Microbial Jeopardy!™ Review and Assessment

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Abstract

Students work individually and collaboratively in teams during a Jeopardy!™-style activity. Questions based upon previous class material are posed to students to assess their learning. Teams are encouraged to help their members answer questions completely and are rewarded when all members have participated. This daily assessment activity emphasizes the key concepts and expectations of the course for students and fosters active group learning. Students also get practice in communicating scientific concepts. The professor can use this assessment of student understanding to modify the focus, pace, and presentation of the current day's material.

Activity

Invitation for User Feedback. If you have used the activity and would like to provide feedback, please send an e-mail to MicrobeLibrary@asmusa.org. Feedback can include ideas which complement the activity and new approaches for implementing the activity. Your comments will be added to the activity under a separate section labeled "Feedback." Comments may be edited.

INTRODUCTION

Prep Time Required.
Time required will change with the topics being assessed. Key concepts of the previous class period or section should be well known to the instructor. It will take roughly 5 minutes to think of three questions related to these key concepts.

Class Time Required.
This activity will take approximately 5 to 7 minutes at the beginning of each class period.

Learning Objectives.
At the completion of this activity, students will have worked cooperatively and regularly to communicate key concepts in microbiology.

Background.
Students should have been present in class or studied about topics discussed during the previous class period in order to be successful in this activity. Students should study regularly in order to support their team.

PROCEDURES

Materials.
None.

Student Version.
During the first class period, students are divided into teams of 4 to 6 people each, depending upon the size of the class. Along with the syllabus, the following information is handed out:

Student Guide to Microbial Jeopardy!™

Throughout the semester, each person on a Microbial Jeopardy!™ team works individually and collaboratively to successfully answer questions at the beginning of each class period, called a Microbial Jeopardy!™ session. Each team's goal is to win the most points during a Microbial Jeopardy!™ unit, the material covered between two exams.

A. *Microbial Jeopardy!™ sessions*
At the beginning of each class period, the instructor will orally pose three questions based on material covered in the previous class period to the teams. Two of the questions will be of Type A, testing for knowledge and basic understanding of material (worth one point), and one of the questions will be of Type B, involving critical thinking and application (worth two points). Students should come to class having reviewed previous class material.

When each question is posed, the individual student that raises his/her hand first is called on to answer the question. If this student gives a thoughtful but wrong answer or a partial answer, he may confer with his teammates for a better response. If the instructor feels the individual has raised his hand without having a well-conceived answer (in other words, a wild guess), the team loses its chance for a second answer to the question. If the second answer is still not correct or complete, the question is posed to the individual from another team who had the second fastest raised hand.

In contrast to the real Jeopardy!™ game show, answers do not need to be given in the form of a question.

Examples of potential questions and answers:

> Sample category: prokaryotic cell structure
>
> *Type A* - What is the basic structure of a gram-positive cell wall?
> *Answer*: Gram-positive bacteria have a thick layer of peptidoglycan embedded with techoic acid and a small number of proteins.
>
> *Type B* - How might the structure of a gram-negative bacterial cell wall determine the effectiveness of an antibiotic that destroys peptidoglycan?
> *Answer*: The lipopolysaccharide layer of gram-negative bacteria may provide a barrier to the antibiotic's access to peptidoglycan. However, if the lipopolysaccharide layer does not inhibit its passage, the antibiotic would easily destroy the cell wall of this bacteria type.

Once a student has answered a question correctly, he is not allowed to raise his hand and formally answer another question until everyone on his team has answered one correctly. Students that have answered questions correctly are, however, encouraged to help their teammates form correct answers.

When each member of your team has answered a question, your team will receive an additional point toward your unit total. This point is in addition to the points awarded for the correct answers to the questions. Once this is achieved, each member of your team is free to answer questions again.

B.*Microbial Jeopardy!™ unit*
The class period before each exam signals the end of the current Microbial Jeopardy!™ unit. On this day, three questions will be answered, as usual. Each team will add up the points it has accrued since the last exam. As with the game show Jeopardy!™, each team will wager any number of its points toward the answer to a Final Jeopardy!™ question. The question will be answered as a team, on paper, after group consultation. Each team has 60 seconds to determine an answer, write it down, and submit it to the instructor.

Final Jeopardy!™ questions will usually refer to a continuing theme of the unit or to supplemental readings assigned during the unit.

> Example Final Jeopardy!™ question for a unit on cell structure:
>
> During this unit we have repeatedly seen the use of membranes to define structures of a cell. How might endosymbiosis be responsible for the use of membranes in defining the organelles of a eukaryotic cell?
>
> *Answer*: Endosymbiosis is when one microorganism lives inside another. The Endosymbiotic Theory suggests that the organelles of eukaryotic cells arose from prokaryotic cells being engulfed by a larger cell and the cells developing a mutually beneficial relationship. The structure of membranes and their ability to pinch off as vesicles and form compartments around molecules lends support to this theory.

The instructor will read each answer out loud to the class, discuss why the answer is right or wrong, and change the team's point totals accordingly. The group that has the largest number of answered questions at the end of each unit will receive a special incentive.

Following the exam, the game starts over with a new Microbial Jeopardy!™ unit.

Instructor Version.

1. Cluster students into teams by row or by some other method that ensures team members are sitting near one another. Encourage these students to form study groups to ensure their team's success. Also have the teams come up with a team name to help foster a commitment to the group.
2. Before questions are asked, let team members remind each other which teammates have not answered questions yet. Students are generally honest about this and can self monitor. Give these students some words of encouragement before you begin.
3. When you ask the questions in class, have your eyes ready. Students will let you know if you don't pick the fastest hand.
4. To prepare questions for each class period, the instructor should think of what concepts he wishes to reinforce. Also, he may want to assess student learning in an area that is particularly difficult or that students appear to be struggling with. The instructor may choose to formulate the questions around his stated list of learning objectives for the class period. In this way the questions are designed around key concepts and are prepared along with the lesson plan.
5. The category for each day is the general topic discussed in the previous class period. You can tell students the category before you begin the questions. Because you are posing questions based on the previous 40 minutes of class time (if your class meets three times a week for 50 minutes each), it is doubtful that you would have multiple categories to cover during a single Microbial Jeopardy!™ session.
6. For each class period or Microbial Jeopardy!™ session, you will need to prepare two Type A questions and one Type B question. Type A questions should ask students to explain concepts or display a basic understanding of a topic. Prepare questions that require a complete answer, greater than one or two words. In this way, even if the student answers "correctly," he may still be asked to consult his team for additional input. This creates a situation where the team is almost always encouraged to collaborate on an answer. The instructor gets a better sense of class comprehension, instead of the comprehension of just a single individual. Only when the student gives a thorough answer to begin with should you not ask for team collaboration. In my experience, students rarely give complete answers on their own at the beginning of the course, but greatly improve their communication skills throughout the semester.

Examples of Type A questions and answers

Category: prokaryotic cell structure

a. What is the general structure of a prokaryotic flagellum?
Answer: A prokaryotic flagellum is made of repeating protein subunits called flagellin that are attached to a basal body near the cell wall.

b. What are two types of pili and what functions do they serve?
Answer: Conjugation pili, or F pili, allow the transfer of genes between two bacterial cells. Attachment pili, or fimbrae, facilitate cell-cell adhesion, as well as adhesion of cells to other surfaces.

c. What is chemotaxis?
Answer: Chemotaxis is the movement of cells toward or away from a substance in their environment. A cell will move toward an increasing gradient of attractant chemicals, like food, and away from an increasing gradient of a repellent, such as a toxin.

d. What are slime layers used for?
Answer: Slime layers are used for protection from drying, trapping nutrients, and cell adhesion.

e. What is the process that might occur in bacteria, such as *Bacillus*, when their environment is depleted of nutrients?
Answer: The bacteria might begin to make endospores by forming a core, cortex, and spore coat that resists drying and heat.

Category: carbohydrate fermentation

a. What is similar between carbohydrate fermentation and the process of aerobic respiration?
Answer: Both of these processes begin with the same set of reactions referred to as glycolysis, where glucose is broken down into pyruvate molecules.

b. What is the role of NADH in carbohydrate fermentation?
Answer: NAD+ is a coenzyme that obtains electrons during the breakdown of glucose in glycolysis, becoming NADH in the process. The NADH must be recycled back to NAD+ for glycolysis to continue.

7. Type B questions should require more synthesis and critical thinking to answer. Again, the answers should be complete, or the team will be consulted for additional input.

Examples of Type B questions and answers

Category: prokaryotic cell structure

a. Why must prokaryotic cells be smaller than eukaryotic cells?
Answer: Eukaryotic cells are organized into various membrane-bound compartments which requires more space in a cell, and they have a cytoskeleton which aids in the movement of molecules and maintains the integrity of greater cell volume. Prokaryotic cells do not have membrane-bound compartments nor do they have a cytoskeleton.

b. How does a cell membrane, having the viscosity of a light oil, successfully keep the contents of a cell contained?
Answer: Some cells use cell walls, and others use cytoskeleton fibers for strength to maintain the cell's integrity. The cell membrane merely serves as a barrier between the outside and inside environments of the cell. It is not used for strength. Molecules move into and out of the cell by osmosis, diffusion, and active transport in response to the cell's external and internal environment.

Category: carbohydrate fermentation

a. More ATP is generated during aerobic respiration than during carbohydrate fermentation. Why might a cell use carbohydrate fermentation over aerobic respiration?
Answer: The cell may not possess the genes to make the enzymes needed to perform the Kreb's cycle or electron transport. Also, in an environment where there is no oxygen, carbohydrate fermentation would be an efficient form of carbohydrate metabolism.

b. Why are there different pathways of carbohydrate fermentation? Why don't all fermenting microorganisms make ethanol and carbon dioxide?
Answer: The microorganism may possess different genes that make enzymes which catalyze the production of lactic acid instead of ethanol and carbon dioxide. Also, this lactic acid production may be beneficial to an organism to defend its environmental niche from competing microorganisms.

c. Oxygen is produced in the process of photosynthesis. Is it likely that a microorganism that performs photosynthesis also performs fermentation?
Answer: If oxygen is toxic to the microorganism, it will obviously not perform photosynthesis. Since we can assume that oxygen is not entirely toxic to this organism, then it would be in the interest of the microorganism to use the oxygen for aerobic respiration. However, the microorganism may only possess enzymes for fermentation pathways and therefore would perform carbohydrate fermentation in the presence of oxygen.

8. It is suggested that you prepare each question in large font on an overhead projector or other projection tool. Read the question out loud, as well, to provide the question both orally and visually. This will help many students process the question easier.
9. When a student does give a complete answer, use it as a short discussion point. You are reviewing material and reinforcing key points. For added incentive, give the student some Halloween candy, a rubber skeleton, etc. during class periods in October, or some similar month-appropriate trinket.
10. Keep track of each team's points between exams. Bring the tally sheet with you to each class period and announce the scores before you ask the first question.
11. When it's time for the Final Microbial Jeopardy!™ question, have students tell you their point wager and write this on the board next to their total Microbial Jeopardy!™ unit points. Then ask the question and have the team write their answer on a single sheet of paper and hand it in after 60 seconds. Read the answers to the class and have them discuss as a class whether each is an appropriate and complete answer. The instructor has the final word.
12. Teams that win the Microbial Jeopardy!™ unit, following each Final Microbial Jeopardy!™ question, must be rewarded with something of some value. I suggest participation points that go toward a grade, extra credit toward the upcoming exam, homemade cookies, or a class Microbe Trophy to be held until the next team completes their questions. With this activity, the peer collaboration and competition and the incentives maintain student effort and enthusiam throughout the semester.

Safety Issues.
Although competition does get tense on occasion, there are no real safety issues to mention.

ASSESSMENT and OUTCOMES

Suggestions for Assessment.
This is an assessment activity. For the instructor, this is an ideal way to put a finger on the pulse of the classroom. The level of difficulty and interpretation of student accomplishment depends on the expectations of the instructor and the intensity of the course. For a General Microbiology course for Biology majors and Environmental Science majors, I expect students to be prepared for class, to be actively involved, to study regularly and in groups, and to know what is expected of them on exams. This activity covers all of those points without students even knowing it. Furthermore, I get a window into their level of understanding with each question asked and can adapt teaching strategies accordingly. When a question generates answers that deviate from what is expected or appears to be unusually difficult for teams, start the current class period by revisiting this concept.

Field Testing.
This activity has been tested for 3 years in both Microbiology and Cell Biology classrooms. The ideal class size is 24, but it has been used in classes of up to 40 students. Students are awake and engaged in this activity. Without fail, even the shyest person, with the support of his teammates, rises to the occasion. Approximately 34% of students list Microbial Jeopardy!™ as what they "most like about this course." My colleagues stop in the hallways and listen to the "laughing and cheering" they hear coming from my classroom. Many of them are now using some aspect of this activity in their own classrooms.

SUPPLEMENTARY MATERIALS

Possible Modifications.

- If a daily assessment is not ideal, this activity can be used less frequently at the end of a chapter or unit.
- This activity can be modified for use in a single Review Day. Teams play by the same rules as stated above. Questions are asked during the entire class period, with some small discussion added when necessary. Team questions are tallied and the class period ends with a Final Microbial Jeopardy!™ question. This is a great way to provide a student review for an exam.
- If the course sections are large, you may modify this activity in many ways. Team sizes can be enlarged to six without much change in the dynamics of the exercise. It is easier to keep track of fewer teams. This activity should probably be used as a single Review Day strategy for larger classes, as well. Three questions per class period does not add up to many points per team when there are 20 teams.
- When used as a Review Day in a large class, I suggest the following format. Divide the class into groups of six plus an additional person designated as the Gameshow Host. Write out the questions, answers, and the points they are worth on index cards and distribute one set of questions to each Host. The groups of six divide further into three teams of two members each. The rules are the same as above, but the teams are smaller. Instruct your Gameshow Hosts to encourage help from a teammate when a student does not give the complete answer shown on the index card. Have the Host keep a tally of points generated from his three teams during the class period. The final minutes can be used for a Final Microbial Jeopardy!™ question. Teams will tell their Gameshow Host how many points they will wager against the final question. You will provide the question to the entire class. Each team will be asked to submit in writing a complete answer to the Final Jeopardy!™ question. Gameshow Hosts will provide you with point tallies for each of their teams. You will give the answer to the Final Microbial "Jeopardy" question before the class period ends. At the beginning of the next class period, before you hand out the exam, you can announce the final standings of the Microbial Jeopardy!™ Review Day and award the winning teams prizes.
- If your class meets only twice per week, you may modify this activity by asking as many as five questions at the beginning of the class. This will work only if you meet for 75 minutes on these days, rather than the normal 50 minute class period for 3 days per week. If your class period is longer, you can afford to spend more time at the beginning engaged in this activity. You may have to go to two categories per Microbial Jeopardy!™ session, depending on the material covered in the previous class period.
- In order to incorporate more writing skills into your course and give students more input into the learning process, you may wish to have students write questions of their own. Following a given class period, students could write questions for use in the next class period, as if they would be used in the next Microbial Jeopardy!™ session. The instructor could compile the questions for use as a study guide for the upcoming exam. The instructor may wish to actually use some of the more useful questions on the upcoming exam, or add them to the Microbial Jeopardy!™ database for use in next semester's class.