Summary for first examination (March 8, 2011)

The first and most basic principle is that students are responsible for all material presented in lecture. The second principle is that students are responsible for material in the assigned portions of the textbook, subject to modifications described below.

Assigned Reading for this examination.
   Chapter 1, Chapter 2, Chapter 3
   Section 6.6
   Box 4.1

Note: The material on bacterial growth in chapter 7 will be covered on the second exam.

Within the above reading assignments there are specific comments about some sections to be emphasized and other sections to be deleted.

Specifics:

A. Topics not covered in detail or at all in lecture, but which are in the textbook and for which students are responsible.
   1. Sample preparation for the electron microscope, including shadowing and freeze-etching.
   2. Scanning electron microscope.
   3. Cytoplasmic matrix.
   5. Types of transport (Section 6.6).
   6. Endospore formation and structure but not the detailed cycle

B. Topics in textbook for which students are not responsible.
   1. Dark field microscope.
   2. Phase contrast microscope.
   3. Fluorescence microscope.
   4. Eucaryotic structures (chapter 4), but note that the origins of mitochondria and chloroplasts are assigned.

Note:

So that all students have the same, fair chance, students will not be permitted to ask questions during the exam.

Enclosed below is the first exam from the spring of 2010. After the exam is a listing of the correct answers.
Please use this old examination wisely. By that I mean that you should understand each of the questions presented, but do not study them to such an extent that you lose sight of the principles involved. This year's exam will have 75 multiple choice questions, some of which will be the same as on the previous exam. However, there will also be a number of questions that are similar to the old ones, but which are different enough that you will be at a disadvantage if you memorized old answers without understanding. One useful study approach is to look carefully at the WRONG answers to each questions on last year’s exam and to figure out why that answer was incorrect.

Each multiple choice question will be worth 1 point. There will also be five short answer questions. Each short answer question can be answered with 2 to 3 sentences and will be worth 5 points.

Introduction to Microbiology
BISC 300
First Midterm Examination

1. Microorganisms are used as model molecular systems. This statement means:
   a) Microorganisms are more primitive than higher organisms and therefore do simpler (that is, model) molecular activities.
   b) The basic molecular genetic activities are very similar in all organisms, although it is easier to study higher organisms.
   c) The molecular activities in microorganisms are not well understood and must be therefore be modeled.
   d) Microorganisms are similar to higher organisms in their molecular reactions so that extrapolations can be made to higher organisms.

2. Which of the following describes an activity of microorganisms related to water quality?
   a) They metabolize the organic compounds in sewage and convert them to organic solvents such as acetone that pollute rivers.
   b) They can be harmed by airborne particles from air pollution and then degrade the sewage less efficiently.
   c) Within a sewage treatment plant, they produce organic compounds and thereby increase water pollution.
   d) In sewage treatment plants they consume large amounts of oxygen as they degrade the organic waste.

3. Petroleum products such as gasoline and jet fuel:
   a) are produced by bacterial processing of crude oil.
   b) are very poisonous to all microorganisms.
   c) can easily be degraded by microorganisms if oxygen is absent.
d) are stored in the absence of oxygen to prevent microbial growth.

4. Antibiotics:
   a) are synthesized in the organic chemistry laboratory and work to kill bacteria.
   b) are formed by bacteria and are harmful to humans.
   c) usually work by specifically harming microorganisms (or even killing them) without harming human cells.
   d) are chemicals that humans synthesize to kill bacteria.

5. Microorganisms are important in food preparation:
   a) by modifying the starting material in some cases so that some foods are made easier for humans to digest.
   b) because they must all be killed so that the food humans eat has no organisms in it.
   c) because their acid production often makes it easier for spoilage organisms to grow.
   d) by recycling waste material to form new food products.
6. Antoni van Leeuwenhoek:
   a) built the first microscope.
   b) used simple microscopes.
   c) used microscopes with interchangeable lenses.
   d) All of the above.

7. The term "procaryote" means the same as:
   a) "fungi".
   b) "bacteria".
   c) "virus".
   d) "microorganism".

8. The development of good compound microscopes was difficult because:
   a) each single lens in the microscope only magnifies by a factor of about 10.
   b) good staining procedures were needed first.
   c) it was first necessary to invent light sources with shorter wavelengths to illuminate the samples.
   d) None of the above.

9. Vitalism:
   a) was refuted by Koch and his workers studying contagious disease.
   b) is the name given to the belief that organisms may arise from non-living material.
   c) is the opposite of spontaneous generation.
   d) is a term that was not applied to microorganisms but only to large organisms such as worms and flies.

10. Pasteur's experiments with swan-necked flasks:
    a) were only successful with microorganisms that do not need oxygen.
    b) only worked well with bacteria that produced endospores.
    c) provided strong evidence against vitalism.
    d) were performed only after he had developed the procedure of Pasteurization.

11. When Pasteur boiled a flask containing fruit juice and then pulled the neck to make a swan-necked flask, no spoilage occurred. Which of the following is an accurate explanation of what happened?
    a) Boiling the flask killed the organisms that were initially present and the pulled out neck prevented them from reentering.
    b) Bacteria that can grow in the absence of oxygen were excluded.
    c) Pulling the neck sealed the glass so nothing could enter the flask.
    d) The boiling activated previously dormant organisms, but the absence of oxygen prevented them from growing.

12. Tyndall had difficulty in repeating Pasteur's experiments because:
    a) Tyndall did not pull out the necks of his flasks into a swan shape.
    b) some of his infusions contained bacteria which form endospores.
c) his long heating times destroyed the chemicals in the infusion.
d) he prevented oxygen from entering his flasks.

13. Tyndall's procedure, called fractional sterilization:
a) kills microorganisms by raising the temperature of the infusion to 121 C.
b) sterilizes a solution by killing a portion of the microorganisms at different times.
c) cannot be used when the solution contains vitamins since they are sensitive to temperatures higher than boiling.
d) all of the above.

14. The spontaneous generation experiments of Pasteur, Tyndall and others showed which of the following?
a) Diseases are caused by spontaneous generation.
b) Spontaneous generation was not detected under the conditions tested.
c) All infusions showed spontaneous generation, even in Pasteur's swan-necked flask experiments.
d) Tyndall showed that Pasteur was incorrect in his assumptions about the presence of organisms in air.

15. A contagious disease:
a) is caused by the transfer of a microorganism between people.
b) is one which causes only mild illness.
c) cannot be passed from sick individuals to healthy ones.
d) is the same thing as an inborn genetic defect, such as diabetes.

16. Koch's Postulates:
a) were used to find the cure for many diseases.
b) were developed for the study of spontaneous generation.
c) require the growth of microorganisms in pure culture.
c) none of the above.

17. Which of the following was essential for the development of Koch's postulates?
a) the construction of an autoclave to sterilize growth media.
b) the discovery that some bacteria form endospores.
c) the use of solid growth medium.
d) understanding that some diseases are caused by eukaryotes such as fungi.

18. Why is it an advantage to prepare a liquid medium and then solidify it with agar?
a) the agar provides extra nutrition for the bacteria.
b) agar is a poison for most bacteria that do not cause disease, making it easier to create pure cultures.
c) bacteria usually grow faster in liquid medium.
d) agar melts at 100 C, so the medium will be solid at the temperatures where most bacteria grow.
19. Pure cultures:
   a) may be created for yeast as well as for bacteria.
   b) may be maintained in liquid as well as on solid medium.
   c) are almost never found in nature, such as in soil.
   d) all of the above.

20. In the bright field microscope, the condenser lens:
   a) focuses the light source onto the specimen.
   b) is between the ocular and the specimen.
   c) is only needed when high power objectives are used.
   d) controls the amount of light that shines on the specimen.

21. The resolution of a microscope:
   a) is determined by the amount of magnification.
   b) improves when light intensity is higher.
   c) is another way of describing focus or clarity of an image.
   d) is better with shorter wavelengths of illumination.
22. The resolution of a bright field microscope can be improved (that is, has a smaller value):
   a) by using longer wavelengths of light.
   b) by using immersion oil between the objective and the specimen.
   c) by increasing light intensity.
   d) none of the above.

23. Immersion oil is used with the 100X objective in lab:
   a) because it has a lower index of refraction than air.
   b) to prevent damage to the objective from scratching against the microscope slide.
   c) because it increases the magnification that is done by the objective.
   d) because it improves the resolution of the microscope.

24. Which of the following is not a factor in determining the resolution of a microscope?
   a) the numerical aperture of the objective.
   b) the index of refraction of the material between the specimen and the objective.
   c) the wavelength of illuminating radiation.
   d) the magnification power of the condenser.

25. The "working distance" of a microscope is:
   a) different for each objective.
   b) smaller for high magnification objectives.
   c) not affected by adding immersion oil.
   d) all of the above.

26. Magnification:
   a) improves resolution.
   b) is independent of resolution.
   c) can be increased by the use of immersion oil.
   d) changes with wavelength.

27. The transmission electron microscope (TEM):
   a) differs from the scanning electron microscope in that it produces secondary electrons.
   b) works best with intact cells that have not been sectioned.
   c) is different from the bright field microscope because the electron beam passes through the specimen in the TEM.
   d) none of the above.

28. The scanning electron microscope:
   a) works best if metal ions have been coated onto the surface of the sample.
   b) is designed to reveal the internal appearance of cells.
c) can only be used to observe bacteria if the cells have been cut into very thin sections.
d) all of the above.

29. The freeze-etch procedure:
a) minimizes the formation of artifacts, since the cells are frozen quickly.
b) does not require the cells to be chemically fixed.
c) is used with the transmission electron microscope.
d) all of the above.
30. The shadowing of specimens for electron microscope observation:
   a) requires careful control of the direction of the light so a shadow is created.
   b) gets its name from the way that metal coats one side of the specimen more than
      the other, making it appear to be a shadow.
   c) is frequently done for scanning electron microscope examination, since the external structure shows the shadow so clearly.
   d) requires appropriate staining with a dye that has proper contrast with the metal that creates the shadow.

31. In most cases, if samples are not fixed before they are stained:
   a) dyes will not stick to the specimen.
   b) different parts of a cell cannot be distinguished.
   c) the staining procedure is likely to alter the shape of the cell.
   d) ultraviolet irradiation must be used to preserve external shape.

32. A mordant is:
   a) not a dye.
   b) a chemical which decreases the effect of a dye.
   c) often used in place of a counterstain.
   d) usually iodine.

33. Positive stains:
   a) can only be used with Gram positive bacteria.
   b) may be used with the electron microscope.
   c) cause yeast cells to appear purple in the light microscope.
   d) are not effective with animal cells due to the absence of a cell wall.

34. Negative stains:
   a) were first developed to examine Gram negative bacteria.
   b) only work in the light microscope.
   c) make bacteria appear red in the light microscope.
   d) reveal external structures on microorganisms.

35. The capsule stain procedure described in class for the light microscope is:
   a) a positive, differential stain.
   b) a negative, differential stain.
   c) both positive and negative, differential stain.
   d) a simple, differential stain.

36. The Gram stain procedure leaves some cells red at the end of the procedure. These red cells:
   a) have been negatively stained.
   b) have been positively stained.
   c) were unable to incorporate the crystal violet stain.
   d) are not decolorized by the addition of ethanol (alcohol).
37. The flagella and endospore staining procedures are:
   a) positive stains.
   b) differential stains.
   c) simple stains.
   d) a) and b).
Note that in the following several questions, the terms "plasma membrane" and "cell membrane" are used interchangeably.

38. The cell membrane:
   a) is outside of the cell wall.
   b) allows the free entry and exit of materials through porins.
   c) of procaryotes is primarily composed of phospholipids.
   d) is very rigid in eucaryotes due to cholesterol.

39. The assembly of phospholipids into a membrane:
   a) requires covalent connections between fatty acid side chains.
   b) allows the polar portions of the phospholipids to associate with each other.
   c) allows the non-polar portions of the phospholipids to associate with each other.
   d) b) and c).

40. Cell membranes are permeability barriers to polar solutes because:
   a) the hydrophilic glycerol backbones of the phospholipids interact with the solutes and repel them.
   b) membranes have selective transport proteins to allow polar solutes to cross.
   c) the fatty acid side chains of the membrane interact hydrophilically with the polar solutes.
   d) water is not associated with these polar solutes, making them hydrophobic.

41. Plasma membranes in bacteria:
   a) are stronger than the membranes of animal cells because of the presence of the cell wall.
   b) are called "fluid" because they have a great deal of water in their middle section.
   c) are probably stabilized by hopanoids.
   d) are separate structures from the nuclear membrane.

42. Diffusion:
   a) is another term for transport of solutes across a membrane.
   b) is a chemical pressure for solute concentrations to become equal.
   c) forces solutes through a membrane if the concentration imbalance is great enough.
   d) helps get solutes into a cell; it does not work to get solutes out.

43. Facilitated diffusion:
   a) does not require a supply of energy such as ATP.
   b) results in the transfer of solutes from regions of low concentration to regions of high concentration.
   c) does not change the molecules that are transported.
   d) a) and c).

44. Active transport:
   a) may be done by using the energy in a companion gradient of protons.
b) only functions to bring materials into a cell, not to export them.
c) cannot move solutes from areas of low concentration to high concentration.
d) occurs without the involvement of specific membrane proteins.
45. Group translocation:
a) only transports molecules from areas of high concentration to low concentration.
b) does not change the molecule being transported.
c) alters the transported molecules, for example by phosphorylating them.
d) obtains energy from the companion gradient of protons.

46. Cell walls:
a) would be stronger if all their amino acids were in the L-form.
b) are strong even though they are flexible.
c) protect cells from damage when placed in dilute solutions.
d) protect cells from damage under acidic conditions.

47. The polysaccharide portion of peptidoglycan is correctly referred to as a heteropolymer which means:
a) some of the sugars are in the D-form and some in the L-form.
b) that peptidoglycan has a peptide portion as well.
c) some bacteria use DAP and some use Lysine in their peptide chain.
d) the polysaccharide contains more than one kind of sugar.

48. The cells of multicellular animals such as humans don't need cell walls because:
a) the membranes allow solutes to penetrate, thereby avoiding the generation of osmotic pressure.
b) the membranes do not have steroids and are therefore much stronger.
c) the cells are rarely exposed to hypotonic conditions.
d) if they lyse, the cell contents are retained in the organism.

49. Peptidoglycan:
a) has no effect on the transport of small molecules across the cell membrane.
b) expands in the same pattern in both rod-shaped and spherical bacteria.
c) is able to expand during synthesis without losing its strength.
d) a) and c).

50. Peptidoglycan:
a) is unique in that it contains D-amino acids.
b) contains long chains of amino acids which may be cross-linked by short chains of sugars.
c) obtains its great strength by completing all possible cross-links between backbone chains.
d) is composed of subunits synthesized outside of the cell membrane.

51. Muramic acid:
a) is unique to procaryote cell walls.
b) is present at twice the level of glucosamine in the peptidoglycan of Gram positive bacteria.
c) is attached to a chain of four amino acids after insertion into a growing peptidoglycan molecule.
d) helps form part of the peptide crosslinks in the outer membrane of Gram negative bacteria.

52. Direct crosslinking:
a) makes Gram negative bacteria have stronger cell walls.
b) results in peptidoglycan that has more open spaces.
c) occurs in the absence of a pentaglycine bridge.
d) does not occur in Gram negative bacteria.

53. Transpeptidation is another term for crosslinking. Which of the following is true about transpeptidation?
a) It only occurs outside the cell membrane as peptidoglycan subunits are inserted into the growing cell wall.
b) It occurs more rapidly in the presence of the antibiotic penicillin.
c) It occurs inside the cell during the synthesis of peptidoglycan subunits.
d) It occurs more rapidly in Gram negative bacteria due to the protection of the outer membrane.

54. The crosslinking of peptidoglycan:
a) results in a more open structure in Gram negative cells with larger spaces between backbone chains.
b) is equally strong with or without the pentaglycine bridge as a spacer.
c) only occurs in actively growing Gram positive bacteria.
d) gets most of its strength because D-amino acids are involved.

55. The third amino acid in the chain of four connected to muramic acid in peptidoglycan:
a) must be DAP.
b) has to be in the L-configuration.
c) must have two amino groups.
d) is the same in all bacteria.

56. The lipopolysaccharide "outer membrane":
a) is an osmotic barrier that requires active transport for the incorporation of small solutes.
b) makes Gram positive bacteria generally resistant to penicillin.
c) is connected to the peptidoglycan in Gram negative bacteria.
d) lies just underneath the peptidoglycan in Gram negative bacteria.

57. Antibiotics such as penicillin are effective:
a) more often against Gram positive bacteria because Gram negative bacteria have their peptidoglycan protected by the outer membrane.
b) because the structure targeted by penicillin is uniquely procaryotic.
c) only when the bacterial cells are growing and expanding their cell walls.
58. Lysozyme:
   a) is produced by many animals as a normal defense against bacteria.
   b) only attacks actively growing bacteria.
   c) is a natural compound produced by some microorganisms to attack other microorganisms.
   d) cleaves protein cross-links in peptidoglycan.

59. The different appearances of Gram positive and Gram negative cells in the Gram stain procedure:
   a) results primarily from chemical differences between the two types of cell walls.
   b) arises from the multiple layers in the cell wall of Gram negative bacteria.
   c) occurs because Gram positive cells keep crystal violet from washing out when alcohol is added.
   d) show that Gram positive walls are much stronger.
60. Old cultures of Gram positive bacteria sometimes appear red at the end of the Gram staining procedure. Why?
   a) These cultures do not incorporate crystal violet.
   b) Their cell wall changes so that they become Gram negative.
   c) The alcohol dehydrates the thick wall, causing it to collapse and trap the crystal violet-iodine complex.
   d) The wall has been weakened due to the failure to insert new peptidoglycan subunits, so that dehydration does not cause collapse.

61. Ribosomes are:
   a) of two sizes in procaryotes.
   b) absent in procaryotes.
   c) the same size in procaryotes and eucaryote organelles.
   d) not present in mitochondria and chloroplasts.

62. Chloroplasts and mitochondria:
   a) can be grown in pure culture in the laboratory.
   b) possess 80s ribosomes.
   c) contain circular DNA molecules.
   d) contain cell walls made of simple polymers of glucose.

63. The endosymbiotic (or endosymbiont) theory:
   a) is supported by the observation that mitochondria and chloroplasts contain linear DNA.
   b) is an explanation for the origin of mitochondria and chloroplasts.
   c) proposes that procaryotes are descended from mitochondria and chloroplasts.
   d) none of the above.

64. Some antibiotics have 70s ribosomes as their target. Which of the following is true when this drug is taken to fight an infection?
   a) Cytoplasmic ribosomes in human cells may be damaged.
   b) Only the bacterial ribosomes on the endoplasmic reticulum are harmed; the unattached ribosomes are unaffected.
   c) Only bacteria are harmed; human cells do not have 70s ribosomes.
   d) Prolonged exposure to such drugs may cause damage to humans, for example by producing anemia, which is a shortage of red blood cells.

65. Pili:
   a) occur on both Gram positive and Gram negative bacteria.
   b) are much shorter than flagella.
   c) may be used to attach bacteria to solid surfaces.
   d) all of the above.

66. Endospores:
   a) are formed by the addition of a heat-resistant layer to the outside of a bacterial cell.
b) contain an internal structure called the sporangium which protects the DNA.

c) are formed during a process called germination.

d) are formed from a small portion of the "mother cell", also called the sporangium.

67. The process of endospore formation:
  a) begins with the removal of the cell's peptidoglycan.
  b) results in substantial dehydration of the spore core.
  c) creates a new structure which is larger than the cell in which it was made.
  d) is a response by the cell to favorable environmental conditions.

68. The germination of an endospore:
  a) results in the formation of an actively growing vegetative cell.
  b) causes all the water in the spore to be lost.
  c) begins with the engulfment of the majority of the original cell's cytoplasm.
  d) none of the above.

69. Capsules and slime layers:
  a) may protect bacteria which cause disease, such as pneumonia, against the phagocytic cells of the human defense system.
  b) are generally composed of proteins.
  c) are thought to assist bacteria by increasing their ability to swim.
  d) all of the above.

70. QUESTION DELETED – ALL STUDENTS RECEIVED CREDIT

71. Flagella in bacteria:
  a) grow from the base, not the tip.
  b) cause motion by rotation
  c) are assembled inside the cell and then exported.
  d) are used to attach the cells to surfaces.

72. Which of the following statements is true for procaryotic flagella?
  a) They are always associated in tufts, never singly.
  b) They are formed from subunits called flagellin in a process called self-assembly.
  c) They cause motion by the sliding of muscle-like fibers against each other.
  d) They cause motion by a whiplike action.

73. In chemotaxis:
  a) bacteria run continuously when in the presence of a uniformly high concentration of an attractant.
  b) bacteria sense attractants when these molecules are bound by the cell's flagella.
  c) twiddles occur whenever a bacterium encounters a repellent.
  d) attractants are sensed when they bind to specific chemoreceptors.

74. During the chemotactic response of bacteria to an attractant:
a) the bacteria will swim more rapidly in the presence of uniformly high concentrations of attractant.
b) bacteria will run continuously (with no twiddles) when the concentration of attractant is uniformly high.
c) the concentration of the attractant is sensed during twiddles.
d) the concentration of the attractant is sensed during runs.

75. Bacterial chemotaxis away from a repellent:
a) has less frequent twiddles when moving "up" the gradient.
b) has shorter runs when moving "up" the gradient.
c) has shorter runs when moving "down" the gradient.
d) none of the above; there is no direction to chemotaxis in the presence of a repellent.
ANSWERS

1. d
2. d
3. d
4. c
5. a
6. b
7. b
8. d
9. b
10. c
11. a
12. b
13. b
14. b
15. a
16. c
17. c
18. d
19. d
20. a
21. d
22. b
23. d
24. d
25. d
26. b
27. d
28. a
29. d
30. b
31. c
32. a
33. b
34. d
35. c
36. b
37. d
38. c
39. d
40. a
41. c
42. b
43. d
Give two reasons that gelatin was not a good choice for solidifying bacterial media.

Gelatin melts just above room temperature (about 28 C) and many bacteria of interest to Koch’s group needed temperatures of 37 C to grow. Therefore, if they were incubated at 37 C, the medium would melt. If the medium melted, then it would not be useful for isolating colonies.

Since gelatin is a naturally occurring protein, many bacteria can eat it. The result would once again be that the solid medium would again become liquid, with the same problems as a result.

Full credit requires a specific statement about the medium returning to a liquid state.
77. Distinguish between resolution and magnification.

Resolution refers to the ability to distinguish between two closely placed objects. The better the resolution, the closer the objects can be and still be seen as separate.

Magnification is the ability to enlarge an image.

Neither resolution nor magnification has anything to do with focus.

78. The peptidoglycan of Gram positive bacteria has two different types of polypeptide chains whereas Gram negative bacteria have only one. Explain.

The polypeptide chain which they both have is the string of four amino acids attached to the muramic acid. Gram positive bacteria have a second polypeptide which is the pentaglycine bridge (indirect linkage).

The question has nothing to do with wall thickness, outer membrane, or the Gram stain procedure.

79. Explain why penicillin only kills actively growing cells and does not harm bacteria which are alive but inactive.

Penicillin’s action is the blocking of transpeptidation (crosslinking); it does not actively attack any structures. Only actively growing cells are forming crosslinks and therefore only the actively growing cells can be affected by penicillin. Inactive cells are not forming crosslinks and are therefore not affected by penicillin.

80. All runs by bacteria eventually end in twiddles, even when they are moving the cell into a "better" position. Explain

Bacterial cells cannot choose the direction they swim during chemotaxis. Even when a run is in a favorable direction and therefore is very long, the cells will stop running and twiddle. This allows the cells the chance to find another direction which might possibly be better than the one they were going before.