

1. A certain bacterium uses proline as an osmoprotectant. What sort of proline transporter serves this purpose best? Why?

- A. An ABC system because of a protein that prevents reverse transport
- B. A uniport because proline will be the only substrate transported
- C. A proline/H⁺ symport because importing H⁺ will reduce the external osmolarity
- D. A Type I Secretion system to secrete proline directly into the environment
- E. A PTS system because adding phosphate keeps proline from leaking back out

2. What is "Horizontal Gene Transmission"?

- A. The transfer of DNA from one bacterium to another using special pili
- B. The exchange of DNA between two bacteria using Type III secretory systems
- C. The transfer of DNA from one bacterium to another using Type III secretory systems
- D. The exchange of protein gene products between two bacteria using Type III secretory systems
- E. The exchange of DNA between two bacteria using special pili

3. If an atypical (non-halophilic) bacterial cell is placed in a hypertonic environment . . .

- A. it will undergo lysis
- B. it will burst, because the cell wall will prevent it from shrinking too much
- C. salt will rush in to equalize concentrations on both sides of the membrane
- D. it will undergo plasmolysis
- E. it will build up turgor pressure, but will not lyse because it has a cell wall

4. The picture at the right shows an unusual type of bacterium that has its flagella within its periplasm. What microscopic technique was needed to observe these flagella?

- A. Phase contrast microscopy
- B. Scanning electron microscopy
- C. Electron cryotomography
- D. Atomic force microscopy
- E. Electron chromatography

5. A positive diagnosis for a particular disease is made by examining a throat swab stained with the Acid-Fast stain. What organism is causing this disease?

- A. an enveloped virus like Influenza
- B. An encapsulated organism like Klebsiella
- C. Mycobacterium
- D. A Gram-positive organism like Streptococcus
- E. Mycoplasma

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7. The luciferase reaction is not routinely used to obtain an accurate bacterial titer. Why not?

- A. It is only based on a statistical estimate of growth.
- B. Dead cells do not produce ATP.
- C. You do not see a reaction with fewer than 10
- D. The amount of ATP produced per cell is not constant.
- E. Luciferase is not a bacterial enzyme.

8. What is the “Sec translocon”?

- A. A chaperone that keeps proteins unfolded for insertion through the inner membrane
- B. A transporter that moves molecules through the outer membrane
- C. A transporter that imports fully folded proteins
- D. A transporter that makes a single channel through both bacterial membranes
- E. A transporter that inserts proteins with a signal sequence through the inner membrane

9. Nucleic acids are put together from their monomers, nucleotides, with _____ bonds.

- A. phosphodiester
- B. parallel
- C. phosphate
- D. ionic
- E. peptide

10. Which of the following is NOT a structural component of Archaeal cell walls?

- A. Chondroitin
- B. Lipopolysaccharides
- C. Pseudopeptidoglycan
- D. Protein
- E. All of the above are structural components

11. Which type of microscopy would be most suitable for examining the 3-dimensional appearance of magnetosomes inside a bacterial cell?

- A. Transmission electron microscopy
- B. Confocal scanning laser microscopy
- C. Phase contrast
- D. Differential interference contrast
- E. Electron cryotomography

12. Electron cryotomography is most useful for _____.

- A. identifying multiple bacterial species simultaneously from a single sample

- B. observing motile bacteria
- C. obtaining a three-dimensional view of internal cellular structures
- D. viewing thick specimens
- E. observing the molecular details of a chemical compound

13. What is the main difference between a negative stain and a positive stain in?

- A. A negative stain stains negative charges; a positive stain stains positive charges.
- B. A negative stain has a negative charge; a positive stain is positively charged.
- C. A negative stain stains the inside of cells; a positive stain stains the outside.
- D. A negative stain is not charged, and stains the background rather than the cell.
- E. A negative stain is used for Gram-negative cells, a positive stain for Gram-positive.

14. How are pili involved in bacterial motility?

- A. AH
- B. They are extended and retracted like grappling hooks
- C. They vibrate rapidly and jiggle the bacterium across a surface
- D. They move back and forth like oars
- E. They hook two bacteria together, making other motion more efficient

15. Which of the following is a unique molecule in the Gram-positive cell envelope (envelope = wall + membrane(s))?

- A. glycine
- B. lipid AD. lipoteichoic acid
- C. D-alanine
- D. lipoprotein

16. Why does passive transport require energy?

- A. To pump a molecule against the PMF
- B. Passive transport doesn't require any energy
- C. To force a molecule through the hydrophobic interior of the membrane
- D. To concentrate a molecule against its concentration gradient
- E. To open facilitated diffusion channels in the membrane

17. The Most Probable Number (MPN) method _____.

- A. is a rough estimate of the actual titer based on optical density
- B. is considered to be a direct cell count, even though it is statistically based
- C. requires multiple culture tubes, but no petri dishes
- D. is used for very large sample volumes
- E. is usually performed by pouring a sample of the culture through a filter

18. How can you improve the resolution of a light microscope?

- A. Dim the intensity of the light source.
- B. View the specimen with a negative stain.

- C. Use a microscope with enhanced contrast.
- D. Use a blue filter under the condenser.
- E. Have the light pass through a medium with a refractive index < 1

19. Rank the following lipids in order from MOSTSOLID to LEASTSOLID at room temperature. (1) Saturated lipids (2) Cis-unsaturated lipids (3) Trans-unsaturated lipids

- A. MOSTSOLID(1) >(2) >(3) LEASTSOLIDB. MOSTSOLID(3) >(2) >(1) LEASTSOLIDC. MOSTSOLID(1) >(3) >(2) LEASTSOLIDD. MOSTSOLID(3) >(1) >(2) LEASTSOLIDE. MOSTSOLID(2) >(1) >(3) LEASTSOLID

20. An atomic force "microscope" is different enough that some people do not consider it a microscope at all. What is so different about it compared to other microscope types?

- A. It has complicated electronic components to control the focus.
- B. It uses a rotating illuminating beam to image the sample at multiple angles.
- C. It produces an image that must be stacked together with other images in a computer.
- D. It does not use light.
- E. There is no true magnification system; just a sensitive electrical probe and amplifier.

21. Flagella and pili can both be responsible for bacterial cell motility.

How are these two types of motility similar?

- A. Both cause cells to move faster in higher concentrations of nutrients.
- B. Both involve secretion and withdrawal of appendages from the cell.
- C. Both involve rotation of filaments outside the cell.
- D. Both use ATP as their direct energy source.
- E. Both cause cells to move in a jerky manner rather than in smooth linear fashion.

22. Refer to the diagram of peptidoglycan at the right. What is different between Gram-negative and Gram-positive peptidoglycan?

- A. The molecule marked "E" is a sugar in G+ cells and an amino acid in G- cells
- B. The bond marked "B" is an α -1,4 bond in G+ cells and a β -1,4 bond in G- cells
- C. The amino acid marked "C" is an L-amino acid in G+ cells and a D-amino acid in G- cells
- D. The structure marked "A" is only found in G+ cells
- E. The structure marked "D" does not exist in G-cells

23. How does an amino acid get through the Gram-negative outer membrane?

- A. By use of energy from the PMS. Through special facilitated diffusion channels
- B. Through teichoic acid channels
- C. By simple diffusion
- D. LPS is much more permeable than phospholipid

24. Which of the following is currently (2008) believed to be major or difference between prokaryotes and eukaryotes?

- A. Eukaryotes have a cytoskeletal framework inside the cytoplasm.

- B. Prokaryotes have RNA, but eukaryotes have DNA.
- C. Prokaryotes all have cell walls made of peptidoglycan.
- D. Eukaryotes have a nucleus surrounded by a nuclear membrane.
- E. Eukaryotes are all multicellular.

25. You suspect a patient has a blood infection caused by a bacterium, and you need to get a titer of bacteria from the patient's blood. How would you do that most effectively?

- A. Use a Coulter Counter to obtain the titer
- B. Spread plate the blood and count the number of colonies
- C. Use a Petroff-Hausser chamber to estimate the titer
- D. Examine the optical density of the blood
- E. Centrifuge the blood and weigh the pellet

26. Chemolithoautotrophic bacteria can increase their growth rate if they contain inclusions called _____ that make the cell's metabolism more efficient.

- A. PHB granules
- B. Chlorosomes
- C. Metachromatic granules
- D. Carboxysomes
- E. Phycobilisomes

27. One advantage of growing cells in continuous culture is that _____.

- A. you can make the cells grow as fast or as slowly as you want.
- B. there is no special equipment required.
- C. their growth rate constant (μ) is higher than in batch culture.
- D. you can get them to produce more secondary metabolites, such as antibiotics.
- E. you can count them more easily than in batch culture.

28. In an environment that was isotonic to the cell's cytoplasm, what effect would penicillin have on logarithmic phase Gram-negative rod-shaped cells?

- A. The cells would lose their rod shape
- B. The cells would lyse
- C. The cells would become Gram positive
- D. The cells would die but remain intact
- E. no effect

29. Is it possible for a bacterium to have a PMF if the bacterium is in an isotonic environment?

- A. Yes, but the bacterium must be Gram negative, since gradients are formed across the inner membrane of Gram negative bacteria.
- B. No. Isotonic means that there are no gradients of any kind across bacterial membranes.
- C. No. Equalization of solute concentrations will also equalize charges, so there will be no overall membrane potential in an isotonic environment.
- D. Yes. But the bacterium must spend ATP to create the PMF by pumping ions.
- E. Yes. Individual ions can still form charge and concentration gradients even though the overall ion concentration is isotonic.

30. LPS(lipopolysaccharide) is highly toxic to mammals. What feature of LPS makes it so unusual compared to other molecules in its class?

- A. It contains a branched polymer of sugar molecules.
- B. It is a lipid, but is amphipathic.
- C. It has a sugar with both alpha and beta glycosidic bonds.
- D. It is a lipid that is not based on a glycerol backbone.
- E. It contains a protein without any chiral carbon atoms.

31. Some bacteria have mycolic acids in their outer membrane. What is a property does the mycolic acid give these bacteria?

- A. Increased membrane permeability
- B. Resistance to chemical disinfectants
- C. A supplemental Proton Motive Force
- D. Resistance to lysozyme
- E. The ability to store phosphate in molecular form

32. You have a bacterial culture with high turbidity. Which of the following would NOT be a reasonable way to quantify the number of bacteria in this sample?

- A. membrane filtration and plating the filter
- B. using the luciferase assay
- C. counting cells in a Petroff-Hausser chamber
- D. dilution of the culture and spread plating
- E. using a Coulter counter

33. This microscope is especially useful for viewing biofilms and other thick specimens. A removable pinhole contributes to the clarity and focus of the image.

- A. Confocal Scanning Laser Microscope
- B. Scanning Electron Microscope
- C. Bright-field Microscope
- D. Transmission Electron Microscope
- E. Fluorescence Microscope

34. You are measuring turbidity as a surrogate for cell number to make a growth curve. What will happen during the death/ decline phase?

- A. turbidity will remain the same, since dead cells still reflect light
- B. It isn't possible to measure turbidity during the death/ decline phase.
- C. turbidity will decrease, since dead cells will also lyse in this phase
- D. turbidity will increase, since there are still cells dividing during this phase
- E. turbidity will continue to increase for awhile, then will decrease

35. We now know that trans-unsaturated fatty acids contribute to heart disease, but they were formerly in widespread use in the food industry. What was an advantage in using them?

- A. They flow easily as liquid even at cold temperatures.
- B. They could be synthesized cheaply by heating cholesterol-free natural oils.
- C. They are the most common fatty acid in cell membrane phospholipids.
- D. They are found in many natural sources, both plant and animal.
- E. They are the most solid of the natural fats, and were used to solidify other fats.

36. This is the structure of the DNA synthesis inhibit or and antiviral drug AZT. How does AZT interfere with the structure of nucleic acids so much that it can be used as an antiviral?

- A. Its 5' end can not participate in a dehydration synthesis reaction.
- B. It doesn't have a sugar in its structure.
- C. Its 3' end can not participate in a dehydration synthesis reaction.
- D. Its base has an alpha linkage to its sugar rather than a beta linkage.
- E. Its nitrogenous base can't form H-bonds.

37. What is the main advantage of using an electron beam rather than light to illuminate a specimen?

- A. An electron beam can be used to view live, unstained cells
- B. Electron beams have a shorter wavelength than light
- C. It is easier to focus an electron beam
- D. The electron beam is brighter
- E. The electron beam penetrates thick specimens better

38. What will happen when cells of the bacterium Mycoplasma are placed in distilled water?

- A. These are very robust cells, and they will grow in distilled water.
- B. They will plasmolyze.
- C. They will lyse.
- D. They will swell with turgor pressure, but will not burst.
- E. They will synthesize osmoprotectants so that they do not plasmolyze.

39. Which of the following statements about viruses is true?

- A. They are usually surrounded by a lipid envelope.
- B. They can not infect bacteria.
- C. Viruses that infect bacteria can not infect humans.
- D. They have an active chemical metabolism.
- E. They have only RNA, no protein.

40. Cytoplasm in normal cells typically has about 15m M[Na⁺]. If you place typical cells in a solution with 150m M[Na⁺], what would happen?

- A. H₂
- B. H₂
- C. H
- D. Na
- E. Na

41. Why are Mycoplasma bacteria considered "pleomorphic"?

- A. They have a thick peptidoglycan layer.
- B. They have no cell wall.
- C. They contain an outer membrane of LPS.
- D. They can protect themselves from osmotic pressure.
- E. They have a layer of mycolic acid.

42. Why would a scientist want to grow a bacterial culture in a chemostat?

- A. She is probably growing a culture of microaerophiles.
- B. So the culture will reach stationary phase more quickly.
- C. She probably has a limited supply of growth media.
- D. So she can adjust the bacterial growth rate.
- E. So she can get the bacteria to produce antibiotics.

43. Which of the following correctly describes comparisons between Bacteria, Eukaryotes and Archaea?

- A. Eukaryotes are a much more diverse group than the other two.
- B. Archaea have protein, just RNA.
- C. Only Bacteria have peptidoglycan in their cell structures.
- D. Bacteria and Eukaryotes have a nucleus; Archaea don't.
- E. Only Eukaryotes have a cytoskeletal protein network within their cells.

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- E. Eukaryotes are a much more diverse group than the other two.

45. The three main branches in the phylogenetic "tree" of life are . . .

- A. Protozoa, Eukaryotes and Bacteria
- B. Plants, Animals and Fungi
- C. Prokaryotes, Eukaryotes and Archaea
- D. Bacteria, Archaea and Eukaryotes
- E. Bacteria, Plants and Animals

46. Why are we interested in studying type III secretion systems?

- A. They are involved in bacterial cell motility, just like flagella
- B. They produce a periplasmic intermediate, whose folding in the periplasm is unique
- C. They allow secretion of fully folded proteins
- D. They are often associated with insertion of toxins directly into eukaryotic cells
- E. They can secrete proteins constantly without any external secretion signal

47. You stain a slide of *Mycobacterium* according to the Gram stain procedure. What will you see under a bright-field microscope?

- A. It has only one membrane, so it will stain purple.
- B. It has a lot of protein in its outer membrane, so it will stain purple.
- C. It has no peptidoglycan, so it would stain pink.
- D. It has no cell wall, so you won't see anything—it won't stain.
- E. It has a very hydrophobic substance in its outer membrane, so it will not stain.

48. Why are Microbiologists so interested in studying bacterial microcompartments (BMCs)?

- A. We can concentrate enzymes whose efficiency we want to increase.
- B. They give us insights into the protein secretion systems.
- C. They resemble other bacterial structures, including flagella and pili.
- D. We can use the materials inside them to make a biodegradable plastic.
- E. Although there is no practical use for BMCs, they are quite interesting scientifically.

49. The structure shown here is able to survive boiling water. The arrow is pointing to a layer of this structure. What is the function of this layer?

- A. To protect against radiation and chemicals
- B. To have DNA wrapped around it so that radiation damage to the DNA can be readily repaired
- C. To soak water from the internal part of the structure, keeping it dry and inert
- D. To carry genetic material to the next generation
- E. To engulf another cell type by endocytosis

50. Whether a eukaryotic cell will use the TCA cycle depends on how much O₂ is present in the environment. What determines whether a bacterium will use its TCA cycle or not?

- A. Whether there is excess glucose in the cell
- B. The need the cell has for reducing power
- C. The need the cell has for ATPD. An excess of NADH in the cell
- D. Still the amount of O₂

51. The protein coat of an endospore . . .

- A. is a thin layer of protein crosslinked with glycosidic bonds.
- B. is involved in drying out the spore core.
- C. is the structural equivalent of the Gram-negative outer membrane.
- D. is formed very early in the sporulation process.
- E. is deposited between the membranes of the forming endospore and the other cell.

52. One major difference between batch culture and continuous culture is that _____.

- A. batch culture never reaches stationary phase
- B. continuous culture involves fewer nutrients
- C. continuous culture allows the researcher to change the bacterial growth rate
- D. continuous culture is set up in a series of flasks, not just one
- E. batch culture is best used to produce primary metabolites, such as ethanol

53. Which of the following is NOT a function of capsules or slimy layers?

- A. enhancing biofilm formation
- B. motility
- C. preventing phagocytosis
- D. surface adhesion
- E. biofouling of filters

54. We said that membranes are semi-permeable. Which of the following can pass freely through the membrane without the use of transporter proteins?

- A. polysaccharides
- B. ATP
- C. H
- D. sm all polar solventslikewater
- E. sm all non-polar molecules

55. Single-celled photosynthetic organisms with nuclei and without cell walls are. . .

- A. Fungi
- B. Plants
- C. Cyanobacteria
- D. Algae
- E. Purple Sulfur Bacteria

56. Which of the following shows a phosphodiester bond?

- A. E.
- B. B. C.

57. Which of the following is a characteristic of a bacterial type II export system?

- A. Secretion from a bacterium directly into a eukaryotic host cell
- B. Use of a leader peptide (signal sequence) to determine which proteins to secrete
- C. Secretion through both inner and outer membrane simultaneously
- D. Secretion of carbohydrates out of the cell
- E. Secretion of fully folded proteins and nucleic acids

58. The main purpose of fermentation reactions in a typical bacterial cell is_____.

- A. to oxidize NADH. to carry out the first step in anabolic reactions that make new cell material
- B. to generate a little bit more energy than just glycolysis does
- C. to make a PMF in the absence of an electron transport chain.
- D. to prepare pyruvate to enter the TCA cycle

59. A phase contrast microscope involves the use of which of the following hardware items?

- A. a fluorescence emission filter
- B. an annular diaphragm and an etched glass plate
- C. a movable pinhole
- D. two Wollaston prisms
- E. a detector or filter for reflected light beams

60. Modern Biology considers that the three domains (kingdoms) of life are. . .

- A. Animal, Vegetable and Mineral
- B. Archaea, Bacteria and Eukaryotes
- C. Bacteria, Plants and Animals
- D. Prokaryotes, Eukaryotes and Viruses
- E. Archaea, Eukaryotes and Plants

61. Why are Mycoplasma bacteria considered “pleomorphic”?

- A. They have a thick peptidoglycan layer.
- B. They can protect themselves from osmotic pressure.
- C. They have no cell wall.
- D. They contain an outer membrane of LPS.
- E. They have a layer of mycolic acid.

62. One major difference between batch culture and continuous culture is that _____.

- A. batch culture is best used to produce primary metabolites, such as ethanol
- B. continuous culture allows the researcher to change the bacterial growth rate
- C. continuous culture is set up in a series of flasks, not just one
- D. batch culture never reaches stationary phase
- E. continuous culture involves fewer nutrients

63. Compared to a mesophile, a psychrophile should have . . .

- A. a greater number of membranes
- B. more saturated lipids
- C. proteins with more surface charges
- D. more hydrogen bonding between lipids
- E. more cis-unsaturated lipids

64. Which of the following is NOT a feature found in Type II secretion systems (T2SS)?

- A. Two-stage secretion with a periplasmic intermediate
- B. A chaperone that prevents the protein from folding before it is secreted
- C. A leader peptide (signal sequence) that identifies proteins to be secreted
- D. A large transport complex in the inner membrane called the “Sec translocon”
- E. Transport is blocked until the bacterium contacts another cell

65. You are using a fluorescence microscope and an antibody-based stain to examine a mixed culture from a patient's blood for the titer of *Treponema pallidum*, the bacterium that causes syphilis. What would be the best method to make this titer determination?

- A. Viable cell count
- B. Turbidity measurement
- C. Membrane filtration and plating
- D. Petroff-Hausser chamber
- E. MPN method

66. A hallmark of a type III secretion system is...

- A. Presence of periplasmic intermediate
- B. Secretion only through the outer membrane
- C. Ability to concentrate proteins a million fold or more
- D. Secretion only once contact has been made with a host cell membrane receptor
- E. Use of cytoplasmic chaperone, Sec B

67. What type of picture is the one that is being used to examine the tiny organism at the right (not the scale bar)?

- A. Atomic force micrograph
- B. Electron cryotomogram
- C. DIC(Nomarski) micrograph
- D. Confocal micrograph
- E. Transmission electron micrograph

68. The fact that bacteria lack an endomembrane system explains their . . .

- A. use of a peptidoglycan cell wall
- B. need for a cytoskeleton
- C. motility
- D. lack of any internal structures
- E. small size

69. The bacterium *Streptococcus mutans* is well known for its ability to form biofilms. What feature of the bacterium is responsible for this ability?

- A. Adhesion pili
- B. Secretion of alginate
- C. Specialized proteins in its outer membrane
- D. A sucrose-induced glycocalyx
- E. Production of acidic fermentation products

70. Which of the following describes the hydrophobic effect?

- A. Temporary charge interactions between hydrophobic molecules
- B. Hydrogen bonding of water around hydrophobic molecules
- C. Covalent bonds between hydrogen and carbon
- D. Ions surrounded by charge-coordinated water molecules
- E. Formation of H₃

71. In a chemotrophic bacterial reaction, electrons are donated from glucose to NAD⁺, forming 2 molecules of pyruvate plus NADH. Which of the following must also be true?

- A. Pyruvate is at a higher energy level than NAD
- B. If this reaction were reversed, NAD
- C. This bacterium must be either aerobic or facultatively anaerobic.
- D. Glucose is being reduced during this reaction.
- E. Glucose is at a higher energy level than NADH.

72. The purpose of osmoprotectants accumulating within bacterial cells is to

- A. prevent the cytoplasm from shriveling up in hyperosmotic environments
- B. Prevent the cell from either lysing or shriveling up, depending on the environment
- C. prevent the cell from lysing in hyperosmotic environments
- D. prevent the cell from lysing in hypoosmotic environments
- E. prevent the cytoplasm from shriveling up in hypoosmotic environments

73. In the United States, swimming beaches are periodically tested for bacterial counts. In Indiana, a beach is closed if the bacterial titer exceeds 125 bacteria per 100 mL. Which of the following would be the best way to determine the titer?

- A. Coulter Counter
- B. Weighing a cell pellet
- C. Membrane filtration and plating
- D. Spread plating on agar in petri dishes
- E. Petroff-Hauser chamber

74. This is a picture of *Neisseria gonorrhoeae* adhering to cervical epithelial cells. What structure is it using to adhere to the cells?

- A. Flagella
- B. Volutin
- C. Nanowires
- D. Pili
- E. Capsule

75. For what purpose would you use a negative stain?

- A. to stain cells whose membranes have a positive charge
- B. to stain cells without a cell wall
- C. to stain cells with a thick peptidoglycan layer
- D. to stain cells with a thin peptidoglycan layer
- E. to stain the background around uncharged structures

76. Which of the following would you expect to find in both photolithoautotrophs and chemoorganoheterotrophs?

- A. Magnetosomes
- B. Volvoplantigranules
- C. Carboxysomes
- D. Chlorosomes
- E. Sulfur granules

77. Which of the following is NOT a part of the process of endospore formation?

- A. Cell divides asymmetrically
- B. Mother cell lyses to release a spore
- C. Special peptidoglycan layer is deposited around the spore
- D. Mother cell engulfs developing spore
- E. Spore replicates its DNA once last time in case conditions improve

78. Which of the following is NOT true of the PTS (phosphotransferase) transport system?

- A. It involves multiple phosphate transfers in a “relay”
- B. It involves direct transfer of a phosphate from ATP to glucose
- C. It is used mostly for transport of carbohydrates
- D. It is found only in Bacteria, not Archaea or Eukaryotes
- E. It uses energy from a high energy phosphate, though not from ATP

79. These bacteria are about 0.1 micrometers (μm) in diameter. How is it that we can see them?

- A. We have added a fluorescent dye and are using confocal microscopy.
- B. We are using an optical trick to see them in 3 dimensions.
- C. 0.1 μm is pretty big for a bacterium, so size is not a problem in this case.
- D. We are illuminating them obliquely and viewing the reflected light.
- E. This is an electron micrograph.

80. Which of the following structures is found only in Bacteria?

- A. lipopolysaccharide
- B. cell membrane
- C. flagellum
- D. nucleus
- E. cell wall

81. How does the MFS antiport pump Na^+ out of the cell?

- A. It uses both the membrane potential and proton gradient energy
- B. It uses energy in the Na^+ gradient
- C. It uses the energy from ATP hydrolysis
- D. It uses the energy of the proton gradient
- E. It uses the membrane potential (charge component of the PMF)

82. What type of microscope would you use to examine a biofilm that was 2 mm thick?

- A. transmission electron
- B. confocal scanning laser
- C. interference (Nomarski)
- D. phase contrast
- E. atomic force

83. Structurally, what does it mean that transport of solute #1 with its gradient allows transport of solute #2 against its gradient?

- A. Solute #1 holds the transporter open long enough for solute #2 to bind
- B. Solute #1 will bind to the inside of the transporter, solute #2 to the outside
- C. It is a thermodynamic “trick”. Solute #1 is actually turned in to solute #2 inside the cell
- D. Solute #1 forms weak bonds with solute #2 so that they enter the cell together
- E. Solute #1 will be transported in to a cell, solute #2 out, as in an antiport

84. What is the metabolic purpose of beta oxidation?

- A. It is a type of bacterial secondary metabolism

- B. It is a way to make bacterial cell w all precursors
- C. It is a way to turn fatty acids into TCA cycle precursors
- D. It is a way to feed cellulose monomers into the pentose phosphate pathway
- E. It is a way to breakdown protein secondary structures

85. Condensation reactions . . .

- A. are classified as reduction reactions
- B. usually require energy input
- C. are usually catabolic
- D. are classified as oxidation reactions
- E. involve an -OH from one molecule and a -C=O from another

86. Which of the following is true about an allosteric inhibitor or?

- A. The inhibitor or alters the active site without binding to it.
- B. There is no way to predict the shape of such an inhibitor or.
- C. The inhibitor or binds to the substrate rather than to the enzyme.
- D. The inhibitor or must be present in large excess over the substrate.
- E. The inhibitor or must at least partially resemble the substrate.

87. What is the function of the bacterial structures shown at the right? (Shown as a combined microscopic and crystallographic view.)

- A. to organize photosynthetic reaction pigments
- B. to store carbon in heterotrophic bacteria
- C. to concentrate enzymes used to reduce CO₂
- D. to store CO₂
- E. to store sulfur in lithotrophic bacteria

88. Which of the following is currently (2008) believed to be a major difference between prokaryotes and eukaryotes?

- A. Eukaryotes have a cytoskeletal framework inside the cytoplasm.
- B. Prokaryotes all have cell walls made of peptidoglycan.
- C. Eukaryotes are all multicellular.
- D. Eukaryotes have a nucleus surrounded by a nuclear membrane.
- E. Prokaryotes have RNA, but eukaryotes have DNA.

89. Amino acids are NOT synthesized from _____.

- A. pyruvate
- B. fermentation products
- C. pentose phosphate pathway intermediates
- D. glycolytic intermediates
- E. TCA cycle intermediates

90. Which of the following is NOT a part of the process of endospore formation?

- A. Special peptidoglycan layer is deposited around the spore
- B. Mother cell engulfs developing spore
- C. Spore replicates its DNA one last time in case conditions improve
- D. Cell divides asymmetrically
- E. Mother cell lyses to release spore

91. We can't digest cellulose, though bacteria can, because. . .

- A. we can't deal with the many branches in the polymer
- B. we can't make cellulose storage polymers, but bacteria can
- C. cellulose is too highly crosslinked by H-bonds for our digestive system
- D. cellulose is a polymer of sugars and amino acids, much like peptidoglycan
- E. we can't digest β -glycosidic bonds, but bacteria can.

92. In this picture you are looking at _____ under a _____ microscope, stained with _____.

- A. capsules, bright-field, negative stain
- B. endospores, transmission electron, nothing
- C. rod-shaped bacteria, dark-field, the Gram stain
- D. protozoa, DIC (Nomarski), simple stain
- E. endospores, phase contrast, nothing

93. A nucleic acid polymer is formed by. . .

- A. Phosphodiester bonds between 5' and 2' carbon atoms
- B. Phosphate-Phosphate ionic interactions
- C. Parallel bonds between alpha and beta carbon atoms
- D. Phosphodiester bonds between 5' and 3' carbon atoms
- E. Peptide bonds between alpha carbon atoms

94. Why is it important to understand that glycosidic bonds can have both alpha and beta anomers (that there can be α and β glycosidic bonds)?

- A. It is much harder to digest β -glycosidic bonds. Only bacteria can do it.
- B. Alpha glycosidic bonds form spontaneously. Beta requires enzyme catalysis.
- C. Alpha bonds are helical and beta are flat. This is important for protein function.
- D. Beta glycosidic bonds can participate in hydrogen bonding. Alpha can not.
- E. Though α -glycosidic bonds are not common, they are found in peptidoglycan.

95. The luciferase reaction is not routinely used to obtain an accurate bacterial titer. Why not?

- A. You do not see a reaction with fewer than 10
- B. Luciferase is not a bacterial enzyme.
- C. Dead cells do not produce ATP.
- D. It is only based on a statistical estimate of growth.
- E. The amount of ATP produced per cell is not constant.

96. Which of the following is NOT involved in the formation of a proton motive force (PMF) in bacteria?

- A. a proton pump that uses energy from sunlight
- B. an ion gradient across the cell membrane
- C. an electron transport chain
- D. a charge separation (voltage gradient) across the cell membrane
- E. an ABC transport protein

97. The picture at right shows the individual proteins in the outer layer of a phycobilisome, a microcompartment found within the cytoplasm of some bacteria. What sort of microscope was used to image this structure?

- A. Atomic force microscope
- B. Differential interference contrast microscope
- C. Confocal scanning laser microscope
- D. Transmission electron microscope
- E. Scanning electron microscope

98. Two bacterial cultures, A and B, were inoculated into "medium M," and produced the growth curves shown at the right. What can you conclude about these cultures?

- A. Culture A produces more primary metabolites than culture B.
- B. Culture A has the higher growth rate.
- C. Culture B had been growing in a nutrient-poor medium before it was inoculated into "medium M."
- D. Culture A had been growing in a medium similar to "medium M" before it was inoculated.
- E. Culture B eventually becomes a continuous culture.

99. Which of the following statements about enzyme inhibitors is correct?

- A. A noncompetitive inhibitor must resemble the substrate at least partially.
- B. Competitive inhibitors are usually found in anabolic pathways.
- C. An allosteric inhibitor binds to an enzyme's active site.
- D. An allosteric inhibitor functions even at a much lower concentration than the substrate.
- E. A competitive inhibitor induces an irreversible shape change in the active site.

100. What is the organism that is depicted in the micrograph at the right (note the scale bar)?

- A. A fungus
- B. A bacterium
- C. A virus
- D. An endospore
- E. A protozoan

101. Is a blood infection with Gram-negative or Gram-positive cells more dangerous? Why?

- A. G+, because the cells can't be killed with readily available antibiotics
- B. G+, because of teichoic acids in the membrane
- C. G-, because we can't make antibodies against any G- cell surface structures.
- D. G-, because of toxic shock induced by LPS endotoxin
- E. G-, because of the O-antigen layer of the outer membrane

102. Which of the following is a hallmark of protozoa, but NOT of bacteria?

- A. the presence of a cytoskeleton
- B. saprophytic lifestyle
- C. two cell forms—yeast and mold
- D. life in extreme environments
- E. endocytosis to engulf nutrients

103. Which of the following is a correct reference to a hydrolysis reaction?

- A. It is a reaction that uses water to break weak bonds.
- B. It is a type of oxidation reaction.
- C. It is a type of anabolic reaction.
- D. An example is:
- E. Carrying it out releases energy.

104. The acid-fast stain is an example of a differential stain. What makes it "differential"?

- A. It stains the background of the slide rather than the cells.
- B. It uses a special differential dye during the staining process.
- C. It uses two stains, along with a solvent that removes stain from some cells but not all.
- D. It stains positively charged molecules in the cell rather than negatively charged molecules.
- E. It stains special bacterial structures called "inclusions" that are present in some cells.

105. Bacteria that can use lipids as a carbon source typically have what type of metabolism?

- A. A lithotrophic one, since lipids are the electron source as well as the carbon source
- B. Facultatively anaerobic since lipidshave both hydrophilic and hydrophobic parts
- C. Entirely oxidative, since fatty acids are oxidized rather than reduced
- D. Strictly respiratory since oxidation of fatty acids generates lots of NADH. Strictly anaerobic, since fatty acids are fermented

106. Refer to the diagram of peptidoglycan at the right. What is different between Gram-negative and Gram-positive peptidoglycan?

- A. The bond marked "B" is an α -1,4 bond in G+ cells and a β -1,4 bond in G- cells
- B. The structure marked "D" does not exist in G-cells
- C. The molecule marked "E" is a sugar in G+ cells and an amino acid in G- cells
- D. The structure marked "A" is only found in G+ cells
- E. The amino acid marked "C" is an L-amino acid in G+ cells and a D-amino acid in G- cells

107. Which of the following is a unique molecule in the Gram-positive cell envelope (envelope = wall + membrane(s))?

- A. glycine
- B. lipoprotein
- C. lipid A / lipoteichoic acid
- D. D-alanine

108. This microscope is especially useful for viewing biofilms and other thick specimens. A movable pinhole contributes to the clarity and focus of the image.

- A. Fluorescence Microscope

- B. Scanning Electron Microscope
- C. Bright-field Microscope
- D. Confocal Scanning Laser Microscope
- E. Transmission Electron Microscope

109. Which of the following statements about enzymes is INCORRECT?

- A. Enzyme pathways require each reaction to occur in order to form the end product.
- B. Enzymes lower the free energy of a reaction.
- C. Enzymes lower the activation energy of a reaction.
- D. RNA and DNA molecules can have catalytic activity.
- E. An induced fit enzyme model involves a subtle change in the tertiary structure when binding a substrate.

110. What is the purpose of a molecular chaperone during protein secretion in bacteria?

- A. It prevents reverse transport of some proteins
- B. It can be used to transport fully folded proteins
- C. It provides the energy for some protein transporters
- D. It keeps a protein in an unfolded conformation until transport
- E. It shepherds a protein through the endomembrane system to bring it to a transporter

111. In the United States, swimming beaches are periodically tested for bacterial counts. In Indiana, a beach is closed if the bacterial titer exceeds 125 bacteria per 100 mL. Which of the following would be the best way to determine this titer?

- A. Coulter Counter
- B. Petroff-Hauser chamber
- C. Weighing a cell pellet
- D. Membrane filtration and plating
- E. Spread plating on agar in petri dishes

112. What is the feature of the Mycobacterial cell envelope that is not found in other bacteria?

- A. Its peptidoglycan is crosslinked with a pentaglycine spacer.
- B. It has no cell wall, only a membrane.
- C. It has an outer membrane with pores that allow small molecules to enter the cell.
- D. It contains a thick layer of very dense lipids in its outer membrane.
- E. It is made of protein rather than lipids and peptidoglycan.

113. Which of the following microscopes depends on interference of illuminating waves that pass through internal cellular structures that have a different refractive index?

- A. Phase contrast microscopy
- B. Darkfield microscopy
- C. Electron cryotomography
- D. Transmission electron microscopy
- E. Fluorescence microscopy

114. How can an

- A. colic can move forwards or backwards toward the higher concentration.
- B. It can't.
- C. The cell follows signals from other cells that are nearer to the attractant than it is.
- D. A protein at one end of the cell acts like an "eyespot" to "see" the attractant.
- E. E. coli can tumble less frequently if it is moving towards a continually increasing attractant concentration.
- F. coli can only move toward attractant that is evenly distributed in a solution.
- G. There is a higher attractant concentration at one end of the cell than at the other, and
- H. coli cell moves toward a point source of a molecular attractant?

115. Which of the following is NOT an example of a direct cell count?

- A. Detecting when a bacterial particle interrupts an electric current
- B. Measuring culture turbidity with a spectrophotometer
- C. Obtaining a cell pellet by centrifugation and measuring its mass
- D. Counting the number of cells per grid square on a ruled microscope slide
- E. Detecting acid production in the well of a biochip

116. The presence of carboxysomes in a bacterial cell indicates that the cell . . .

- A. is an autotroph
- B. can use an organic electron donor or
- C. can store carbon reserves
- D. is an auxotroph
- E. is a phototroph

117. In the following spontaneous reaction: Aox + Bred → Ared + Box

- A. Loses both H
- B. Bred
- C. Agives electrons to BB. Agives energy to BC. Bloses energy

118. Which of these is important for the function of flagella, but not for Type III secretory systems?

- A. An ATPase
- B. Membrane bushings
- C. AH
- D. A rot or complex
- E. A hollow exterior filament

119. Pili are involved in all of the following EXCEPT . . .

- A. Motility
- B. Biofilm formation
- C. Surface attachment
- D. Horizontal gene transfer
- E. Protein secretion

120. Taken together, the experiments of Pasteur, Tyndall and Koch demonstrated that . . .

- A. some bacteria can not be killed
- B. some forms of bacteria are not living organisms
- C. as long as air can be kept out, a solution can be kept sterile

- D. sometimes an experiment must be repeated for it to work right
- E. as long as no living organisms enter a solution, it can be kept sterile indefinitely

121. Glucose is "broken down" into glycols. What does "broken down" mean in this case?

- A. Glucose is reduced
- B. Glucose is first condensed, and then oxidized
- C. Glucose is first reduced, and then hydrolyzed
- D. Glucose is first hydrolyzed, and then oxidized
- E. Glucose is first oxidized, and then reduced

122. Some bacteria have mycolic acids in their outer membrane. What property does the mycolic acid give these bacteria?

- A. The ability to store phosphate in molecular form
- B. A supplemental Proton Motive Force
- C. Increased membrane permeability
- D. Resistance to chemical disinfectants
- E. Resistance to lysozyme

123. You're a microbiologist looking at a biofilm from a lithotrophic bacterium. Some cells have sulfur granules, but not all do. What other organelles could you expect to find in this culture?

- A. Nanowires
- B. PHA granules
- C. Magnetosomes
- D. Phycobilisomes
- E. Flagella

124. What form of energy is directly generated by the oxidative decarboxylation of pyruvate?

- A. Rotary motion
- B. ATPB. AH
- C. Acetyl-Co AE. NADH

125. When a Gram-positive bacterial cell is placed in a hyperosmotic environment, what happens?

- A. It lyses.
- B. Turg or pressure builds up inside the cell, but the cell does not lyse.
- C. Ions flow rapidly into the cell through the membrane.
- D. Water flows out of the cell through passive diffusion carriers.
- E. Water must be pumped into the cell to dilute the salts.

126. These viruses infect the bacterium *Escherichia coli*. Which of the following MUST also be true?

- A. Their diameter (whiteline) is less than 1 nanometer.
- B. They have a lipid envelope.
- C. The viruses are prokaryotes.
- D. They can not infect humans.
- E. They contain no protein.

127. What type of microscope views a specimen with light reflected from the specimen rather than passed through the specimen?

- A. phase contrast
- B. darkfield
- C. confocal scanning laser
- D. interference (Nomarski)
- E. bright field

128. A major difference between Gram-negative and Gram-positive cell walls is . . .

- A. Gram-negative walls have teichoic acid storage polymers
- B. Gram-positive walls are enclosed within a membrane-bound space
- C. Gram-negative walls are much thicker than Gram-positive walls
- D. Gram-positive walls are made of peptidoglycan
- E. Gram-positive walls are crosslinked via a pentaglycine interbridge

129. What is "Horizontal Gene Transmission"?

- A. The exchange of protein gene products between two bacteria using Type III secretory systems
- B. The exchange of DNA between two bacteria using special pili
- C. The transfer of DNA from one bacterium to another using special pili
- D. The transfer of DNA from one bacterium to another using Type III secretory systems
- E. The exchange of DNA between two bacteria using Type III secretory systems

130. A bacterium is growing in a medium with a $[K^+]$ of 1 mM. The bacterium uses a uniport to accumulate K^+ to 10 mM concentration inside the cell. What is the energy for this transport?

- A. ATP hydrolysis
- B. The membrane potential
- C. The pH gradient
- D. The K^+ gradient
- E. No energy is required for this transport

131. In which of the following polymers would you find alpha-glycosidic bonds?

- A. Starch
- B. Cellulose
- C. Peptidoglycan
- D. DNA
- E. Proteins

132. Which of the following is a similarity between Type II and Type III secretion systems?

- A. Use of ATP hydrolysis as the energy source for transport
- B. Presence of an extracellular needle complex
- C. Formation of periplasmic intermediate
- D. Structural relationship to structures for motility
- E. Ability to secrete proteins while they are still being synthesized by the ribosome

133. Modern Biology considers that the three domains (kingdoms) of life are . . .

- A. Archaea, Bacteria and Eukaryotes
- B. Animal, Vegetable and Mineral
- C. Prokaryotes, Eukaryotes and Viruses
- D. Archaea, Eukaryotes and Plants
- E. Bacteria, Plants and Animals

134. What functions do bacterial microcompartments carry out?

- A. They store phosphate reserves that bacteria use during times of phosphate starvation.
- B. They store carbon reserves that bacteria use during times of carbon starvation.
- C. They concentrate photosynthetic pigments.
- D. They orient bacteria in a oxygen gradient.
- E. They concentrate enzymes and their substrates to improve reaction rates.

135. Which of the following peptidoglycan structures is affected by penicillin?

- A. AB.
- BC.
- CD.
- DE.
- E

136. All of the following are advantages of the PTS system, EXCEPT...

- A. It readies glucose for the metabolic reactions in which it will later be used
- B. It takes advantage of Le Chatelier's Principle to increase transport efficiency
- C. It allows the regulation of intracellular reactions in response to glucose
- D. It allows the cell to sense the presence of glucose
- E. It is an efficient transfer of phosphate from ATP directly to glucose

137. Which of the following is NOT a characteristic of the bacterial PTS transport system?

- A. It saves energy by bringing glucose into the cell in a form that is ready for glycolysis
- B. It can be used to import and export a wide variety of solutes
- C. The use of many steps in a relay allows for metabolic regulation in response to glucose
- D. Le Chatelier's Principle ensures that phosphorylated solutes can accumulate inside the cell.
- E. It involves phosphate transfer between several proteins in intermediates

138. Why is pyruvate an especially important molecule in central catabolism?

- A. It is the starting material for anabolic reactions that make nucleic acids.
- B. It can either accept electrons from NADH or donate electrons to NAD
- C. It is a high-energy molecule that can serve as an energy source for auxotrophs.
- D. All carbohydrates are converted to pyruvate before glycolysis can begin.
- E. It is an important intermediate in the TCA cycle.

139. What is the purpose of lactic acid fermentation in bacterial metabolism?

- A. to oxidize NADH, to produce ATP anaerobically
- B. to make lactate, an important growth factor
- C. to produce reducing power
- D. to produce a PMF anaerobically

140. Why does

- A. coli
- B. coli reverse the direction of its flagellar rotation periodically?
- C. It doesn't.
- D. The cell fails to encounter a higher attractant concentration.
- E. The reversal is random; it is not regulated by the
- F. coli flagella far apart if they reverse rotation.
- G. That's how the cell reverses the direction in which it is traveling.
- H. So the cell can make ATP rather than use ATP to turn the flagella.

141. Prions are infectious agents that contain

- A. DNA and protein
- B. protein only
- C. RNA only
- D. RNA and protein
- E. RNA, DNA and protein

142. An active transport uniport uses what source of energy to bring molecules across the cell membrane?

- A. Uniports do not use energy
- B. ATP
- C. The potential energy in the gradient of the molecule being transported
- D. The voltage potential (electrical charge) across the membrane
- E. The proton gradient

143. How many oxidation reactions occur in the biochemical pathway shown at the right?

- A. 5
- B. 3
- C. 2
- D. 1
- E. none

144. In a protein alpha helix, hydrogen bonds form between . . .

- A. the sugars ribose and deoxyribose
- B. the chiral carbon atoms of the amino acids
- C. atoms in the peptide bonds that join amino acids together

D. purine and pyrimidine nucleotides

E. R-groups (sidechains) of the polar amino acids

145. You are examining an organism under the microscope. It is about 15 micrometers (μm) in diameter. A chemical analysis shows that it contains DNA, RNA and protein, as well as other macromolecules. You grow it on a petri dish to get a pure culture, but this time when you look at it under the microscope it consists of filaments 100 μm long and 8 μm wide. Explain this.

- A. It is diffusion-limited when it is growing on the petri dish.
- B. You are looking at eukaryotic algae, with long flagella.
- C. You were looking at a virus that became contaminated with rod-shaped bacteria.
- D. You are looking at a culture of ciliated protozoa.
- E. You are looking at a fungal culture.

146. Mycolic acids cause mycobacteria to . . .

- A. resist chemical damage
- B. be Gram positive
- C. be shapeless
- D. be toxic to humans
- E. stick to surfaces

147. Whether a eukaryotic cell will use the TCA cycle depends on how much O₂ is present in the environment. What determines whether a bacterium will use its TCA cycle or not?

- A. The need the cell has for reducing power
- B. Still the amount of O₂
- C. Whether there is excess glucose in the cell
- D. The need the cell has for ATPD. An excess of NADH in the cell

148. Two bacterial cultures, A and B, were inoculated in to "medium M," and produced the growth curves shown at the right. What can you conclude about these cultures?

- A. Culture A produces more primary metabolites than culture B.
- B. Culture B had been growing in a nutrient-poor medium before it was inoculated in to "medium M."
- C. Culture B eventually becomes a continuous culture.
- D. Culture A had been growing in a medium similar to "medium M" before it was inoculated.
- E. Culture A has the higher growth rate.

149. Archaea have . . .

- A. phosphotransferase systems
- B. a cell membrane
- C. peptidoglycan
- D. chloroplasts

E. anucleus

150. What type of microscope measures electric current passing through a probe rather than using any part of the electromagnetic spectrum?

- A. atomic force
- B. interference (Nomarski)
- C. electron tomography
- D. bright field
- E. scanning electron

151. The structure indicated by the arrow is most important for . . .

- A. surface attachment of biofilms
- B. electron transfer between cells
- C. protein storage
- D. motility
- E. DNA transfer

152. Which equation could be used to solve the following problem? A sample of milk has been pasteurized (bacterial count reduced by 5 logs). If the bacteria are growing at a rate of 0.1 per hour, how long will it take until there are as many bacteria in the milk as there were before the pasteurization?

- A. There is not enough information to set up an equation to solve this problem.
- B. $\ln(100,000) = (0.1)(t)$
- C. $1 = 100,000e$
- D. $5 = 1e$
- E. (10

153. Cells in a biofilm are very tightly adherent to one another, have variable metabolic activity, and many are dead. What technique would be best to enumerate (count) the cells in a biofilm?

- A. dry and weigh the biofilm
- B. most probable number method
- C. measure metabolic acid production
- D. turbidity measurement
- E. Coulter counter

154. How do prions cause infectious diseases?

- A. They bind to tRNA, preventing it from being translated into a protein that the host needs.
- B. They grow inside a host cell and eventually become numerous enough to lyse it.
- C. They secrete digestive enzymes that kill a host and then consume it saprophytically.
- D. They misfold, and then cause other proteins to misfold, eventually damaging host cells.
- E. They insert their DNA into the host's DNA, thereby taking over the host cell genetically.

155. Alpha helices and beta pleated sheets . . .

- A. both require enzymes in order for them to form
- B. both involve hydrogen bonding among amino acid R-groups
- C. can not be digested by humans, but can be by bacteria
- D. are both considered to be protein secondary structures
- E. both involve hydrophobic interactions in addition to hydrogen bonds

156. Why do we consider that the bacterial Type III secretion system is an intermediate in flagellar evolution?

- A. Both T3SS and flagella are involved in cell motility.
- B. Both T3SS and flagella are made of the proteins flagellin and pilin.
- C. T3SS and flagella are both examples of bacterial rotary motors.
- D. T3SS and flagella are both hollow filaments with similar membrane proteins.
- E. T3SS and flagella are found only in Gram-positive cells.

157. Which of the following is the most highly oxidized molecule?

- A. CO₂
- B. H₂
- C. C₂
- D. C₆

158. In order to view this specimen, a special technique must be used. Why?

- A. This technique helps to view very thick specimens.
- B. The light used by this technique is polarized, which improves resolution.
- C. The specimen is thinner than 0.2 microns.
- D. This technique is a form of differential stain that improves contrast.
- E. This technique must be used to view individual cells.

159. The large intracellular structures seen inside this cell are likely used for . . .

- A. survival in harsh environments
- B. photosynthesis
- C. orientation in a magnetic gradient
- D. storage of electron acceptors
- E. storage of carbon reserves for later metabolism

160. Amino acids are NOT synthesized from _____.

- A. fermentation products
- B. pentose phosphate pathway intermediates
- C. TCA cycle intermediates
- D. glycolytic intermediates
- E. pyruvate

161. All of the following reactions release energy EXCEPT _____.

- A. pyruvate → lactate
- B. pyruvate → acetyl-CoA
- C. glucose → CO₂
- D. NADH → NAD
- E. glucose → pyruvate

162. Enzyme X has the amino acid threonine in its active site. A mutation that replaced threonine with valine would likely have what effect on enzyme X?

- A. It would have very little effect.
- B. It would denature alpha helices, but not beta sheets.
- C. It would cause the enzyme to completely denature.
- D. It would cause the active site to become an allosteric site.

E. It would cause the active site to become partially denatured.

163. The drug valinomycin affects the membrane potential, but not the Δp H. Which of the following transporters would be most affected by treatment with valinomycin?

- A. An ADP/ATP antiport
- B. A lysine uniport
- C. A H⁺/glucose symport
- D. A type III secretion system
- E. A gated H⁺/glucose symport

164. Which of the following reactions involves net release of energy?

- A. Making glucose from starch
- B. Making a membrane from phospholipids
- C. Assembling a protein from amino acids
- D. Reducing CO₂
- E. Adding a phosphate to the structure of a protein

165. Which of the carbon atoms in this nucleotide could be the 3' end of a DNA molecule?

- A. AB.
- BC.
- CD.
- DE.
- E

166. Which of the following methods of enumerating bacterial growth could be most easily adapted to counting only motile bacterial cells in a culture?

- A. Luciferase reaction
- B. Weighing bacterial biomass
- C. Coulter counter
- D. Petroff-Hausser chamber
- E. Membrane filtration and plating

167. This molecule is one of the most versatile in central catabolism. It can be oxidized or reduced. It is a point at which side reactions feed into central catabolism, and is also a starting material for anabolic reactions.

- A. Glucose
- B. ATP
- C. Acetyl-CoA
- D. Pyruvate
- E. CO₂

168. How can an

- A. E. coli cantumble less frequently if it is moving towards a continually increasing attractant concentration.
- B. A protein in at one end of the cell acts like an "eyespot" to "see" the attractant.
- C. There is a higher attractant concentration at one end of the cell than at the other, and
- D. It can't.

- E. The cell follows signals from other cells that are nearer to the attractant than it is.
- F. *E. coli* can move forwards or backwards toward the higher concentration.
- G. *E. coli* can only move toward attractants that are evenly distributed in a solution.
- H. *E. coli* cell moves toward a point source of a molecular attractant?

169. Which of the structures on the diagram at the right is affected by the enzyme lysozyme?

- A. AB.
- B. BC.
- C. CD.
- D. DE.
- E

170. The purpose of osmoprotectants accumulating within bacterial cells is to

- A. Prevent the cell from either lysing or shriveling up, depending on the environment
- B. prevent the cell from lysing in hyperosmotic environments
- C. prevent the cell from lysing in hypoosmotic environments
- D. prevent the cytoplasm from shriveling up in hyperosmotic environments
- E. prevent the cytoplasm from shriveling up in hypoosmotic environments

171. Which of the following is NOT a feature of the “gated rocker-switch” mechanism for transporter function?

- A. Gate opening stabilized by binding of symported or antiported ion
- B. Plug in transport channel moved aside by energy from ATP
- C. Substrate binding site near the middle of the membrane bilayer
- D. Gates help reduce transport in the reverse direction
- E. Transport channel open alternately to the outside, then the inside of the cell

172. Bacteria can vary the lipid structures they use in their membrane, depending on the temperature. The goal is to keep the membrane from melting, but not allowing it to get so solid that proteins can't move around. How would the membrane of a psychrophile growing at 28 °C compare to the membrane of the same organism growing at 5 °C?

- A. It would consist of all trans-unsaturated lipids at 5
- B. It would melt at 5
- C. It would have more cis-unsaturated lipids at 5
- D. It would solidify at 5
- E. It would have more saturated lipids at 5

173. Which of the following would NOT require enzyme catalysis?

- A. Condensation of two amino acid side chains to form a peptide bond
- B. Rotation of proline's R-group by 180 degrees
- C. Interaction between the R-groups of two cysteine amino acids
- D. "Breaking down" a protein in its primary structure
- E. Folding of a protein into an alpha helix

174. What is wrong with this model of a nucleic acid molecule?

- A. The model is not antiparallel
- B. G-C should have only two hydrogen bonds and A-U one

C. A doesn't pair with U. The bases are not attached to the correct carbon

D. The phosphodiester bonds are not represented correctly

175. Which of the following would typically be done in a chemostat?

- A. Storing a culture long-term without allowing it to grow
- B. Determining how long bacteria may survive in a natural environment
- C. Enriching a culture for persister cells
- D. Measuring the growth rate, μ , under a variety of nutrient concentrations
- E. Harvesting antibiotics

176. What part of bacterial cells is called "endotoxin" because of its toxic effects in vertebrates?

- A. Lipopolysaccharide
- B. Peptidoglycan
- C. Pili
- D. Teichoic acids
- E. Flagella

177. Viewing a thick specimen, such as a bacterial biofilm, would likely require which of the following?

- A. a movable eyepiece
- B. a special condenser
- C. a differential stain
- D. a phase-shifting element
- E. two Wollaston prisms

178. Which biochemical pathway is correctly matched with a macromolecular product it produces?

- A. Proteins come from TCA cycle intermediates
- B. Nucleic Acids are produced from glycolysis
- C. Carbohydrates are produced by beta-oxidation
- D. Lipids are derived from TCA cycle intermediates
- E. Lipids are derived from the Pentose Phosphate pathway

179. A negative stain is best used to view _____ structures.

- A. positively charged
- B. Gram-negative
- C. uncharged
- D. internal
- E. negatively charged

180. A competitive inhibitor of an enzyme _____.

- A. must structurally resemble the substrate of the enzyme it inhibits
- B. binds to an allosteric site on the enzyme
- C. inhibits an enzyme even at a much lower concentration than the substrate
- D. works by denaturing or modifying the shape of the active site
- E. can only inhibit enzymes in anabolic pathways

181. Which of these is NOT a correct description of a double-stranded nucleic acid?

- A. The 5'-to-3' direction on one strand is opposite to the 5'-to-3' direction on the other strand.
- B. Each strand is synthesized by forming covalent phosphodiester bonds between monomers.
- C. The sugars in the monomer structures come from the Pentose Phosphate Pathway.
- D. Purines must hydrogen-bond with other purines and pyrimidines with pyrimidines.
- E. The 5' ends are phosphorylated and the 3' ends are hydroxylated.

182. What type of transport is carried out by the PTS (phosphotransferase system)?

- A. Import of sugars
- B. Import of positively charged ions such as NH₄⁺
- C. Import of negatively charged amino acids
- D. Export of proteins in to the cell membrane
- E. Export of fully folded proteins

183. The main purpose of the TCA cycle in central catabolism is _____.

- A. to feed compounds from the Pentose Phosphate Cycle into central catabolism
- B. to produce carboxylic acids for metabolism
- C. to produce additional reducing power
- D. to produce additional ATP. to regenerate NAD

184. Which of the following is NOT an example of a direct cell count?

- A. Counting the number of cells per grid square on a ruled microscope slide
- B. Detecting when a bacterial particle interrupts an electric current
- C. Obtaining a cell pellet by centrifugation and measuring its mass
- D. Measuring culture turbidity with a spectrophotometer
- E. Detecting acid production in the well of a biochip

185. Saying that microbes are "diffusion limited" is the same as saying that they . . .

- A. have a cytoskeleton
- B. rely on passive diffusion for transport across their membrane
- C. lack an organized intracellular transport system
- D. are eukaryotes
- E. usually grow in an environment with a high diffusion rate

186. What is the best technique to use if you wish to count the relative numbers of two different bacterial species on the same slide?

- A. Phase Contrast microscope, with a Gram stain
- B. Atomic Force Microscope, unstained

C. Fluorescence Microscope, with fluorescent antibody staining

D. Bright Field, with a negative stain

E. Confocal Scanning Laser Microscope, with a simple stain

187. Which equation would you use to solve the following problem: You inoculate a single cell with a doubling time of 30 minutes into 50 ml of culture medium and allow it to grow for 7 days. How many cells will be in the culture after 7 days.

- A. $N=50e$
- B. $N=e$
- C. $50N=(\ln 30)(7 \times 24)$
- D. Binary fission will not continue for 7 days, so this can not be solved with the growth equation.
- E. $N=e$

188. How can the contrast of a microscopic image be improved?

- A. By using a longer wavelength of illuminating light
- B. By increasing the magnification
- C. By staining the specimen
- D. By using electrons for illumination rather than light
- E. By using microscope slide oil

189. Why is that live bacteria cannot be seen well with a bright field microscope?

- A. The high energy light of the bright field microscope kills them.
- B. The contrast achieved by bright field microscopy is too low.
- C. Bright field microscopes "see" 3-dimensions, but bacteria have only two.
- D. The resolution of a bright field microscope is too poor.
- E. They are too small.

190. A pharmacist wants to develop a drug that inhibits a bacterial enzyme. He has an option to develop either a competitive inhibitor or (CI) or a non-competitive inhibitor or (NCI). All other things (toxicity, cost, etc.) being equal, which one would he prefer to develop? Why?

- A. The NCI, because he can design it by derivatizing the enzyme's normal substrate
- B. The CI, because it can inhibit the enzyme by several different mechanisms
- C. The CI, because it will specifically target allosteric enzymes
- D. The NCI, because it still allows the substrate to bind to the enzyme's active site
- E. The NCI, because it does not have to be present in large concentration excess

191. What would happen to Mycoplasma cells placed in a solution that is hypotonic with respect to the cytoplasm of the cells?

- A. They would plasmolyze
- B. They would lyse
- C. They would experience an increase in turgor pressure, but would not lyse
- D. They would synthesize osmoprotectants
- E. They would not experience any changes

192. An organism with carboxysomes would be expected to be a . . .

- A. auxotroph
- B. phototroph
- C. heterotroph
- D. autotroph
- E. organotroph

193. Some transporters have gates. What is the purpose of the gates in gated transporters?

- A. To make it easier for the solute to bind the active site of the transporter
- B. To increase the accumulation ratio by preventing reverse transport
- C. To ensure that the transporter doesn't open until ATP is hydrolyzed
- D. To stabilize the outward-facing conformation of an import transporter
- E. To reduce the amount of energy needed to move the rocker switch

194. Which of the following is NOT involved in the formation of a proton motive force (PMF) in bacteria?

- A. a proton pump that uses energy from sunlight
- B. an ion gradient across the cell membrane
- C. an electron transport chain
- D. an ABC transport protein
- E. a charge separation (voltage gradient) across the cell membrane

195. Eureka! You have discovered a new organism! You decide to analyze it chemically. Finding which of the following would mean that your new organism CANNOT be a virus?

- A. NADH
- B. DNA, RNA, Proteins
- C. Lipids

196. Why is it important to understand that glycosidic bonds can have both alpha and beta anomers (that there can be α and β glycosidic bonds)?

- A. Beta glycosidic bonds can participate in hydrogen bonding. Alpha cannot.
- B. Alpha glycosidic bonds form spontaneously. Beta requires enzymatic catalysis.
- C. Though α -glycosidic bonds are not common, they are found in peptidoglycan.
- D. Alpha bonds are helical and beta are flat. This is important for protein function.
- E. It is much harder to digest β -glycosidic bonds. Only bacteria can do it.

197. An unusual membrane lipid is shown at the right. How does this differ from a typical lipid?

- A. The type of bond to the glycerol
- B. The fact that it is not a bilayer
- C. The type of bond to the glycerol, and the saturation of the lipid
- D. The type of bond to the glycerol, and the attachment to two glycerols
- E. The saturation of the lipid and presence of two fatty acids

198. Some bacterial cells can synthesize osmoprotectants to avoid _____.

- A. plasmolysis in a hypertonic environment

- B. lysis in a hypotonic environment
- C. lysis in a hypertonic environment
- D. turg or pressure against their cell walls
- E. plasmolysis in a hypotonic environment

199. Which of the following equations would be used to solve this problem? (You may need a calculator or a formula.) “How many bacteria would you need to start with in order to have as many cells as the Earth’s population (6 billion) within 12 hours? The bacterium divides in 30 minutes.”

- A. $x = (6 \times 10)^{12}$
- B. $(6 \times 10)^{12}$
- C. $(6 \times 10)^{12}$
- D. $(6 \times 10)^{12}$
- E. $x = (6 \times 10)^{12}$

200. Why is a glycocalyx usually viewed by using the negative staining procedure?

- A. The glycocalyx usually has no charge.
- B. This stain is required for the type of microscope usually used to see a glycocalyx.
- C. The glycocalyx usually has a positive charge.
- D. The glycocalyx contains negatively charged phosphate groups.
- E. The glycocalyx contains a thin layer of sugars, much like in peptidoglycan.

201. You stain a slide of *Mycobacterium* according to the Gram stain procedure. What will you see under a bright-field microscope?

- A. It has no cell wall, so you won’t see anything—it won’t stain.
- B. It has a very hydrophobic substance in its outer membrane, so it will not stain.
- C. It has only one membrane, so it will stain purple.
- D. It has no peptidoglycan, so it would stain pink.
- E. It has a lot of protein in its outer membrane, so it will stain purple.

202. The PMS is used directly for all of the following EXCEPT . . .

- A. ATP synthesis via chemiosmosis
- B. transport of water through aquaporins
- C. transport through major facilitators (MFS) transporters
- D. transport of the amino acid glutamate into the cell
- E. flagellar rotation

203. A phosphodiester bond is important in the structure of . . .

- A. Phospholipids
- B. The PTS system
- C. Phosphorylated proteins
- D. RNA
- E. Alpha helix

204. What are Archaea?

- A. An unusual type of Bacteria that grows in harsh environments
- B. One of the forms of the algal lifecycle
- C. One of the two forms in the fungal lifecycle
- D. A kingdom of Prokaryotes that lack peptidoglycan
- E. A type of virus that infects bacterial cells

205. An non-competitive(allosteric) enzymeinhibit or _____.

- A. binds to an enzyme's active site
- B. must resemble the substrate at least partially
- C. affects only the allosteric site where it binds
- D. must be present in large excess to inhibit an enzyme effectively
- E. induces a shape change in the active site

206. Which biochemical pathway is correctly matched with a macromolecular product it produces?

- A. Lipids are derived from TCA cycle intermediates
- B. Proteins come from TCA cycle intermediates
- C. Carbohydrates are produced by beta-oxidation
- D. Lipids are derived from the Pentose Phosphate pathway
- E. Nucleic Acids are produced from glycolysis

207. We mentioned that viroids can infect and kill plant cells. How?

- A. They inhibit protein synthesis by the plant cell.
- B. Their coat interacts specifically with proteins on the plant cell wall.
- C. They replicate to fill the plant cell's cytoplasm.
- D. Their DNA takes over the plant cell's nucleus.
- E. They cause other proteins in the plant cell to misfold.

208. The pictures shown here represent the same organism at different stages in its life cycle. What is the organism?

- A. a type of algae
- B. a protozoan
- C. a type of fungus
- D. a bacteriophage
- E. a type of archaea

209. The most evolutionary primitive rocker-switch model for transport proteins requires...

- A. A transporter with two alternative conformations
- B. A proton motive force to provide energy
- C. A transporter with a periplasmic binding protein
- D. ATP hydrolysis to provide energy
- E. Solute gates to prevent reverse transport

210. Which of the following bacteria does NOT contain peptidoglycan in their cell walls?

- A. Mycoplasma
- B. All of the above contains peptidoglycan
- C. Gramnegative
- D. Grampositive
- E. Mycobacteria

211. What makes passive transport “passive”?

- A. It is unable to concentrate a solute against a chemical gradient
- B. While the PMF can be used for transport, ATP is not
- C. There is no transporter involved in the transport
- D. There is no form of energy involved in the transport
- E. It can only be used for osmotic transport of water, not solutes

212. Which of the following amino acids does NOT have D-and L-stereoisomers?

- A. Glutamate
- B. Valine
- C. Lysine
- D. Glycine
- E. Phenylalanine

213. Some bacteria can catabolize lipids as carbon and energy sources. How do lipids enter central metabolic pathways?

- A. They are first deaminated, and then enter central catabolism in many places.
- B. They are decarboxylated and enter glycolysis as sugar.
- C. They are reduced and then fermented to ethanol and CO₂.
- D. They are first hydrolyzed, then oxidized, and enter glycolysis and the TCA cycle.
- E. They are first oxidized, then enter glycolysis and the pentose phosphate pathway.

214. In a chemotrophic bacterial reaction, electrons are donated from glucose to NAD⁺, forming 2 molecules of pyruvate plus NADH. Which of the following must also be true?

- A. Glucose is at a higher energy level than NADH.
- B. If this reaction were reversed, NAD
- C. Pyruvate is at a higher energy level than NAD
- D. Glucose is being reduced during this reaction.
- E. This bacterium must be either aerobic or facultatively anaerobic.

215. The reaction NADH → NAD⁺⁺H + occurs in BOTH _____.

- A. the TCA cycle and respiration
- B. glycolysis and the TCA cycle
- C. respiration and fermentation
- D. respiration and photosynthesis
- E. glycolysis and pyruvate oxidation

216. Which type of microscope is best for examining unstained protozoal cells?

- A. Differential interference contrast microscope
- B. Transmission electron microscope
- C. Atomic force microscope
- D. Bright field microscope
- E. Fluorescence microscope

217. Capsules or slimelayers are wholly or partly responsible for all of the following EXCEPT...

- A. motility
- B. avoiding phagocytosis
- C. formation of biofilms
- D. biofouling of filters
- E. surface adhesion

218. What part of bacterial cells is called "endotoxin" because of its toxic effects in invertebrates?

- A. Flagella
- B. Teichoic acids
- C. Lipopolysaccharide
- D. Peptidoglycan
- E. Pili

219. The main product of the TCA cycle is _____.

- A. ATP
- B. glucose
- C. NADH
- D. NAD
- E. pyruvate

220. Which of the following lipids would be the most fluid at room temperature?

- A. Lipids with 3 cis-unsaturated fatty acids
- B. Lipids with 3 saturated fatty acids
- C. Phospholipids
- D. Lipids with 3 trans-unsaturated fatty acids
- E. Lipids with mixed cis- and trans-unsaturated fatty acids

221. These bacteria are about 0.1 micrometers (μm) in diameter. How is it that we can see them?

- A. 0.1 μm is pretty big for a bacterium, so size is not a problem in this case.
- B. We are illuminating them obliquely and viewing the reflected light.
- C. This is an electron micrograph.
- D. We are using an optical trick to see them in 3 dimensions.
- E. We have added a fluorescent dye and are using confocal microscopy.

222. Molecule A donates electrons to molecule B

- A. Molecule A is being reduced during this reaction.
- B. Molecule B has higher energy than molecule A at the beginning of the reaction.
- C. During the reaction, molecule B loses some energy, but not as much as molecule A gains.
- D. During the reaction, molecule B loses more energy than molecule A gains.

E. During the reaction, molecule A loses more energy than molecule B gains.

F. Which of the following is true?

223. Last semester, when he was working with bacteriophage in the lab, a student came to me and said his doctor had told him he had a viral infection.

He was pretty sure he had acquired the infection from the bacteriophage he was working with in lab. What would you have told him?

- A. Bacteriophages don't have DNA, so the infection shouldn't be too serious.
- B. Bacteriophages are not viruses.
- C. The student should work on his sterile techniques so something like this won't happen again.
- D. Bacteriophages can't infect humans.
- E. Bacteriophages are dimorphic. We don't use the human variety in lab.

224. What is the function of the bright structures seen inside these chemolithoautotrophic cells?

- A. They store chlorophyll.
- B. They store carbon for use during times of starvation.
- C. They can provide a source of electrons.
- D. They allow the cells to float at the top of a pond.
- E. They align the cell with a magnetic field.

225. Which staining technique is correctly matched with a microscopetechnique for which that stain would typically be used?

- A. Fluorescent stain and phase contrast microscopy
- B. Acid-fast stain and bright-field microscopy
- C. Negative stain and dark-field microscopy
- D. Gram stain and differential interference contrast microscopy
- E. Methylene blue simple stain and transmission electron microscopy

226. Which of the following methods would give the lowest count for a population of bacteria in stationary phase?

- A. Measuring the mass of the culture
- B. Counting colonies on a pour plate
- C. Turbidity measurement
- D. Petroff-Hauser chamber
- E. Coulter counter

227. Pili are involved in all of the following EXCEPT . . .

- A. Motility
- B. Protein secretion
- C. Surface attachment
- D. Biofilm formation
- E. Horizontal gene transfer

228. What happens to a swimming bacterial cell when its flagella reverse their direction of rotation?

- A. Flagella are unidirectional. It is impossible for them to reverse rotation.
- B. The cell reverses its direction of travel.
- C. Nothing. The bacterium continues until its flagella become methylated.
- D. H
- E. The cell re-orientates randomly to face a new direction.

229. What is the unique feature of the Mycobacterial cell wall?

- A. It has no cell wall, only a membrane.
- B. Its peptidoglycan is crosslinked directly rather than with a pentaglycine spacer.
- C. It is made of protein rather than lipids and peptidoglycan.
- D. It contains a thick layer of very dense lipids.
- E. It stains better with a negative stain than with a positive stain.

230. Bacterial central catabolism includes all of the following EXCEPT _____.

- A. glycolysis
- B. substrate-level phosphorylation
- C. formation of reducing power
- D. TCA cycle
- E. respiratory electron transport

231. Which of the following is NOT a function of capsules or slime layers?

- A. motility
- B. biofouling of filters
- C. surface adhesion
- D. enhancing biofilm formation
- E. preventing phagocytosis

232. From which central metabolic pathway(s) is DNA synthesized by the cell?

- A. from glycolytic intermediates condensed with a product of acetyl-Co A
- B. from the oxidative decarboxylation of pyruvate
- C. from TCA cycle intermediates
- D. from the pentose phosphate pathway
- E. from glycolytic intermediates

233. The important feature of a Confocal Scanning Laser Microscope is _____.

- A. a ring condenser that only allows illumination from the side of the specimen
- B. a sensitive detector that can detect X-rays bounced from the surface of a specimen
- C. a prism that polarizes light into two planes, thereby allowing 3-D images
- D. a nanoprobe that measures electric current at the end of a cantilevered arm
- E. a pinhole that blocks light from all but one plane of a thick specimen

234. You have discovered a new organism that is about 200 nm across its largest dimension. It contains DNA, RNA, protein and lipid. It can replicate its DNA, but requires a host cell in which to do that. It appears to have no ATP generating mechanism. What is it? Why?

- A. A virus because of its size
- B. A prion because it has protein and can replicate
- C. A parasite eukaryote because of its size
- D. A prokaryote because of its composition
- E. An aviroid, because it's small, but isn't a virus

235. How is the energy of a H⁺ gradient most directly used by the cell to uptake glucose?

- A. Binding of a H⁺ holds a transporter open until glucose also binds
- B. The H⁺ binds to glucose and makes it impossible for glucose to leave the cell
- C. The H⁺ gradient makes ATP, which powers a glucose transporter
- D. Binding of a H⁺ flips the transporter to the alternate conformation
- E. The H⁺ provides a charge gradient that pulls glucose in to the cell

236. In the following spontaneous reaction: Aox + Bred → Ared + Box

- A. A loses both H
- B. B red
- C. A gives electrons to B. B gives energy to C. C loses energy

237. How do prions cause diseases like mad cow disease?

- A. They use the host cell's metabolism to reproduce, very much like viruses do.
- B. They act as a template to misfold native proteins.
- C. They produce and secrete a potent neurotoxin.
- D. Their RNA interferes with the production of RNA in host cells.
- E. They reproduce by inserting their DNA into host cells.

238. What do bacterial ABC drug efflux pumps and Type III secretory systems have in common?

- A. Neither requires contact with another cell to initiate transport
- B. Both are structurally related to flagella
- C. Neither involves a periplasmic intermediate
- D. Both make use of a needle complex
- E. Both allow transport of fully folded proteins

239. You have developed a new way to enumerate the bacteria in a culture. It involves covalently adding a fluorescent label to peptidoglycan monomers so that newly synthesized peptidoglycan becomes fluorescent. Then a special device counts only fluorescent cells. This method _____.

- A. is a type of viable cell count
- B. will count both dead cells and live cells
- C. is a type of direct cell count
- D. will count all live cells, whether or not they are growing
- E. will produce a higher titer than a Coulter Counter will

240. This reaction is an example of . . .

- A. oxidation
- B. reduction
- C. transpeptidation
- D. condensation
- E. hydrolysis

241. The three main branches in the phylogenetic "tree" of life are . . .

- A. Prokaryotes, Eukaryotes and Archaea
- B. Bacteria, Plants and Animals
- C. Bacteria, Archaea and Eukaryotes
- D. Plants, Animals and Fungi
- E. Protozoa, Eukaryotes and Bacteria

242. Amphiphatic phospholipids form a membrane bilayer if placed in water. What would happen if the membrane were replaced in a nonpolar solvent?

- A. It would form a micelle
- B. The bilayer would fall apart and form a thin monolayer on top of the solvent
- C. The phospholipids would no longer be amphiphatic
- D. Nothing - because it's amphiphatic it would be the same as in water
- E. It would turn inside out

243. One way to enhance contrast under a microscope without enhancing resolution is to _____.

- A. It is not possible to enhance contrast without also enhancing resolution.
- B. use a lower wavelength of illuminating light
- C. use a simple stain
- D. use microscopes slide oil
- E. use an electron microscope

244. Which of the following statements about bacteriophage is incorrect?

- A. They are very tiny infectious RNA particles.
- B. They have a protein coat.
- C. They can infect both bacteria and plants.
- D. They are examples of chemolithoheterotrophs.
- E. They contain both DNA and RNA.

245. Which of the following entities makes more copies of itself by acting as a template for protein folding?

- A. Prokaryote
- B. Proivirus
- C. Prion
- D. Virus
- E. Viroid

246. What is currently your best description of a biological membrane?

- A. Mostly protein with a few phospholipids scattered among the proteins.
- B. The inside part of the membrane is phospholipid; the outside part is protein.
- C. The outside part of the membrane is phosphate, the inside part is lipid.
- D. About 50% protein with phospholipids grouped in mobile rafts between the proteins.
- E. Mostly phospholipids with a few peripheral and integral membrane proteins.

247. Prions are infectious agents that contain

- A. RNA, DNA and protein
- B. protein only
- C. RNA and protein
- D. DNA and protein
- E. RNA only

248. Salmonella is one of the important bacteria responsible for causing human diarrhea. It generally takes a million to ten million cells of Salmonella to make a person sick.

You're running a medical clinic, and a patient comes to you with diarrhea. You want to count the titer of Salmonella in the fecal sample accurately, but as quickly as possible. Which of the following would be the best way to do it?

- A. Filter a fecal sample and plate the filter onto complex media
- B. Weigh a pellet from a fecal sample
- C. Use a Petroff-Hausser chamber with a fluorescence microscope
- D. Dilute the fecal sample and plate it onto selective media
- E. Use a Coulter Counter

249. Which of the following is NOT true of cellulose?

- A. It is considered biodegradable, even though humans can't digest it.
- B. It has intramolecular hydrogen bonds
- C. It is branched
- D. It is linked β -1,4. It contains just one glucose isomer

250. At the right is a bacterial growth curve. What can you conclude about the culture from which the growth curve was measured?

- A. After 9 hours, no cells are still dividing.
- B. It was grown in a chemostat.
- C. It produced only secondary metabolites.
- D. After 9 hours, no nutrients are left in the medium.
- E. It did not have to adapt to new growth conditions.

251. What would happen to Mycoplasma cells placed in a solution that was hypotonic with respect to the cytoplasm of the cells?

- A. They would synthesize osmoprotectants
- B. They would lyse
- C. They would experience an increase in turgor pressure, but would not lyse
- D. They would plasmolyze
- E. They would not experience any changes

252. In a protein tertiary structure, the side chains (R-groups) of the amino acids valine and isoleucine (structures on p. 13) could interact by . . .

- A. polar covalent bonding
- B. hydrogen bonding
- C. covalent bonding
- D. vander Waals interactions
- E. ionic interactions

253. What is wrong with this model of a nucleic acid molecule?

- A. G-C should have only two hydrogen bonds and A-U one
- B. The phosphodiester bonds are not represented correctly
- C. The model is not antiparallel
- D. A doesn't pair with U. The bases are not attached to the correct carbon

254. What is the function of the LPS that is a part of some bacterial cell envelopes?

- A. It is a carbohydrate storage polymer.
- B. It is a phosphate storage polymer.
- C. It is necessary for bacteria to invade human host cells.
- D. It is an additional permeability barrier.
- E. It helps some cells retain sugar or pressure to avoid lyse.

255. Why are Microbiologists interested in studying bacterial microcompartments (BMCs)?

- A. We can use the materials inside them to make a biodegradable plastic.
- B. Although there is no practical use for BMCs, they are quite interesting scientifically.
- C. Yes Respiratory+Fermentative
- D. Yes Respiratory
- E. No Fermentative
- F. No Respiratory
- G. No Respiratory
- H. Yes Respiratory
- I. Yes Fermentative
- J. Yes Respiratory+Fermentative
- K. Yes Fermentative
- L. No Fermentative
- M. They resemble other bacterial structures, including flagella and pili.
- N. They give us insights into the protein secretion systems.
- O. We can concentrate enzymes whose efficiency we want to increase.

256. A former student of mine now works as a microbiologist for a company that makes medical implants. His company was thinking of using cell mass as a surrogate measurement (as a "st and-in") for endotoxin concentration. My student wondered whether this was a good idea, and he called to ask me about it. What do you think? Was it a good idea?

- A. It doesn't matter, since endotoxin is only toxic to other bacteria.
- B. Yes. The more cells there are, the more endotoxin they would have.
- C. Yes. Endotoxin makes up a substantial portion of the peptidoglycan structure. C. No. Not all bacteria have endotoxin. Mass wouldn't tell you if they have it or not. D. No. It would be better to use a viable cell count for this.

257. Why is that live bacteria can not be seen well with a bright field microscope?

- A. Bright field microscopes "see" 3-dimensions, but bacteria have only two.
- B. The contrast achieved by bright field microscopy is too low.
- C. They are too small.
- D. The high energy light of the bright field microscope kills them.
- E. The resolution of a bright field microscope is too poor.

258. One advantage of growing cells in continuous culture is that _____.

- A. you can get them to produce more secondary metabolites, such as antibiotics.
- B. you can count them more easily than in batch culture.
- C. you can make the cells grow as fast or as slowly as you want.
- D. their growth rate constant (μ) is higher than in batch culture.
- E. there is no special equipment required.

259. Which of the following is NOT a feature of facilitated diffusion channels, such as aquaporins?

- A. They can not concentrate a solute on one side of the membrane
- B. They transport solutes in only 1 direction
- C. They switch between two stable conformations
- D. They require energy in order to open and close
- E. They are considered passive transporters

260. There is much interest in using bacteriophages to kill the bacteria that cause infectious diseases in humans. Which of the following is a valid concern about such therapy?

- A. The bacterial viruses might also infect humans.
- B. The virus preparation might be contaminated with a few live bacterial cells.
- C. The bacterial viruses might carry bacterial DNA into human cells.
- D. Bacterial viruses might mutate into uncontrollable "superbugs."
- E. The viruses might evolve into new bacterial cells.

261. How is hydrogen bonding involved in the structure of cellular lipid molecules?

- A. More H-bonds cause straighter phospholipids.
- B. Proteins and lipids join by H-bonding to form biological membranes. E. H-bonding is not involved in the structure of a lipid molecule.
- C. Fatty acids join to glycerol by H-bonds.
- D. The many C-H groups in fatty acids can form an extensive H-bonded network.

262. Which of the following represents the structure of a peptide bond correctly?

- A. B. C.
- B. E.

263. Taken together, the experiments of Pasteur, Tyndall and Koch demonstrated that . . .

- A. some forms of bacteria are not living organisms
- B. as long as air can be kept out, a solution can be kept sterile
- C. sometimes an experiment must be repeated for it to work right
- D. as long as no living organisms enter a solution, it can be kept sterile indefinitely
- E. some bacteria can not be killed

264. A major difference between Gram-negative and Gram-positive cell walls is . . .

- A. Gram-positive walls are cross-linked via a pentaglycine interbridge
- B. Gram-negative walls are much thicker than Gram-positive walls
- C. Gram-positive walls are made of peptidoglycan

D. Gram-negative walls have teichoic acid storage polymers

E. Gram-positive walls are enclosed within a membrane-bound space

265. In Pasteur's famous experiment that finally disproved spontaneous generation, bacteria grew

- A. in all flasks, regardless of how they were treated experimentally.
- B. only in media that came in contact with air
- C. only once the media had been boiled
- D. only in media that came in contact with other bacteria
- E. only in the flasks with a swan neck

266. Which of the following is true about weak bonds in protein tertiary structure?

- A. It is important for protein function that they can form and break spontaneously.
- B. They include the structure O=C- - - N-H
- C. They only occur when cysteine is present in the protein's primary structure.
- D. They form between amino groups and carboxyl groups within peptide bonds.
- E. They form mostly between amino acids with nonpolar R-groups.

267. Which of the following is true about a condensation reaction?

- A. It is usually regarded as a catabolic reaction.
- B. An example is the following reaction:
- C. It is one way cells can "break down" long polymers.
- D. It generally requires energy input.
- E. It involves loss of water from the cell in a hypertonic environment.

268. The negative staining procedure must be used to visualize a bacterial capsule in the bright field microscope. What conclusion can you make from that statement?

- A. The capsule must be phosphorylated.
- B. Bacteria that have a capsule must also have a thin peptidoglycan layer.
- C. Carbohydrates must not be able to bind charged dyes.
- D. A capsule must be made from positively charged amino acids.
- E. Better resolution of capsule structure could be achieved by darkfield microscopy.

269. What are prions?

- A. Small cells that lack a cell membrane.
- B. Infectious RNA with no protein.
- C. Very tiny virus-like particles.
- D. Infectious proteins with no nucleic acid.
- E. Peptidoglycan particles that affect the immune system.

270. Secondary metabolites, such as antibiotics, are produced most effectively _____.

- A. by persister cells

- B. by cells in crowded growth conditions
- C. when the number of cells = N₀
- D. when nutrients are constantly added to a culture
- E. as cells are adapting to growth in a new medium

271. Which of the following microscopes depends on the phenomenon of photodrag to differentiate between structures with different refractive index?

- A. Dark-field
- B. Bright-field
- C. Confocal
- D. TEMD. Phase contrast

272. Most, though not all, bacteria have an electron transport chain. Why?

- A. to carry out redox reactions
- B. to remove excess electrons from the cell
- C. to use O₂
- D. to create a proton gradient
- E. to perform substrate-level phosphorylation

273. Phosphate that will be used to make cellular structures is stored in . . .

- A. DNA
- B. Voluting granules
- C. ATP
- D. PHB granules
- E. Phosphobilisomes

274. Bacteria can vary the lipids they use in their membrane, depending on the temperature. The goal is to keep the membrane from melting, but not allowing it to get so solid that proteins can't move around. How would the membrane of a psychrotroph growing at 28 °C compare to the membrane of the same organism growing at 5 °C?

- A. It would melt at 5
- B. It would have more cis-unsaturated lipids at 5
- C. It would solidify at 5
- D. It would have more saturated lipids at 5
- E. It would consist of all trans-unsaturated lipids at 5

275. Why does the PTS (phosphotransferase system) use a phosphorelay mechanism?

- A. It is the simplest possible mechanism to import glucose
- B. The phosphate picks up a little more energy with each transfer
- C. To sense the available carbohydrate and regulate cell responses accordingly
- D. To pump phosphate out of the cell against the membrane potential
- E. It is the only mechanism available for primary active transport

276. Which of the following bacteria does NOT contain peptidoglycan in their cell walls?

- A. Grampositive
- B. Mycobacteria
- C. Gramnegative
- D. All of the above contains peptidoglycan
- E. Mycoplasma

277. A pharmaceutical technician wished to produce large quantities of a bacterial secondary metabolite from a chemolithoheterotroph. She grew the organism in a chemostat with glucose, H₂ and oxygen, plus trace elements and growth factors. But she got very low yields of this secondary metabolite. What was her mistake?

- A. She should not have used glucose.
- B. She needed sulfate in addition to H₂.
- C. She should not have used a chemostat.
- D. The oxygen was probably toxic to her bacteria.
- E. She probably did not wait long enough.

278. Which part of a bacterial endospore contains a special type of peptidoglycan that is responsible for absorbing the water from the core to keep it dry?

- A. AB. BC. CD. DE. The structure that absorbs water from the core is actually a part of the other cell, and is lost early during the sporulation process.

279. Which of the following is something that Pasteur could have concluded logically after his swan-necked flask experiment?

- A. Bacteria need air in order to grow.
- B. Bacteria use pili to adhere to dust particles in the air.
- C. Microbes can regenerate spontaneously from a "vital principle" in the broth.
- D. Boiling destroys microbes in broth, and they do not regrow from air.
- E. Endospores are very difficult to kill, and can survive boiling.

280. Beta sheets . . .

- A. may involve H-bonds between the R-groups of polar amino acids
- B. involve peptide bond amine groups as H-bond donors
- C. are bonds found in cellulose
- D. is a type of structure in which D-amino acids are more common than L-amino acids
- E. may involve H-bonds between the R-groups of nonpolar amino acids

281. Which of the following statements about enzymes is INCORRECT?

- A. Enzymes lower the free energy of a reaction.
- B. Enzymes lower the activation energy of a reaction.
- C. An induced fit enzyme model involves a subtle change in the tertiary structure when binding a substrate.
- D. RNA and DNA molecules can have catalytic activity.
- E. Enzyme pathways require each reaction to occur in order to form the end product.

282. A primary active transporter is essentially irreversible (it only transports molecules in one direction) because...

- A. It alters the molecule once it is inside the cell, so it can not go back out
- B. It requires a protein to bond from the outside before the channel can open
- C. It uses ATP, which is a much more powerful energy source than the PMF
- D. It is the main type of transporter in most cells
- E. It establishes a molecular gradient that keeps molecules from moving in the other direction

283. Oxidative decarboxylation occurs during three separate reactions in central catabolism. The main purpose of these reactions is to _____.

- A. oxidize CO₂ C. make glucose
- B. produce ATP by substrate-level phosphorylation
- C. donate electrons to pyruvate
- D. produce reducing power

284. Why is the phosphorelay mechanism involved in sugar transport in bacteria?

- A. Each protein in the relay can be used to regulate other cell processes based on the presence
- B. The energy from the phosphate is increased slightly at each step until it is enough to open
- C. Each protein in the relay can receive a phosphate from a different phosphate carrier, either
- D. The phosphorelay can be used to make a PMF, which can then be used to make ATP
- E. Each protein in the phosphorelay can transport a different sugar molecule

285. What special feature of ABC import transporters makes them essentially irreversible?

- A. A protein that binds solute before it signals from the periplasm for the transporter to open
- B. Their transport of very large, and even fully folded proteins
- C. A signal sequence on transported proteins that does not allow reverse transport
- D. Molecular gates controlled by binding of the solute to the transporter
- E. A rocker-switch that only opens to the periplasm

286. Which of the following structures is found only in Bacteria?

- A. cell membrane
- B. cell wall
- C. lipopolysaccharide
- D. flagellum
- E. nucleus

287. Which of these is NOT a correct description of a double-stranded nucleic acid?

- A. Purines must hydrogen-bond with other purines and pyrimidines with pyrimidines.
- B. The 5'-to-3' direction on one strand is opposite to the 5'-to-3' direction on the other strand.
- C. Each strand is synthesized by forming covalent phosphodiester bonds between monomers.
- D. The 5' ends are phosphorylated and the 3' ends are hydroxylated.
- E. The sugars in the monomer structures come from the Pentose Phosphate Pathway.

288. It is important for a bacterium to keep its membranes from either melting or solidifying as the temperature of the environment changes. Membranes of psychrophilic bacteria must therefore have more _____ than membranes of mesophiles.

- A. cis-unsaturated lipids
- B. phosphate groups
- C. trans-unsaturated lipids
- D. lipopolysaccharide
- E. saturated lipids

289. We said in an early lecture that science should be "predictive." What does this mean?

- A. If you change a variable in an experiment, you know how the results will change.
- B. You know in advance which experiments will work and which won't.
- C. If you repeat the same experiment, you get the same results.
- D. You can deduce how a biological system will evolve in the future.
- E. You can try a completely new experiment and know in advance what the results will be.

290. Which type of microscope is the best to use for viewing viruses attached to human host cells?

- A. Phase contrast microscope
- B. Darkfield microscope
- C. Scanning electron microscope
- D. Confocal scanning laser microscope
- E. Atomic force microscope

291. Volutes in (metachromatic) granules are used to store . . .

- A. Sulfur
- B. CO₂
- C. Glucose
- D. Photosynthetic pigments
- E. Phosphate

292. Both Phase Contrast and Nomarski (DIC) microscopy are based on what optical principle?

- A. Light waves can add to or cancel each other resulting in a dark image.
- B. Passing through a specimen alters the spacing of the peaks in a light wave.
- C. The angle of incidence of a light wave equals the angle of reflection.
- D. Light can be separated into perpendicular polarized beams.
- E. A 3-dimensional image can be built up by combining plane images.

293. Much of the bacterial cell membrane is made of lipids.

Where do lipids come from during bacterial metabolism?

- A. They are made by oxidative phosphorylation
- B. They are rebuilt from glycerol and acetyl-Co A
- C. From fermentation of pyruvate
- D. By catabolic reactions from glucose
- E. Bacteria must ingest lipids in their diet; they can not be synthesized

294. There is currently much interest in studying efflux pumps that bacteria use to eliminate toxins and antibiotics. What is one characteristic of these efflux pumps?

- A. They include a long extracellular "needle complex"

- B. They allow secretion of fully folded proteins
- C. They are made of lipids rather than proteins
- D. The toxin is secreted through bacterial membranes in 1 step
- E. The toxin is secreted through both bacterial membranes and a host cell membrane in one

295. Which of the following is a unique feature of the PTS transport system?

- A. A relay that allows many opportunities for regulation of the transporter
- B. Solute-controlled gates to prevent transported solutes from leaving the cell
- C. The use of periplasmic binding protein
- D. Two-stage transport with an intermediate in the periplasm
- E. The use of ATP as an energy source rather than the PMF

296. Which type of microscope uses special prism to make a thin specimen appear pseudo-3-dimensional?

- A. Phase Contrast
- B. Scanning Electron Microscope
- C. Differential Interference Contrast
- D. Atomic Force Microscope
- E. Dark Field

297. Viroids are . . .

- A. empty protein coats without any nucleic acid
- B. infectious proteins that serve as folding templates for other proteins
- C. small virus-like particles
- D. small pieces of RNA without a protein coat
- E. an other name for plant viruses

298. The bacterium

- A. Motion in a continuous straight line
- B. Directed motion with occasional random re-orientations
- C. Motion in continuous counterclockwise circles
- D. coli exhibits flagellar motility and chemotaxis toward the amino acid alanine. If E. coli is placed in a 100 millimolar solution of alanine, which of the following would best describe its behavior?
 - E. Random, undirected motion
 - F. No motion - cells would not move in this solution

299. Last semester, when he was working with bacteriophage in the lab, a student came to me and said his doctor had told him he had a viral infection.

He was pretty sure he had acquired the infection from the bacteriophage he was working with in lab. What would you have told him?

- A. Bacteriophages don't have DNA, so the infection shouldn't be too serious.
- B. Bacteriophage are dimorphic. We don't use the human variety in lab.
- C. Bacteriophage can't infect humans.
- D. The student should work on his sterile techniques so something like this won't happen again.

E. Bacteriophage are not viruses.

300. Cells in a biofilm are very tightly adherent to one another, have variable metabolic activity, and many are dead. What technique would be best to enumerate (count) the cells in a biofilm?

- A. Coulter counter
- B. turbidity measurement
- C. most probable number method
- D. measure metabolic acid production
- E. dry and weigh the biofilm

301. Agree at deal of the structure of a bacterium is composed of carbohydrates. Which of the following structures does NOT involve carbohydrates?

- A. Glycocalyx
- B. LPS(lipopolysaccharide)
- C. Peptidoglycan
- D. Carboxysomes
- E. Starchgranules

302. The bacterium Streptomyces does not undergo binary fission, but rather each cell elongates and then divides to become from 6 to 10 identical daughter cells. What would be the best way to enumerate the cells in this culture?

- A. Coulter Counter
- B. Viable Cell Count
- C. Turbidity
- D. Measure acid production from metabolism
- E. Directly weighing a cell pellet from the culture

303. Compare the two cultures represented by the growth curves at right. Which of the following conclusions can you make?

- A. Culture A has more persister cells.
- B. Culture B has the higher growth rate.
- C. Culture B was likely placed in a nutrient-rich medium just before growth.
- D. Culture A never reaches stationary phase.
- E. After 10 hours, all cells in culture A have stopped dividing.

304. The contrast of a specimen viewed by light microscopy can be improved by _____.

- A. using a longer wavelength light to illuminate the specimen
- B. using a blue filter under the condenser
- C. blocking directly transmitted light
- D. increasing the magnification
- E. using immersion oil

305. What is a disulfide bond?

- A. A type of hydrophobic bond between cysteine amino acids
- B. A bond found in alpha helices and beta sheets
- C. A type of bond that holds carbohydrate polymer together
- D. A bond between the sulfur atoms in a DNA double helix
- E. A covalent bond that is involved in forming protein tertiary structures

306. How does an amino acid get through the Gram-negative outer membrane?

- A. By use of energy from the PMF. Through special facilitated diffusion channels
- B. By simple diffusion
- C. Through teichoic acid channels
- D. LPS is much more permeable than phospholipid

307. Which of the following is NOT true of cellulose?

- A. It is linked β -1,4D. It contains just one glucose isomer
- B. It is branched
- C. It has intramolecular hydrogen bonds
- D. It is considered biodegradable, even though humans can't digest it.

308. Which of the following does NOT involve hydrogen bonding?

- A. Ice floats in water.
- B. Lipids form from fatty acids and glycerol.
- C. Evaporation of sweat cools your body.
- D. DNA forms a double helix.
- E. Water striders (insects) can walk on the surface of a pond.

309. LPS(lipopolysaccharide) is highly toxic to mammals. What feature of LPS makes it unusual compared to other molecules in its class?

- A. It is a lipid, but is amphipathic.
- B. It has a sugar with both alpha and beta glycosidic bonds.
- C. It contains a branched polymer of sugar molecules.
- D. It has a lipid that is not based on a glycerol backbone.
- E. It contains a protein without any chiral carbon atoms.

310. For many years, when we examined the structure of certain cells by transmission electron microscopy, we saw linear striations (or stripes) that may or may not correspond to round bodies seen in cross sections of these same cells (see arrows). It would be of interest to know how many of these there are, and whether they are folded and doubled back one each other within one of the layers of the cell. What tool could best be used to answer this research question?

- A. Scanning electron microscopy
- B. Electron cryotomography
- C. Dark-field microscopy
- D. Nomarski (DIC) microscopy
- E. Atomic force microscopy

311. The reaction $\text{NADH} \rightarrow \text{NAD} + \text{H}_2\text{O}$ occurs in BOTH _____.

- A. respiration and photosynthesis
- B. glycolysis and the TCA cycle
- C. respiration and fermentation
- D. the TCA cycle and respiration
- E. glycolysis and pyruvate oxidation

312. A new bacterial enumeration method has been developed that moves bacteria physically from one chamber of a microchip to another with a micromanipulator or (sort of like an atomic force microscope probe tip). This would be an example of _____.

- A. a statistical method
- B. a direct cell count
- C. optical density measurement
- D. a viable cell count
- E. an indirect measurement

313. Cytoplasm in normal cells typically has about 15m M[Na +]. If you placed typical cells in a solution with 150m M[Na +], what would happen?

- A. Na
- B. H
- C. Na
- D. H₂
- E. H₂

314. A structure that is 50 nanometers in diameter and is composed only of protein, RNA and lipid would most likely be an example of which of the following?

- A. a micelle
- B. an naked virus
- C. a prion
- D. an enveloped virus
- E. an aviroid

315. More than 99% of the organisms present in a soil sample do not grow in laboratory media. What would be the most appropriate way to count the organisms present in a soil sample?

- A. Petroff-Hausser chamber
- B. Pour plate technique
- C. Dry and weigh the soil sample
- D. Coulter counter
- E. Perform a luciferase assay

316. An atypical bacterial cell is growing in atypical culture. It is using the ATP synthase to make ATP. Then a scientist adds a chemical to its membrane that permits protons to flow freely across the lipid bilayer. Will the bacterium still be able to use its ATP synthase?

- A. No. Without a proton gradient, there is no PMF, and no PMF means no ATP synthase.
- B. Yes, but only as a Type III secretory system, which uses ATP rather than the PMF.
- C. Yes, because it can still have a PMF, even without a proton gradient.
- D. Yes, because electrons can still be donated to ADP to make ATP.
- E. No. The reaction to make ATP requires a ΔH°

317. Which of the following is NOT a structural component of Archaeal cell walls?

- A. Chondroitin
- B. Pseudopeptidoglycan
- C. Lipopolysaccharides
- D. Proteins

E. All of the above are structural components

318. What is the feature of the Mycobacterial cell envelope that is not found in other bacteria?

- A. It is made of protein rather than lipids and peptidoglycan.
- B. It has an outer membrane with porins to allow small molecules to enter the cell.
- C. Its peptidoglycan is crosslinked with a pentaglycine spacer.
- D. It contains a thick layer of very dense lipids in its outer membrane.
- E. It has no cell wall, only a membrane.

319. Bacterially synthesized osmoprotectants are most useful to prevent _____ in a _____ environment.

- A. lyse; hypertonic
- B. lyse; hypotonic
- C. plasmolysis; hypertonic
- D. plasmolysis; hypotonic
- E. denaturation; thermophilic

320. Structures that transport electrons between bacterial cells in a dense culture are called _____.

- A. Glycocalyces
- B. Biofilms
- C. Nanowires
- D. Electrontransport chains
- E. Electrosomes

321. Based on what you know about how the following methods for bacterial growth enumeration work, you should be able to classify one of them as a direct method. Which one?

- A. Gas production measured in a Durham tube
- B. Acid production measured on a nanochip
- C. Using the luciferase assay
- D. Most Probable Number estimation
- E. Measurement of bacterial turbidity with a spectrophotometer

322. You inoculate a pure culture onto a petri dish, but when you look at the culture after it has grown, you find both of the organisms shown at the right. What is the best explanation for this?

- A. Your bacterial culture was contaminated with phage.
- B. Your culture was contaminated with prokaryotes.
- C. Some of the protozoa you plated have formed spores.
- D. You plated a culture of algae.
- E. Your pure culture was a fungus.

323. *Streptococcus mutans* produces this only in the presence of sucrose, leading to the development of dental caries (cavities).

- A. Glycocalyx
- B. Nanowires
- C. Adhesion pili

D. Type III secretionsystem

E. Lacticacid

324. What is the role of the periplasmic binding protein in ABC uptake systems?

A. It is a chaperone that keeps secreted proteins folded

B. It blocks reverse transport of the solute

C. It provides a channel through the outer membrane

D. It hydrolyzes ATP

E. It provides energy to "switch" the conformation of the transporter

325. Atypical bacterial cell is growing in a typical culture. It is using the ATP synthase to make ATP. Then a scientist adds a chemical to its membrane that permits protons to flow freely across the lipid bilayer. Will the bacteria still be able to use its ATP synthase?

- A. Yes, but only as a Type III secretory system, which uses ATP rather than the PMF.
- B. Yes, because it can still have a PMF, even without a proton gradient.
- C. No. The reaction to make ATP requires H_2 .
- D. Yes, because electrons can still be donated to ADP to make ATP.
- E. No. Without a proton gradient, there is no PMF, and no PMF means no ATP synthase.

326. If a Gram-positive bacterium is placed in a solution that is hypotonic with respect to its cytoplasm, how will it survive?

- A. It has a cell wall.
- B. It will synthesize a second membrane.
- C. It will rapidly secrete solutes.
- D. It will rapidly secrete water.
- E. It will synthesize osmoprotectants.

327. Tyndall all repeated the same experiment, but got different results. This was because

- A. he used different flasks than Pasteur
- B. he didn't do the experiment right
- C. he didn't boil the flasks for as long a time as Pasteur did
- D. the media he was trying to sterilize contained endospores
- E. he was working in England, but Pasteur was working in France

328. How does starch compare to cellulose?

- A. Starch is more linear (less highly branched) than cellulose.
- B. Cellulose degradation requires enzymes; starch degradation does not.
- C. They are composed of different carbohydrate monomers.
- D. Starch has fewer hydrogen bonds in its structure than cellulose does.
- E. Starch is an alpha helix; cellulose is a beta sheet.