anemia allele have selective advantage against what illness?

- A- Malaria
- B- Tuberculosis
- C- Typhoid fever
- D- HIV

What is cDNA is complementary to?

- A- Exons
- B- Introns
- C- Promoters
- D- All of these

Biology 385: Assessment Questions

What does a negative free energy change indicate?

- A- The reaction is not possible.
- B- Energy must be added to the reaction before it can proceed.
- C- The reactant is predominant at equilibrium.
- D- The reaction is exergonic.

What does an allosteric inhibitor do?

- A- Increases the rate of substrate binding
- B- Binds and activates the high-affinity state of the enzymes
- C- Is identical to the active site
- D- Binds at the allosteric site
- E- All of the above

Lipid movement in phospholipid bilayers is _____

- A- Dependent upon temperature.
- B- Affected by the presence of cholesterol and the length of the fatty acid chain.
- C- Frequent for flip-flop as well as lateral diffusion.

- D- A and B only
- E- All the above

Which of the following statements is **not** true of glycolysis?

- A- It can occur in the presence of oxygen.
- B- The pathway is highly conserved among organisms.
- C- Glucose has to be used as the energy source.
- D- The pathway is exergonic.
- E- Intermediates in the pathway have 3 or 6 carbon atoms.

While protein is synthesized on rough ER, which of the following processing may be occurring simultaneously?

- A- Insertion through a core complex into the ER lumen
- B- Folding of the protein into secondary structure
- C- Glycosylation
- D- Removal of the signal peptide
- E- All of the above
- F- None of the above

6. What is/are function(s) performed by the endoplasmic reticulum?

- A- Potassium storage in muscle cells.
- B- Drug detoxification by catalase.
- C- N-linked glycosylation of polypeptides.
- D- Addition of lipid residues.
- E- Both choices B and C

Which of the below is **not** a way by which cells reduce signaling from trans-membrane receptors?

- A- Reducing the amount of ligand available to bind the receptor
- B- Degradation of the receptor after receptor-mediated endocytosis
- C- Flipping the receptor so it is orientated with the ligand-binding domain on the cytoplasmic side of the plasma membrane
- D- Cell adaptation so there is receptor desensitization

What is signal transduction?

- A- The production of “second messengers”
- B- The ability of a cell to translate a receptor-ligand interaction into changes in behavior or gene expression
- C- A logical flow of information
- D- Exceedingly small quantities of ligand resulting in a strong response in the target cell.

Why are kinases and phosphatases essential to cells?

- A- They help turn proteins “on and off” through changes in phosphorylation status
- B- They destroy damaged proteins
- C- They can sense short polyA tails in mRNA as a signal to degrade them
- D- They destroy second messengers, thereby turning off a signal transduction pathway
- E- All of the above

What is the transfer of energy from a photoexcited electron to another electron of an adjacent pigment molecule is known as

- A- Photoexcitation
- B- Quantum leap
- C- Photophosphorylation
- D- Resonance energy transfer
- E- Photorespiration