Problem-Based Group Examinations

Resource Type: Curriculum: Classroom

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Authors

Erica Suchman
Colorado State University
Fort Collins, Colorado 80523
USA
Email: Erica.Suchman@colostate.edu

Ralph Smith
Colorado State University
Fort Collins, Colorado 80523
USA

Abstract

This activity consists of four in-class group examinations students will complete during the semester. Students are initially given an ungraded group exam to facilitate group formation and provide familiarization with the group process. A benefit of group exams is that students meet group members with whom they will study outside of class on a regular basis.

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

This activity includes four examinations covering the following topics:
A. Microbial classification, comparing and contrasting eukarya, bacteria, and archea, and the five kingdoms
B. Metabolism and bioremediation
C. Transcription, translation, and mutations
D. Viral genome types, life cycles, and antiviral drugs

Core Themes Addressed.
A. Microbial classification: 5. Integrating themes - microbial diversity; 1. Microbial cell biology - cellular structure and function.

B. Metabolism and bioremediation: 5. Integrating themes - microbial diversity; 1. Microbial cell biology - cell energy metabolism; 4. Interactions and impact of microorganisms in the environment - microbial recycling of resources and microbes transforming the environment.

C. Transcription, translation, and mutations: 1. Microbial cell biology - cell information flow within a cell; 2. Microbial genetics - inheritance of genetic information and causes, consequences, and uses of mutations.

D. Viral genome types, life cycles, and antiviral drugs: 1. Microbial cell biology - cell information flow within a cell; 2. Microbial genetics - inheritance of genetic information; 5. Integrating themes - microbial diversity; 3. Interactions and impact of microorganisms on humans.

Intended Audience.
A. Microbiology/biology majors, allied health majors, science education majors, nonmajors
B. Microbiology/biology majors
C. and D. Microbiology/biology majors, science education majors

Time Required.
One 50-minute class period; however, students are required to work on group exams outside of class for at least a few hours.

Pedagogical Function.
This activity was designed to help students move beyond simply memorizing content to using critical thinking skills to solve problems using material learned in class. It is also designed to familiarize students with finding information in their textbooks. Furthermore, it helps students develop the teamwork skills they will need in their careers and encourages them to study with other students in the class.

Background.
A. To prepare for this activity students have heard five lectures on bacterial cell components (cell membranes, cell wall,

cytoplasmic and external components). In each of these lectures differences between eukarya, bacteria, and archea are pointed out. However, some of the information on the group exam has not been covered in class, and students must use their books to find it (e.g., Can fungi have cellulose in their cell walls? Are there protista without mitochondria?).

B. To prepare for this activity students have heard six lectures on bacterial metabolism and have been introduced to the concept of bioremediation.

C. To prepare for this activity students have heard five lectures on transcription, translation, nucleic acids, and mutations.

D. To prepare for this activity students have heard five lectures on transcription, translation, nucleic acids, and mutations and three lectures on the properties of viruses including the different types of viral genomes and how different virus types reproduce.

PROCEDURE

Materials.
Included are the group examinations that we give out to students and the keys that are used to grade these examinations. The Appendix provides a link to the course syllabus and a schedule describing the group exams.

A. Microbial classification:

- Classification exam (PDF)
- Classification exam key (PDF)

B. Metabolism and bioremediation:

- Metabolism group exam (PDF)
- Metabolism exam key (PDF)

C. Transcription, translation, and mutations:

- Genetics group exam (PDF)
- Genetics group exam key (PDF)

D. Viral genome types, life cycles, and antiviral drugs:

- Virus reproduction exam (PDF)
- Virus reproduction exam key (PDF)

Instructor Version.

- During our course students take four in-class small group examinations. These exercises require them to synthesize information from lectures and text using critical thinking skills to solve problems.
- The first in-class examination (on microbial classification) is not graded and allows students to find a self-selected group and learn how group exams work. This ungraded group exam asks students to classify microbes based on a list of characteristics. It covers microbial classification, comparing and contrasting eukarya, bacteria, and archea, and the five kingdoms.
- Three other graded group exams are given during the semester covering topics students traditionally had a difficult time thinking about conceptually, including metabolism; transcription, translation, and mutations; and viral genome types, replication, and antiviral drugs.
- The group exams are always given after a few lectures introducing the subject matter to be covered on the exam.
- Students form permanent six-member groups during their third group exam, allowing them to change groups twice if they are unhappy with their group.
- The students are each given the in-class examinations one week before they are to meet to complete the assignment. We inform students that group examinations are not designed to be completed in 35 minutes and that if they do not work on these examinations outside of class we anticipate that they will be unable to complete them in the time available.
- On the day of the in-class examination, groups meet to compare the answers each student has brought to class and together compile a common written answer. During the class period, the instructor circulates to answer questions and observe progress. The instructor verifies the attendance of each group's members by initialing the student's names on a common sheet.
- Groups compile a common answer to the in-class examination and turn it in for credit. The last page of the exam has a "page of dissent." This page was added to allow students to disagree with the answer their group submits. If a student registers a dissent they must sign it. If the dissenter is correct only he or she will get the credit, and if the group is correct only the dissenter will lose credit.
- The last 15 minutes of class are dedicated to going over the answers, as we found that students learned more if we went over the answers with them.
- There are three graded in-class examinations each worth 20 points with the lowest score for the three examinations dropped. Dropping one score eliminates the need to have make-up examinations for students who miss the examinations.
- Students are strongly encouraged by the instructor throughout the semester to study on a regular basis with members of their group.

Safety Issues. None

ASSESSMENT and OUTCOMES

Suggestions for Assessment.
Students are graded on the quality and accuracy of the written answers provided on in-class group exams. As we have used them, the two group exam grades that are kept for each student (after dropping the lowest score) comprise 6.7% of the

total grade. All of our group assignments taken together contribute 16.7% to the student's grades. Specific point breakdown is as follows:

Group projects point break down (total 100 points):

Graded in-class group exams, 2 worth 20 points each	40 points
Group poster grade	50 points
Group member evaluations	10 points

Grading (total 600 points):

In-class individual examinations, 3 worth 100 points each	300 points
Comprehensive final	200 points
Group projects	100 points

Problems and Caveats.

1. Self-selected or instructor-selected groups: We believe this is a decision to be made by the instructor based on class demographics and personal feelings.
2. Attendance: We have found it necessary to verify the presence of each group member on the day of the group exams because students will say other students are present who are not. Verifying attendance provides the added benefit of allowing the instructor to learn the names of many of the students as he/she walks around the room initialing the presence of each student.
3. Dysfunctional groups do occur: We request that students try to work out any differences and only come to the instructors if this fails. We have on occasion had to mediate disputes within groups. After the first graded group examination, if students do very poorly they are strongly encouraged to break up.
4. Students working equitably in their groups: We try to insure that students work equitably in two ways: 1) The questions they answer on group exams are fair game for individual in-class examinations, and 2) ten points of each student's grade are given by the other members of the group so students who do not participate can have their grade decreased by the other members of their group.
5. Advertising matters: When we first added group projects to our class we called them group projects. However, we found that students would not look at the problems before class and would then complain that they did not have time to finish, even though we had counseled them that they were expected to complete them outside of class and simply meet with their groups to determine the best answer. Changing the name to in-class group examinations made an unexpectedly large change in the level of commitment and preparation of the students.
6. Timing of group formation: Try to avoid forming permanent groups until after the course drop/add deadline to avoid small and fragmented groups.
7. Instructor workload: Our class generally has around 160 students, which means we are only grading about 20 to 30 group exams. Even though the answers are often lengthy and complicated, these can be graded in a few hours, as opposed to the few days it would take an instructor to grade 160 individual papers.
8. The page of dissent: We found it necessary to add this page because students often complained that they knew the right answer but their group refused to believe them. We added this page to eliminate complaints. Very few students ever dissent, but occasionally they do, and often they are correct. Therefore, we feel this page is essential to happy, functional groups.
9. Group poster project modifications: When groups are required to make posters, some adjustments are needed for groups of different sizes. We sometimes have a group with less than six people because the class is not divisible by six. When this occurs the group is required to provide the last section of the poster as a group and usually receives a small amount of extra credit for their portion. Once we had a group with more than six and we created another section to be provided on the poster for that student.

Problems and Caveats that are pertinent to specific group exams.

1. Many students, and some textbook writers, make the mistake of equating the template strand with the sense strand. This is incorrect. According to Benjamin Lewin, "...the strand of DNA synthesis that directs synthesis of the mRNA via complementary base pairing is called the template strand or anti-sense strand. The other DNA strand bears the same sequence as the mRNA (except that it possesses T instead of U) and is called the coding strand or sense strand" (Genes VII, p. 119-120. Oxford University Press, 2000.).

2. Metabolism and bioremediation:
You will notice that we say "on a strictly theoretical basis." The objective of this group exam is to look at the types of metabolism bacteria can perform based on the types of molecules they can alter in their environments. We changed the group exam to say "on a theoretical basis" because students were simply finding equations that carry out the requested conversions without understanding what these equations meant and would be upset that they received little credit for finding equations in the book that "worked." Therefore, we emphasize strongly to students that we do not want equations or even to know if bacteria exist that can do these reactions; instead, we want to see that they understand the types of reactions that can lead to the oxidation of organic and inorganic molecules and the reduction of inorganic molecules such as oxygen, nitrogen, sulfur, etc.

Student Data.

We have been doing group exams for over seven semesters and have surveyed students as to their responses to this type of activity. Some of the initial results of these surveys have recently been published in: **Suchman, E., R. Smith, S. Ahermae, K. McDowell, W. Timpson.** 2000. The use of small groups in a large lecture microbiology course. J. Ind. Microbiol. Biotechnol. **25:**121-126.

In recent surveys students were asked the following questions.

Student course evaluations of active learning strategies

Question	Response

	Agree or strongly agree (%)	Neutral (%)	Disagree or strongly disagree (%)
The group exams helped improve my learning	76.4[a] 71.0[b]	11.8[a] 14.0[b]	11.8[a] 15.0[b]

[a]Dr. Suchman's class; 51 students surveyed.

[b]Dr. Smith's class; 114 students surveyed.

We also were awarded a grant for a pedagogical study of our course. We used the money to conduct student consultation groups with students who had finished our course and were continuing in microbiology courses. The results of the relevant analysis are shown below.

Student consultation group results evaluating group activities

Question	Response[a]		
	Agree or strongly agree (%)	Neutral (%)	Disagree or strongly disagree (%)
The group exams helped me understand the concepts	63.5	11.5	25.0
The group exams helped me learn how to work with people	51.9	21.2	26.9
The people in my group contributed equitably	51.9	15.4	32.7
I enjoyed the group projects	53.9	19.2	26.9
I prefer to work alone, not in groups	32.7	21.2	46.1

[a]53 students surveyed.

SUPPLEMENTARY MATERIALS

Possible Modifications.
1. If you have a small enough class these examinations could be filled out by individual students, however, we feel the group work offers a variety of added educational benefits such as learning teamwork skills and finding people in the class to study with. Furthermore, there is much debate in education circles about self-selected versus faculty-selected groups. Our class has students with over 30 different majors who have widely varying commitments to the course, so we are unwilling to force students into groups, preferring to allow self-selection.
2. We assign the groups a final project after all in-class exams are complete. Each group is to develop a poster covering a disease of choice.

Appendix.
Course syllabus and schedule describing our group exams.

- General microbiology course syllabus - Suchman
- General microbiology course schedule - Suchman

Group Project—Compare and Contrast the Prokaryotic and Eucaryotic Cell, Eubacteria, and Archeabacteria.

Your group just came back from an expedition to South America. While you were there you isolated four organisms from the environment. Your group's job is to determine if each organism is a eukaryote, eubacteria, or archeabacteria and decide into which kingdom in the five-kingdom classification system (i.e., Plantae, Protista, Fungi, Animalia, and Monera) it fits. Below is a list of data acquired from each of the organisms. Please indicate for **each piece of information** which type and kingdom of organism could have the characteristic. At the end, please indicate whether you believe each cell is a eukaryote, eubacteria or archeabacteria and to which kingdom you believe the organism belongs(e.g., characteristic analyzed: has a cell membrane; type: eukaryote, eubacteria or archeabacteria; and possible kingdoms: Plantae, Protista, Fungi, Animalia, and Monera.

Organism 1

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archeabacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ester-linked straight chain fatty acids and cholesterol		
2. Chlorophyll	Absent		
3. Cell division	Mitosis		
4. Ribosome size	70S and 80S		
5. Motility	Yes, using cilia		
6. Mitochondria	Present		
7. Cytoskeleton	Present		
8. Cell wall composition	No cell wall present		

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archeabacteria, and to which kingdom does it belong and why? Hint this organism is single celled.

Organism 2

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archeabacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ester-linked straight chain fatty acids, and hapanoids		
2. Chlorophyll	Present		
3. Cell division	Binary fission		
4. Ribosome size	70S		
5. Motility	Yes, using flagella		
6. Mitochondria	Absent		
7. Cytoskeleton	Absent		
8. Cell wall composition	*N*-acetylglucosamine, *N*-acetylmuramic acid, andamino acids		

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archeabacteria, and to which kingdom does it belong and why? Hint this organism is single celled.

Organism 3

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archeabacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ether-linked branched chain fatty acids		
2. Chlorophyll	Absent		
3. Cell division	Binary fission		
4. Ribosome size	70S		
5. Motility	None		
6. Mitochondria	Absent		
7. Cytoskeleton	Absent		
8. Cell wall composition	*N*-acetylglucosamine, *N*-acetylalosaminuronic acid, amino acids		

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archeabacteria, and to which kingdom does it belong and why? Hint this organism is single celled.

Organism 4

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archeabacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ester-linked straight chain fatty acids and cholesterol		
2. Chlorophyll	Absent		
3. Cell division	Mitosis		
4. Ribosome size	70S and 80S		
5. Motility	None		
6. Mitochondria	Present		
7. Cytoskeleton	Present		
8. Cell wall composition	Cellulose		

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archeabacteria, and to which kingdom does it belong and why? Hint this organism is multicellular.

Common features

1. Have a cell membrane.
2. Have phospholipid bilayer cell membranes.
3. Cell membranes follow fluid mosaic model (phospholipids with intrinsic and extrinsic proteins, etc.)).
4. Membranes are semipermeable barriers to the outside world.
5. Ribosomes present.
6. Ribosomes make proteins.
7. Have chromosomes.
8. Have cytoplasm.
9. Cytoplasm is mostly water.
10. Can be motile.

Separating features

1. Only eukaryotes have phospholipid bilayer-bound organelles.
2. Only eukaryotes have histones around DNA.
3. Eukaryotes have much more DNA.
4. Mammalian and eukaryotic chromosomes are linear; prokaryotic chromosomes are circular.
5. Eukaryotic DNA in nucleus; prokaryotic in nucleoid.
6. Prokaryotes have plasmids.
7. Eukaryotic RNA is spliced; prokaryotic is not.
8. Eukaryotic RNA is more complex.
9. Different sized ribosomes.
10 Eukaryotic motility is more complex, can use cilia, pseudopodia.
11. Eukaryotic cytoplasm is more complex: has structure.
12. Eukaryotes and prokaryotes have different promoters for txn.
13. Mammalian cells have no cell wall.
14. Mammalian cells cannot make endospores.
15. Eukaryotes reproduce by mitosis; prokaryotes by binary fission.
16. Prokaryotic cells can exchange genetic information via transformation, conjugation, etc.
17. There are different steroids in the cell membrane.
18. Eukaryotes do not have a periplasmic space.

Common features

1. Have a cell membrane.
2. Have phsopholipid bilayer cell membranes.
3. Cell membranes follow fluid mosaic model (phospholipids with intrinsic and extrinsic proteins, etc.)
4. Membranes are semipermeable barriers to the outside world.
5. 70S ribosomes present.
6. Ribosomes make proteins.
7. Have circular chromosomes.
8. Have cytoplasm.
9. Cytoplasm is mostly water.

Separating features

1. Same-sized ribosomes are structurally different.
2. Not equally susceptible to antibiotics that inhibit ribosome function.
3. Different lipids in the membrane; branched chains in archaebacteria only.
4. Ester-linked lipids only in eubacteria, ether linked in archaebacteria.
5. Eubacteria are widespread; archaebacteria live in harsh environments.

Group Project—Compare and Contrast the Prokaryotic and Eucaryotic Cell, Eubacteria, and Archeabacteria.

Your group just came back from an expedition to South America. While you were there you isolated four organisms from the environment. Your group's job is to determine if each organism is a eukaryote, eubacteria, or archeabacteria and decide into which kingdom in the five-kingdom classification system (i.e., Plantae, Protista, Fungi, Animalia, and Monera) it fits. Below is a list of data acquired from each of the organisms. Please indicate for **each piece of information** which type and kingdom of organism could have the characteristic. At the end, please indicate whether you believe each cell is a eukaryote, eubacteria or archeabacteria and to which kingdom you believe the organism belongs (e.g., characteristic analyzed: has a cell membrane; type: eukaryote, eubacteria, archeabacteria; and possible kingdoms: Plantae, Protista, Fungi, Animalia, Monera.

Organism 1

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archaebacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ester-linked straight chain fatty acids and cholesterol	Eukaryote only	Plantae, Protista, Fungi, Animalia
2. Chlorophyll	Absent	Eukaryote, eubacteria, archaebacteria	Monera, Protista, Fungi, Animalia, rare plantae
3. Cell division	Mitosis	Eukaryote only	Protista, Fungi, Animalia, Plantae
4. Ribosome size	70S and 80S	Eukaryote: 80S in cytoplasm, 70S in mitochondria	Plantae, Protista, Fungi, Animalia
5. Motility	Yes, using cilia	Eukaryote only	Protista
6. Mitochondria	Present	Eukaryote only	Plantae, Protista, Fungi, Animalia
7. Cytoskeleton	Present	Eukaryote only	Plantae, Protista, Fungi, Animalia
8. Cell wall composition	No cell wall present	Eukaryote, eubacteria, archaebacteria	Protista, Animalia, Monera

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archaebacteria, and to which kingdom does it belong and why? Hint this organism is single celled. Nonphotosynthetic protozoa: we know it is not Animalia because it is not multicellular (if it was sperm it would have flagella). It has no cell wall or chlorophyll, therefore it is not in the kingdom Plantae. It has organelles and a cytoskeleton, so it is not in the kingdom Monera. It has no cell wall therefore it is not in the kingdom Fungi.

Organism 2

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archaebacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ester-linked straight chain fatty acids, and hapanoids	Eubacteria	Monera
2. Chlorophyll	Present	Eukaryote, eubacteria	Plantae, Monera, Protista
3. Cell division	Binary fission	Eukaryote, eubacteria, archaebacteria	Protista, Monera
4. Ribosome size	70S	Eubacteria, archaebacteria	Monera
5. Motility	Yes, using flagella	Eukaryote, eubacteria, archaebacteria	Protista, Fungi, Monera, Animalia (sperm only)
6. Mitochondria	Absent	Eukaryote, eubacteria, archaebacteria	Protista, Monera
7. Cytoskeleton	Absent	Eubacteria, archaebacteria	Monera
8. Cell wall composition	*N*-acetylglucosamine, *N*-acetylmuramic acid, andamino acids	Eubacteria	Monera

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archaeabacteria, and to which kingdom does it belong and why? Hint this organism is single celled.

Eubacteria, Monera: the type of cell wall tells you it is an eubacteria. The lack of sterols in the membrane, mitochondria, 80S ribosomes, and cytoskeleton indicate it is not eukaryotic. Although there are protozoa without mitochondria, the membrane and cell wall tell you it is not a protozoa.

Organism 3

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archaebacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ether-linked branched chain fatty acids	Archaebacteria	Monera
2. Chlorophyll	Absent	Eukaryote, eubacteria, archaebacteria	Protista, Fungi, Animalia, Monera, rare Plantae
3. Cell division	Binary fission	Eukaryote, eubacteria, archaebacteria	Protista, Monera
4. Ribosome size	70S	Eubacteria, archaebacteria	Monera
5. Motility	None	Eukaryote, eubacteria, archeabacteria	Plantae, Protista, Fungi, Animalia, Monera
6. Mitochondria	Absent	Eukaryote, eubacteria, archaebacteria	Protista, Monera
7. Cytoskeleton	Absent	Eubacteria, archaebacteria	Monera
8. Cell wall composition	*N*-acetylglucosamine, *N*-acetylalosaminuronicacid, amino acids	Archaebacteria	Monera

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archaebacteria, and to which kingdom does it belong and why? Hint this organism is single celled. Archaebacteria, Monera: cell wall composition and membrane composition indicate that this is an archaebacteria, kingdom Monera. The type of fatty acids and the way they bond the membrane, the 70S ribosomes, and the lack of mitochondria and cytoskeleton tell you this is not an eukaryotic cell.

Organism 4

Characteristic analyzed	Result	Type of organism which could have this result: eubacteria, eukaryote or archaebacteria. List all possibilities.	Kingdom to which an organism with this result could belong. List all possibilities.
1. Cell membrane components	Ester-linked straight chain fatty acids and cholesterol	Eukaryote	Plantae, Protista, Fungi, Animalia
2. Chlorophyll	Absent	Eukaryote, eubacteria, archaebacteria	Protista, Fungi, Animalia, Monera, Rare Plantae
3. Cell division	Mitosis	Eukaryote	Plantae, Protista, Fungi, Animalia
4. Ribosome size	70S and 80S	Eukaryote	Plantae, Protista, Fungi, Animalia
5. Motility	None	Eukaryote, eubacteria, archaebacteria	Plantae, Protista, Fungi, Animalia, Monera
6. Mitochondria	Present	Eukaryote	Plantae, Protista, Fungi, Animalia
7. Cytoskeleton	Present	Eukaryote	Plantae, Protista, Fungi, Animalia
8. Cell wall composition	Cellulose	Eukaryote	Plantae, Protista, Fungi

Conclusions: using all of the information above, is this organism an eukaryote, eubacteria, or archaebacteria, and to which kingdom does it belong and why? Hint this organism is multicellular. Eukaryotic, Fungi (although it could be a rare nonphotosynthetic plant): the cell membrane, and cell wall type tell you this is an eukaryotic cell; the lack of chlorophyll tells you this is most likely not in the kingdom Plantae. The presence of the cell wall tells you this is not in Animalia. The fact that it is multicellular tells you it is not in the kingdom Protista (they are all unicellular; the red and brown sea algae are in the kingdom Plantae). If this was a single-celled organism, it could have been a single-celled fungi or a Protista.Putting organisms into kingdoms is often not as easy as it seems!

Common features

1. Have a cell membrane.

2. Have phospholipid bilayer cell membranes.
3. Cell membranes follow fluid mosaic model (phospholipids with intrinsic and extrinsic proteins, etc.)).
4. Membranes are semipermeable barriers to the outside world.
5. Ribosomes present.
6. Ribosomes make proteins.
7. Have chromosomes.
8. Have cytoplasm.
9. Cytoplasm is mostly water.
10. Can be motile.

Separating features

1. Only eukaryotes have phospholipid bilayer-bound organelles.
2. Only eukaryotes have histones around DNA.
3. Eukaryotes have much more DNA.

4. Mammalian and eukaryotic chromosomes are linear; prokaryotic chromosomes are circular.
5. Eukaryotic DNA in nucleus; prokaryotic in nucleoid.
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Common features

1. Have a cell membrane.
2. Have phsopholipid bilayer cell membranes.

3. Cell membranes follow fluid mosaic model (phospholipids with intrinsic and extrinsic proteins, etc.)
4. Membranes are semipermeable barriers to the outside world.
5. 70S ribosomes present.

6. Ribosomes make proteins.
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9. Cytoplasm is mostly water.

Separating features

1. Same-sized ribosomes are structurally different.
2. Not equally susceptible to antibiotics that inhibit ribosome function.
3. Different lipids in the membrane; branched chains in archaebacteria only.
4. Ester-linked lipids only in eubacteria, ether linked in archaebacteria.
5. Eubacteria are widespread; archaebacteria live in harsh environments.

Group Exam 1 METABOLISM.

Date _____

Member's of the group present for project 1 **listed in alphabetical order please**!

Instructor verification

1 _____ _____

2 _____ _____

3 _____ _____

4 _____ _____

5 _____ _____

6 _____ _____

You have landed a great job with a microbiology firm, Microbes 'R' Us in Fort Collins, Colorado. The firm's job is to provide information about microbes to those that use them, such as companies that produce microbially fermented foods, or perform bioremediation. You have been assigned to a group with five other fine scientists. Your mission is to provide information to the following companies regarding the types of microbes they should use.

1. Your first assignment is to provide information to the firm BigMoney Inc, a chemical producer in Kansas interested in using microbes to clean toxic spills (bioremediation). BigMoney Inc. has had a major spill of inorganic H_2S that contaminated the soil around their plant. Scientists at BigMoney have developed mechanisms for removing sulfur (S) from soil but have not found one for H_2S. They want to know on a **strictly theoretical** basis (regardless of whether bacteria exist in nature that actually do these specific reactions) if there are any types of bacteria that could metabolize H_2S to give rise to S?

(H_2S) ⟶ (S) a) Is this an oxidation or reduction? b) Is H_2S acting as an electron acceptor or donor?

c) Which of the following metabolic pathways - aerobic respiration, anaerobic respiration, aerobic chemolithotrophy and anaerobic chemolithotrophy - could be used to carry out this reaction? Remember, think strictly theoretically. You must think about whether each of these reactions can oxidize or reduce inorganic materials. You may not change the pathways in any manner except the exact molecules that serve as the final electron acceptors and the initial electrons donors; however, the donors and acceptors may NOT change type (organic versus inorganic). Note: you must indicate ALL metabolic pathways that could be used.

d) For each of the ways that could be used, describe exactly how S will be formed providing the following information: 1) Is the initial electron donor (from where the electrons are being taken) inorganic or organic? 2) Which of the pathways discussed in class - glycolysis, TCA, electron transport, chemolithotrophy, photosynthesis, fermentation - will be used to get the electrons, and 3) Is the final electron acceptor organic or inorganic? 4) Please provide a specific example of an electron acceptor and donor pair **that would work** and briefly describe why it was chosen. Hint: remember that you must consider the Redox potential of the electron acceptor compared to that of the electron donor. Note: you may assume other molecules, both organic and inorganic, are present in the soil.

2. BigMoney Inc. has also had a major spill of inorganic nitrite ($N0_2^-$) that contaminated the soil around their plant. Scientists at BigMoney have developed mechanisms for removing ammonia (NH_4) from soil, but have not found one for nitrite ($N0_2^-$). They want to know on a **strictly theoretical** basis (regardless of whether bacteria exist in nature that actually do these specific reactions) if there are any types of bacteria that could metabolize nitrite ($N0_2^-$)to give rise to ammonia (NH_4)?

2. Nitrite ($N0_2^-$) ⟶ Ammonia (NH_4). a) Is this an oxidation or reduction? b) Is nitrite serving as an electron acceptor or donor?

c) Which of the following metabolic pathways - aerobic respiration, anaerobic respiration, aerobic chemolithotrophy, and anaerobic chemolithotrophy - could be used to carry out this reaction? Remember, think strictly theoretically. You must think about whether each of these reactions can oxidize or reduce inorganic materials. You may not change the pathways in any manner except the exact molecules that serve as the final electron acceptors and the initial electron donors; however, the donors and acceptors may NOT change type (organic versus inorganic). Note: you must indicate ALL metabolic pathways that could be used.

d) For each of the ways that could be used, describe exactly how ammonia will be formed providing the following information: 1) Is the initial electron donor (from where the electrons are being taken) organic or inorganic, 2) Which of the pathways discussed in class - glycolysis, TCA, electron transport, chemolithotrophy, photosynthesis, fermentation - will be used to get the electrons, and 3) Is the final electron acceptor organic or inorganic? 4. Please provide a specific example of an electron acceptor and donor pair **that would work** and briefly describe why it was chosen. Hint: remember that you must consider the Redox potential of the electron acceptor compared to that of the electron donor. Note: you may assume other molecules, both organic and inorganic ,are present in the soil.

3. The company BigMoney Inc. is in trouble again. This time they have had a major spill of a hydrocarbon fuel. They looked through the literature and found the following information describing the types of metabolism used by microbes to degrade hydrocarbons at 25 contaminated sites. Not having taken microbiology or biochemistry, they want to know what this information means. Please choose one of the types of metabolism shown **OTHER THAN** aerobic respiration. Assume that any bacteria capable of degrading hydrocarbons is capable of first breaking the hydrocarbons down into glyceraldehyde 3-phosphate. For the type of metabolism you chose please answer the following questions:

At the 25 sites the ranking of methods for biodegradation of hydrocarbon fuel spills was:

Methanogenesis	**42%**
Sulfate reduction	**30%**
Denitrification	**12%**
Iron reduction	**9%**
Aerobic respiration	**7%**

a. Why does the bacteria break the hydrocarbon down into glyceraldehyde 3-phosphate?

b. List the pathways - glycolysis, TCA, electron transport, fermentation, photosynthesis, and chemolithotrophy - a bacterium would use during this type of metabolism.

c. Indicate the final electron acceptor used in the type of metabolism you chose.

d. Where do the electrons given to the electron acceptor come from? Or what is the FIRST electron donor at the beginning of metabolism?

e. Indicate whether the type of metabolism you have just described is fermentation, photosynthesis, anaerobic respiration, aerobic chemolithotrophy or anaerobic chemolithotrophy. Please note that the type of methanogenesis occurring here is usually NOT fermentation.

f. How would your answer differ if you were describing aerobic respiration?

The “Page of Dissent”

Students who disagree with the answers provided by the group can register their dissent on this page. If you disagree with your group’s answer and you are RIGHT, you will get back the points your group lost. If you disagree with your group’s answer and you are WRONG, you will lose points; only those people who dissent will lose points.

How to dissent: State the question to which you are dissenting, your dissent, and a brief justification. Students who dissent must sign their names to the dissent. If there are multiple dissents, each dissent must be signed individually. Only students who have signed their names to a dissent will get credit for it if they are correct, so make sure you sign all dissents you wish to make. Note: if we cannot determine to which question you dissent, we will not grade the dissent, so make sure you are very clear.

Metabolism Group Exam Key

1. $H_2S \rightarrow S$ H_2S is oxidized (it is the donor): aerobic and anaerobic chemolithotrophy

Pathways used for BOTH: chemolithotrophy or electron transport chain
Donor BOTH: H_2S
Acceptor aerobic: oxygen
Acceptor anaerobic: some other inorganic molecule
Example: H_2S donates electrons to oxygen or some other inorganic electron acceptor with a more positive redox potential than H_2S (-0.274). (e.g., oxygen → water (0.815), $Fe^{3+} \rightarrow Fe^{2+}$ (0.771) NO_3, or NO_2 will also work)

2. $N0_2^- \rightarrow NH_3$ Nitrite is reduced (acceptor) Nitrite can serve as the final electron acceptor in anaerobic respiration or anaerobic chemolithotrophy.

Anaerobic chemolithotrophy
Pathways: chemolithotropy or electron transport only
Acceptor: NO_2
Donor: some other REDUCED inorganic molecule
Example: H_2S (-0.274) donates electrons to NO_2. NOTE: redox potential of NO_2 (0.44) is more positive than donor.

Anaerobic respiration
Pathways: glycolysis, TCA electron transport chain
Donor: organic materials in soil
Acceptor: NO_2
Example: Sugars, proteins, lipids etc. in soil donate electrons (via anaerobic respiration, NADH (-0.32), FADH (-0.18) to NO_2(0.44) which has a more positive redox potential.

3. The company BigMoney Inc. is in trouble again. This time they have had a major spill of a hydrocarbon fuel. They looked through the literature and found the following charts describing the types of metabolism used by microbes to degrade hydrocarbons at 25 contaminated sites.

A. Why does the bacteria break the hydrocarbon down into glyceraldehyde 3-phosphate?
So it can feed into glycolysis and enter the pathways for oxidation.

B. List the pathways - glycolysis, TCA, electron transport, fermentation, photosynthesis, chemolithotrophy - a bacterium would use during this type of metabolism.
Glycolysis, TCA, electron transport

C. Indicate the final electron acceptor used in the type of metabolism you chose.
Denitrification : $N0_3 \rightarrow N_2$
Iron reduction: $Fe^{3+} \rightarrow Fe^{2+}$
Sulfate reduction: $S0_4^{2-} \rightarrow H_2S$
Methanogenesis: $C0_2 \rightarrow CH_4$

D. Where do the electrons given to the electron acceptor come from? Or what is the FIRST electron donor at the beginning of metabolism?
The hydrocarbon

E. Indicate whether the type of metabolism you have just described is fermentation, photosynthesis, anaerobic respiration, or chemolithotrophy. Please note that the type of methanogenesis occurring here is usually <u>NOT</u> fermentation.
Anaerobic respiration

F. How would your answer differ if you were describing aerobic respiration?
Aerobic respiration: exactly the same EXCEPT that oxygen will serve as the final electron acceptor.

Group Exam # 2: Transcription, Translation, and Mutation

Group Number _____ Date _____

Members of the group present for project #2 listed in alphabetical order please! Instructor verification

1 _____ _____

2 _____ _____

3 _____ _____

4 _____ _____

5 _____ _____

6 _____ _____

Table 13.1 The Genetic Code Harley et al. Microbiology 2nd Ed.

First Position (5′ End)	Second Position: U	Second Position: C	Second Position: A	Second Position: G	Third Position (3′ End)
U	UUU Phe F	UCU Ser S	UAU Tyr Y	UGU Cys C	U
	UUC Phe F	UCC Ser S	UAC Tyr Y	UGC Cys C	C
	UUA Leu L	UCA Ser S	UAA STOP	UGA STOP	A
	UUG Leu L	UCG Ser S	UAG STOP	UGG Trp W	G
C	CUU Leu L	CCU Pro P	CAU His H	CGU Arg R	U
	CUC Leu L	CCC Pro P	CAC His H	CGC Arg R	C
	CUA Leu L	CCA Pro P	CAA Gln Q	CGA Arg R	A
	CUG Leu L	CCG Pro P	CAG Gln Q	CGG Arg R	G
A	AUU Ile I	ACU Thr T	AAU Asn N	AGU Ser S	U
	AUC Ile I	ACC Thr T	AAC Asn N	AGC Ser S	C
	AUA Ile I	ACA Thr T	AAA Lys K	AGA Arg R	A
	AUG Met M	ACG Thr T	AAG Lys K	AGG Arg R	G
G	GUU Val V	GCU Ala A	GAU Asp D	GGU Gly G	U
	GUC Val V	GCC Ala A	GAC Asp D	GGC Gly G	C
	GUA Val V	GCA Ala A	GAA Glu E	GGA Gly G	A
	GUG Val V	GCG Ala A	GAG Glu E	GGG Gly G	G

Single letter codes for amino acids

ala (alanine)	A	gly (glycine)	G	phe (phenylalanine)	F
arg (arginine)	R	his (histidine)	H	pro (proline)	P
asn (asparagine)	N	ile (isoleucine)	I	ser (serine)	S
asp (aspartic acid)	D	leu (leucine)	L	thr (threonine)	T
cys (cysteine)	C	lys (lysine)	K	trp (tryptophan)	W
glu (glutamic acid)	E	met (methionine)	M	tyr (tyrosine)	Y
gln (glutamine)	Q			val (valine)	V

Please use the chart above, and the <u>sense</u> prokaryotic DNA sequence below to answer the following questions. <u>All of the questions use the same sense DNA sequence.</u>

5’ sense DNA strand +1 3’
GTTTGACACCGCATGGCCGGCTCGTATAATGTATGGATGAGGACATGTTTATCAGGGAATTCCTGTATTAGCCGTGCTATGCG

1. Please identify the three underlined sequences in the DNA provided, and briefly describe their importance.

2. What is the sequence of the mRNA? Be sure to point out which are the 5’ and 3’ ends. Note: you can ignore the transcription termination signal that would be present (due to the very large size of the stem-loop structure that signals transcription termination, this signal has been left out).

3. Please describe any important sequences in the prokaryotic mRNA that are required for translation.

4. Please describe the major differences between eukaryotic and prokaryotic mRNAs.

5. What is the amino acid sequence coded for by this sequence? What is the "message"? Please use the single-letter codes for each amino acid to decipher the "message". Hints: 1) the fmet amino acid is often deleted from the finished protein in prokaryotes, and 2) the message should actually say something to you in English. You must show all of your work to get any credit!

6. Assume that an error has occurred during DNA replication, and the sense DNA strand has a mutation in the base sequence at the site where the base is written in bold and underlined. Please decipher the new "message."

5' sense DNA strand +1 3'
GTTTGACACCGCATGGCCGGCTCGTATAATGTATGGATGAGGACATGTTTATCAGGGAATTCC**G**GTATTAGCCGTGCTATGCG

a) What is the sequence of the new "message"? Please use the single-letter codes for each amino acid to decipher the "message." Again show all of your work.

b) What type of mutation - silent, nonsense, missense, frameshift, or neutral - has occurred? If you can not determine the type of mutation, indicate which ones you have narrowed down to and why you can not make a final determination.

7) Assume that an error has occurred during DNA replication, and the new sense DNA strand has a mutation in the base sequence such that the nucleotide that is in bold and underlined has been inserted into the normal sequence. Please decipher the new "message."

5' sense DNA strand +1 3'
GTTTGACACCGCATGGCCGGCTCGTATAATGTATGGATGAGGACATGTTTATCAGGGAA**G**TTCCTGTATTAGCCGTGCTATGCG

a) What is the sequence of the new "message"? Please use the single-letter codes for each amino acid to decipher the "message." Again, show all of your work.

b) What type of mutation - silent, nonsense, missense, frameshift, or neutral - has occurred? If you can not determine the type of mutation, indicate which ones you have narrowed down to and why you can not make a final determination.

The “Page of Dissent”

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How to dissent: State the question to which you are dissenting, your dissent, and a brief justification. Students who dissent must sign their names to the dissent. If there are multiple dissents, each dissent must be signed individually. Only students who have signed their names to a dissent will get credit for it if they are correct, so make sure you sign all dissents you wish to make. Note: if we can not determine to which question you dissent we will not grade the dissent, so make sure you are very clear.

Dr. Smith's and Dr. Suchman's Group Exam 2 - KEY

Group Exam 2. Transcription, Translation, and Mutation

Please use the chart above, and the sense, prokaryotic, DNA sequence below to answer the following questions. All of the questions use the same sense DNA sequence.

5' sense DNA strand +1 (transcription start site) 3'

GTTTGACACCGCATGGCCGGCTCGTATAATGTATGGATGAGGACATGTTTATCAGGGAATTCCTGTATTAGCCGTGCTATGCG

-35 bp (RNA pol recognition site) -10 (RNA pol binding site)

1. Please identify the three underlined sequences in the DNA provided and briefly describe their importance.
PLEASE SEE ABOVE; 1 POINT FOR EACH CORRECT ANSWER (3 POINTS).

2. What is the sequence of the mRNA? Be sure to point out which are the 5' and 3' ends. Note: you can ignore the transcription termination signal that would be present (due to the very large size of the stem-loop structure that signals transcription termination, this signal has been left out).
1 POINT FOR STARTING AT U; 1/2 POINT FOR U's SUBSTITUTED FOR T's; 1 POINT FOR GOING TO THE END AND NOT STOPPING AT THE STOP CODON; 1/2 POINT FOR LABELLING 5' AND 3' ENDS CORRECTLY; 1 POINT FOR USING THE CORRECT STRAND (4 POINTS).

5' UGAGGACAUGUUUAUCAGGGAAUUCCUGUAUUAGCCGUGCUAUGCG 3'

3. Please describe any important sequences in the prokaryotic mRNA that are required for translation.

5' UGAGGACAUGUUUAUCAGGGAAUUCCUGUAUUAGCCGUGCUAUGCG 3'
1 2 3

1 POINT FOR EACH CORRECT ANSWER (3 POINTS).
1. SHINE DELGARNO: RIBOSOME BINDING SITE AGGA
2. START CODON AUG
3. STOP CODON UAG

4. Please describe the major differences between eukaryotic and prokaryotic mRNAs. If this were a eukaryotic sequence how might the mRNA be different?
1 POINT FOR EACH CORRECT ANSWER (3 POINTS).
1. NO SHINE DELGARNO SEQUENCE
2. IT COULD HAVE INTRONS AND EXONS
3. IT COULD NOT BE POLY CISTRONIC
4. IT COULD BE POST TRANSCRIPTIONALLY MODIFIED AT THE 3' AND 5' ENDS, (OPTIONAL ANSWER, DO NOT HAVE TO SAY)

5. What is the amino acid sequence coded for by this sequence? What is the "message"? Please use the single-letter codes for each amino acid to decipher the "message." Hints: the fmet amino acid is often deleted from the finished protein in prokaryotes, and 2) the message should actually say something to you in English. You must show all of your work to get any credit!

5' UGAGGAC AUG/UUU/AUC/AGG/GAA/UUC/CUG/UAU/UAGCCGUGCUAUGCG 3'
M | F I R E F L Y FIREFLY!

1 POINT FOR STARTING AT AUG; 1 POINT FOR READING THE CODON CHART CORRECTLY; 1 POINT FOR STOPPING AT THE STOP CODON (3 POINTS).

6. Assume that an error has occurred during DNA replication, and the sense DNA strand has a mutation in the base sequence at the site where the base is written in bold and underlined. Please decipher the new "message."

5’ sense DNA strand +1 3’
GTTTGACACCGCATGGCCGGCTCGTATAATGTATGGATGAGGACATGTTTATCAGGGAATTCC**G**GTATTAGCCGTGCTATGCG

a) What is the sequence of the new “message”? Please use the single-letter codes for each amino acid to decipher the “message.” Again show all of your work.

5' UGAGGAC AUG/UUU/AUC/AGG/GAA/UUC/CGG/UAU/UAGCCGUGCUAUGCG 3’
M | F I R E F R Y

YAPPY FACE 1/2 POINT

b) What type of mutation–silent, nonsense, missense, frameshift, neutral–has occurred? If you cannot determine the type of mutation, indicate which ones you have narrowed down to and why you cannot make a final determination.

CANNOT DETERMINE! IT IS *EITHER NEUTRAL OR MISSENSE*. YOU HAVE CHANGED AN AMINO ACID, BUT YOU WOULD HAVE TO ASSAY THE ENZYME ACTIVITY TO DECIDE IF THIS CHANGE AFFECTS THE PROTEIN'S FUNCTION.

1 POINT FOR MISSENSE; 1 POINT FOR REALIZING YOU CANNOT TELL (2 POINTS).

7) Assume that an error has occurred during DNA replication, and the new sense DNA strand has a mutation in the base sequence such that the nucleotide that is in bold and underlined has been inserted into the normal sequence. Please decipher the new “message.”

5’ sense DNA strand +1 3’
GTTTGACACCGCATGGCCGGCTCGTATAATGTATGGATGAGGACATGTTTATCAGGGAA**G**TTCCTGTATTAGCCGTGCTATGCG

AUG/UUU/AUC/AGG/GAA/GUU/CCU/GUA/UUA/GCC/GUG/CUA/UGC/G
M F I R E V P V L A V L C **NO STOP CODON, SO IT KEEPS GOING…1/2 POINT**

b) What type of mutation–silent, nonsense, missense, frameshift, neutral–has occurred? If you cannot determine the type of mutation, indicate which ones you have narrowed down to and why you cannot make a final determination.
FRAME SHIFT 1 POINT

Group Exam 3. Virus Reproduction

Group Number _____ Date _____

Members of the group present for project 4 listed in alphabetical order please! Instructor verification

1 _____ _____

2 _____ _____

3 _____ _____

4 _____ _____

5 _____ _____

Note: for the midterm you will be expected to be able to answer the following questions for any of the four types of viruses (DNA, positive (+) or negative (-) strand RNA, retrovirus)

Virus 1. Following is the genome of your DNA virus: Iridovirus genome: Ds DNA

```
                                          +1
5′ GTTTGACACTTTATGCTTCCGGCTCGTATAATGTATGGAATAGGAGCATGTTTATTAGTCACTAGTATCGACCGAT 3′      SENSE
3′ CAAACTGTGAAATACGAAGGCCGAGCATATTACATACCTTATCCTCGTACAAATAATCAGTGATCATAGCTGGCTA 5′      TEMPLATE
```

1. Does this virus need to bring any viral enzymes into the cell's cytoplasm with the nucleic acids? In other words, what viral enzymes, if any, will the virus require *before* it can make any viral enzymes in the host cell? If any viral enzymes must be carried into the cell, which enzymes does it need and why? If none are needed, why not? Please explain. (2 points)

2. What proteins can the virus produce once it is inside the cell?

3. What proteins do we know this viral genome codes for?

4. Knowing that in DNA viruses the promoters used are similar to the ones used in the cells they infect, what is the sequence of the viral mRNA? Be sure to indicate the 5' and 3' ends. Note: 1) due to the large size of the transcription termination signal it has been omitted, assume transcription ends at the end of the given sequence, and 2) the viral promoter sequences are underlined in the sequence above. (2 points)

5. What will the amino acid sequence of the protein produced by this virus be? Please use the single-letter amino acid code provided. Note: if done correctly, after removing the methionine it should say something to you! *Show all of your work to get credit!* (2 points)

6. Please list the cellular machinery or enzymes this virus could use in the host cell and briefly describe the function of that machinery. (2 points)

7. If you were going to design a drug to inhibit the replication of this virus without killing the host cell, what viral enzymes in the viral replication cycle would you try to target and why? If there are no viral enzymes that could be targeted, please say so, explain why, and give another way you might inhibit viral infection of host cells. (2 points)

Virus 2. Following is the genome of your RNA virus: Arenavirus genome: - RNA

3′ AUAGCUACUCUCUUCUGACCUAAUUACUUAUUCGUGAGGU 5′

1. Does this virus need to bring any viral enzymes into the cell's cytoplasm with the nucleic acids? In other words, what viral enzymes, if any, will the virus require *before* it can make any viral enzymes in the host cell? If any viral enzymes must be carried into the cell, which enzymes does it need and why? If none are needed, why not? Please explain. (2 points)

2. What proteins can the virus produce once it is inside the cell?

3. What proteins do we know this viral genome codes for?

4. Ignoring the need for a promoter (RNA viruses have much more complicated promoters, assume transcription begins at the first nucleotide), what is the sequence of the viral mRNA that your virus will use to produce proteins? Be sure to indicate the 5' and 3' ends. Note: due to the large size of the transcription termination signal it has been omitted, assume transcription ends at the end of the given sequence. (2 points)

5. What will the amino acid sequence of the protein produced by this virus be? Please use the single-letter amino acid code provided. Note: if done correctly, after removing the methionine it should say something to you! Show all of your work to get credit! (2 points)

6. What cellular machinery will this virus use in the host cell? Please list the cellular machinery this virus will use and describe the function of that machinery. (2 points)

7. If you were going to design a drug to inhibit the replication of this virus without killing the host cell, what viral enzymes in the viral replication cycle would you try to target and why? If there are no viral enzymes that could be targeted, please say so, explain why, and give another way you might inhibit viral infection of host cells. (2 points)

Single-letter codes for amino acids

ala (alanine)	A	gly (glycine)	G	phe (phenylalanine)	F
arg (arginine)	R	his (histidine)	H	pro (proline)	P
asn (asparagine)	N	ile (isoleucine)	I	ser (serine)	S
asp (aspartic acid)	D	leu (leucine)	L	thr (threonine)	T
cys (cysteine)	C	lys (lysine)	K	trp (tryptophan)	W
glu (glutamic acid)	E	met (methionine)	M	tyr (tyrosine)	Y
gln (glutamine)	Q			val (valine)	V

The “Page of Dissent”

Students who disagree with the answers provided by the group can register their dissent answer on this page. If you disagree with your group’s answer and you are RIGHT, you will get back the points your group lost. If you disagree with your group’s answer and you are WRONG, you will lose points; only those people who dissent will lose points.

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Dr. Suchman's and Dr. Smith's Group Exam 3. Virus Reproduction

Virus 1. Following is the genome of your DNA virus:

Polydnavirus genome: Ds DNA

```
                                                +1
5′ GTTTGACACTTTATGCTTCCGGCTCGTATAATGTATGGAATAGGAGCATGTTTATTAGTCACTAGTATCGACCGAT 3′      SENSE
3′ CAAACTGTGAAATACGAAGGCCGAGCATATTACATACCTTATCCTCGTACAAATAATCAGTGATCATAGCTGGCTA 5′      TEMPLATE
```

1. Does this virus need to bring any enzymes into the cell's cytoplasm with the nucleic acids? In other words, what viral enzymes, if any, will the virus require *before* it can make any viral enzymes in the host cell? If any viral enzymes must be carried into the cell, which enzymes does it need and why? If none are needed, why not? Please explain. (2 points)

No viral enzymes needed; everything can be provided by the cell.

4. Knowing that in DNA viruses the promoters used are similar to the ones used in the cells they infect, what is the sequence of the viral mRNA that your virus will use to produce proteins? Be sure to indicate the 5' and 3' ends. Note: 1) due to the large size of the transcription termination signal it has been omitted, assume transcription ends at the end of the given sequence, and 2) the viral promoter sequences are underlined in the sequence above. (2 points)

5′ AUAGGAGCAUGUUUAUUAGUCACUAGUAUCGACCGAU3′

5. What will the amino acid sequence of the protein produced by this virus be? Please use the single-letter amino acid code provided. Note: if done correctly, after removing the methionine it should say something to you! *Show all of your work to get credit!* (2 points)

5′ AUAGGAGCAUG/UUU/AUU/AGU/CAC/UAG/UAUCGACCGAU3′

M/ F I S H

6. Please list the cellular machinery or enzymes this virus could use in the host cell and briefly describe the function of that machinery.

DNA replication machinery to reproduce viral DNA genome
Transcription machinery to produce viral mRNAs
Translation machinery to produce viral proteins

7. If you were going to design a drug to inhibit the replication of this virus without killing the host cell, what viral enzymes in the viral replication cycle would you try to target and why? If there are no viral enzymes that could be targeted, please say so, explain why, and give another way you might inhibit viral infection of host cells. (2 points)

It is very hard to treat this virus, since it uses everything of the hosts. Therefore you cannot inhibit the replication. You could inhibit absorption, penetration, or exit of the virus from the cell.

Virus 2. Following is the genome of your RNA virus: Arenavirus genome: - RNA

3′ AUAGCUACUCUCUUCUGACCUAAUUACUUAUUCGUGAGGU 5′

1. Does this virus need to bring any enzymes into the cell's cytoplasm with the nucleic acids? In other words, what viral enzymes, if any, will the virus require *before* it can make any viral enzymes in the host cell? If any viral enzymes must be carried into the cell, which enzymes does it need and why? If none are needed, why not? Please explain. (2 points)

Yes. It must bring in the RNA-dependent RNA polymerase called transcriptase to make mRNA from the negative-stranded RNA; the cell does not do this, and so, has no enzymes the virus can use. The negative-stranded RNA cannot go to the ribosomes to make proteins.

4. Ignoring the need for a promoter (RNA viruses have much more complicated promoters, assume transcription begins at the first nucleotide), what is the sequence of the viral mRNA that your virus will use to produce proteins? Be sure to indicate the 5' and 3' ends. Note: due to the large size of the transcription termination signal it has been omitted, assume transcription ends at the end of the given sequence. (2 points)

5′ UAUCGAUGAGAGAAGACUGGAUUAAUGAAUAAGCACUCCA 3′

5. What will the amino acid sequence of the protein produced by this virus be? Please use the single-letter amino acid code provided. Note: if done correctly, after removing the methionine it should say something to you! Show all of your work to get credit! (2 points)

5′UAUCG AUG/AGA/GAA/GAC/UGG/AUU/AAU/GAA/UAA/GCACUCCA 3′

M / R E D W I N E

4. What cellular machinery will this virus use in the host cell? Please list the cellular machinery this virus will use and describe the function of that machinery.

The only thing it will is the translation machinery.

5. If you were going to design a drug to inhibit the replication of this virus without killing the host cell, what viral enzymes in the viral replication cycle would you try to target and why? If there are no viral enzymes that could be targeted, please say so, explain why, and give another way you might inhibit viral infection of host cells. (2 points)

You could inhibit viral transcriptase, the enzyme that produces + RNA using - RNA as a template, or replicase, the enzyme that produces the double-stranded replicative form from the - RNA.

MB300 General Microbiology syllabus, Spring semester, 2001 Lecturer: Erica Suchman, Ph.D.

Office: B125 Microbiology building

Telephone: 491-6521

Office hours: Monday 10-12:50 p.m.

E-mail: esuchman@cvmbs.colostate.edu

Text: Microbiology, 4th ed., by L. M. Prescott, J. P. Harley and D. A. Klein
Web page: http://webct.cvmbs.colostate.edu:8900

Course description: MB300, General Microbiology, is a one-semester course in general microbiology. This course consists of three one-hour lectures (M, W, F) per week. Review sessions are held as appropriate, generally during the week before examinations. The course surveys the discipline of microbiology, and it meets the needs of students interested in microbiology, other biological sciences, biotechnology, chemical and environmental engineering, environmental health, medical technology, nutrition, plant and animal sciences, and many of the agricultural sciences. This course also fulfills the microbiology requirement for preprofessional students who intend to enroll in medical, dental, veterinary, or other related professional programs. Lectures highlight the assigned reading material in the textbook and occasionally bring in other relevant material. The additional material is presented both in lecture format and in printed handouts. Students are responsible for the material covered in the assigned reading, the lectures, and thehandout material.

Group projects: In the third week of class you will form a group with five other members of the class (each group may have no more or less than six members!). Your group will take three graded in-class group examinations during the semester (please note the days of the group exams on your course schedule). These are take-home exams that each member of the group takes home, completes, and brings to class on the day of the group exam. Your group then fills in one answer sheet for your group that is graded. Your lowest group exam score is dropped; therefore, there are absolutely NO makeups of group exams for any reason. Also, you cannot get a score for a group exam unless you are present on the day of the group exam. You may receive a total of 40 points from the group exams. You are encouraged to meet outside of class with other members of your group or any other students in the class to work on these exams. These exams allow us to examine in more detail information that students normally have a difficult time grasping. Furthermore, questions from the group exams are used on regular midterm and final examinations. After the first group exam if you are not happy with your group, you may move to a new group for group exam 2. On March 19, you select your PERMANENT group. During this class period, your group also selects a disease for which you will prepare a group poster. Each member of the group prepares one portion of the group poster (the microbe, epidemiology, the disease, treatment, prevention, or diagnosis). Your assignment on the poster is established on March 19. The poster is worth a total of 50 points. Five points are awarded when each member shows up at the MANDATORY GROUP MEETING DURING CLASS on the 12th week of class. During this meeting, each member of the group must bring TYPED material that is to be included on the poster. You receive 2 points for showing up at this mandatory meeting and 3 points for turning in your TYPED materials. The group analyzes all of the materials provided at this time, gives each member feedback, and turns in these materials and a review sheet at the end of class. After the group poster is finished, a group grade determined by the quality of the group's finished product, its attractiveness, and how well the pieces fit together and worth a maximum of 10 points is given to each member of the group . An individual grade of up to 35 points is awarded to each group member for the quality, accuracy, and completeness of the information he/she provided. You will view

other class members' posters during the last week of class. Posters are displayed for over a week so you may view them at your own convenience, but we have provided two lecture periods to insure that you have time to view them. At least ten questions (20 points) on the final examination are taken directly from these posters. You will be given a list of information to obtain from each poster. The members of your group decide the final 10 points of each individual's group grade. Each group member evaluates the other members of their group regarding their participation in all of the group activities, including the poster. You receive the average of the scores that each of the members of your group gives you. These evaluations are due April 25 and late evaluations are not accepted.

MB300 Examinations and grading: First examination 100 points

Second examination 100 points

Third examination 100 points

In-class group exams 40 points (3 exams each worth 20 points, with credit given for your highest 2 scores)

Group poster 50 points (5 points for draft exchange, 10 points for group poster score, 35 points for individual score)

Group member evaluations 10 points

Final examination 200 points; COMPREHENSIVE! (125 points in the final examination are from material covered in lectures after examination 3, 25 points each from material covered in exams 1, 2 and 3). Total 600 points (100%)

Extra credit exercise: One 10-point extra-credit exercise designed to expand your thinking about microbiology is provided during the semester. Your scores from the extra credit exercise are added to your final grade.

MB300 Web Page http://webct.cvmbs.colostate.edu:8900

We have created a home page for this course. We improve our page each semester. A handout is available that outlines locations on campus where you can access the web. If you need help getting started please feel free to come see me during office hours, and I will be happy to teach you. The syllabus, the course schedule, the course lectures, daily handouts, old exams, and some study guides are available on this page. The page also has a bulletin board on which you can post questions that come up while you are studying. You can look at the bulletin board any time to see what is posted there. You will also be able to see questions that other students ask. There is also a section which links to other interesting pages (useful when doing posters), a glossary of terms, microbiology reading (for fun), a list of professional societies, and animations designed to help you prepare for examinations. Also note: on the web page there are interactive exams designed to help you prepare for tests. You can answer questions from old exams , submit your answers, and receive a computer-generated score. You can also view your own grade (and ONLY your own grade) on the MB300 web page.

To log onto the web page, follow the directions below:

1. Type in the address, http://webct.cvmbs.colostate.edu:8900.

2. Scroll down and click the box that says "login" to MyWebCT.

3. Under "username" type the first initial of your first name followed by your whole last name ALL IN LOWER CASE followed by the first 3 digits of your student identification number. For example, I would type

esuchman112.

4. Under "password" type in your 9-digit student identification number WITHOUT any spaces or dashes (112233444). If this does not work for you please let me know, and I will help you get started.

My teaching philosophy: MB300 is a fast-paced upper division biology course. We will be covering a great deal of material in order to prepare you for any classes you may take that will require a basic knowledge of microbiology. Due to the large volume of material that we are expected to cover in this course, lectures will move at a fairly quick pace. As the instructor, my job is to make the information as organized and interesting as possible. As students you also have jobs. You will not learn much in this course unless you take an active role in your education. Simply attending lectures is not enough for most students to earn more than a passing grade. Fast-paced lectures will be much easier to follow if you have at least skimmed through the material before coming to class. To make this easier for you, I have narrowed down the specific pages I will be covering for each lecture, and I have tried to keep the number of pages at 15 or less. Furthermore, my lectures will be available on the web before class. The web page also has a section that provides suggestions for doing well in MB300. I am available for office hours twice a week. Feel free to visit me during these office hours to discuss any subjects you feel you do not fully understand from lecture. Also, I have tried to incorporate other ways of learning into the curriculum by including demonstrations and group projects as part of the experience. As a team we can work together to learn all the microbiology you will need to be successful in this class and any future classes you may take! My goals for this course: 1) teach you to "think" about microbiology, not just memorize it, and 2) show you where and how to find information about microbiology.

Honors option: Students enrolled in Section 3, the honors section, are required to perform an extra exercise to earn their honors option. I have chosen a service learning activity in which honors students visit local elementary schools and teach students about handwashing and where microbes live. All honors students should see me ASAP to begin preparing for this activity.

Important dates

January 29 - Practice group examination.

January 31 - Extended schedule change period ends.

February 12 - Examination 1

February 21 - In-class examination 1- this one counts!

March 19 - In-class examination 2. Form final groups; pick disease for poster. (Withdraw) drop period ends.

March 21 - Examination 2.

April 2 - In-class examination 3.

April 9 - Examination 3.

April 13 - Poster preparation day- MANDATORY SESSION

April 18 - Posters due.

April 25 - Group evaluations due.

April 30 & May 2 - Poster viewing days

May 10 - FINAL EXAM – 9:10 – 11:10 am, C111 Aylsworth.

EXAM REVIEWS: February 9 - Review for exam 1, 4-? p.m., B120 Microbiology building
March 19 - Review for exam 2, 5-? p.m., B120 Microbiology building

April 6 - Review for exam 3, 4-? p.m., B120 Microbiology building.

May 8 - Review for final exam, 4-? p.m., B120 Microbiology building.

MB300 General Microbiology Course Schedule

Fall Semester, 2000. Section 9 a.m. – 9:50 a.m. MWF. C111 Aylsworth. Dr. Erica Suchman

Date	**Week**	***Lecture Topics***	***Lecture Number***	***Reading Assignment***
Aug. 21	1	Introduction. Scope of contemporary microbiology	**1**	**1**:12-15
Aug. 23		Microscopy and prokaryotic cell morphology.	**2**	**2**:17-34, **3**:37-42
Aug. 25		Cell wall: gram positive, gram negative	**3**	**3:**41-58
Aug. 28	2	Internal structures, endospores	**4**	**3**:44-50, 64, 66-70
Aug. 30		Flagella, motility, chemotaxis	**5**	**3**:58-66
Sept. 1		Practice group exam: compare eucaryotes, procaryotes and archaeobacteria		**4:**90-93**, 20:**422-427
Sept. 3	3	Exponential growth and its measurement	**6**	**6:**114-119, 123-132
Sept. 8		Control of microorganisms	**7**	**7:**137-148**, 33:**679-684
Sept. 11	4	Microbial nutrition: nutritional types	**8**	**5:**99-101
Sept. 13		Metabolism and energy production	**9**	**8:**152-161
Sept. 15		Glycolysis, respiration (aerobic, anaerobic)	**10**	**9**:164-174, 176-177
Sept. 18	5	**EXAM 1 (lectures 1-9, practice group exam)**		
Sept. 20		Fermentation, catabolism of other compounds, photosynthesis	**11**	**9**:174-187
Sept. 22		Fermentation, etc continued	**12**	**9:**174-187
Sept. 25	6	Environmental microbiology	**13**	**40:**836-842, **41:**853-882
Sept. 27		**In class group exam 1: metabolism**		
Sept. 29		Metabolism: synthesis of DNA	**14**	**11**:212-221
Oct. 2	7	Metabolism: synthesis of RNA	**15**	**11**:221-226, **13**:258-262
Oct. 4		Metabolism: protein synthesis	**16**	**11**:226-233, **13**:258-262
Oct. 6		Metabolism: control of RNA, mRNA synthesis	**17**	**12:**237-245
Oct. 9	8	Microbial genetics: mutations	**18**	**13:**262-274, **33:**690-692
Oct. 11		**In class group exam 2: Transcription, translation. Form final group, pick disease**		
Oct. 13		Microbial genetics: transformation	**19**	**14**:279-284, 290-294, **13**:256-262

Oct. 16	9	**EXAM 2 (lectures 10-18, group exams 1 and 2)**		
Oct. 18		Microbial genetics: conjugation	**20**	**14**:289-294, 298-300
Oct. 20		Microbial genetics: transduction	**21**	**14**:294-298, **13**:256-258
Oct. 23	10	Properties of viruses: structure, growth	**22**	**16:**337-354, **18:**373-376
Oct. 25		Properties of viruses: genome, reproduction	**23**	**18**:373-389
Oct. 27		Properties of viruses: genome, reproduction	**24**	**18:**373-389, **33:**693-95
Oct. 30	11	**In class group exam #3: Viral reproduction**		
Nov. 1		Recombinant DNA technology	**25**	**15:**311-332
Nov. 3		Recombinant DNA technology	**26**	**15:**311-332
Nov. 6	12	**EXAM #3 (Lectures 19-26, group exam #3)**		
Nov. 8		Symbiosis	**27**	**28**:566-578, **29**:581-602
Nov. 10		**Group project: Poster Prep day; Mandatory meeting: Bring 2 copies of TYPED materials!!**		
Nov. 13	13	Medical Microbiology	**28**	**29**:581-602
Nov. 15		Medical microbiology: the immune response POSTERS DUE AT MICROBIOLOGY BY 1 p.m.	**29**	**30**:606-622
Nov. 17		Medical Microbiology: the immune response:	**30**	**30**:606-622, **31**:633-639
Nov. 27	14	Epidemiology of disease	**31**	**35**:721-735
Nov. 29		Food microbiology, food safety **Group evaluations due by end of lecture!**	**32**	**43**:909-929
Dec. 1		Food microbiology, food safety	**33**	**43**:909-929
Dec. 4	15	Poster display day, Microbiology building		
Dec. 6		Poster display day, Microbiology building		
Dec. 8		Industrial microbiology-bioremediation	**34**	**44**:932-960
Wed. Dec. 15		**Final exam, sections (7:00 a.m.- 9:00 a.m.), Aylsworth C111 BUMMER!!!**		