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| **Figure number** | **Question** | **Answer** |
| 1.1 | If the broth in Pasteur’s swan-necked flasks had contained endospores, what results would have been observed? | Growth might occur in the flask without tipping if the spores were not killed by heating |
| 1.2 | What is the Golden Age of Microbiology? | The time period when most infectious disease causing microbes were identified and early work on viruses had begun. |
| 1.3 | Why might the gauze masks not protect against the influenza  virus? | Viruses are small enough to pass through gauze |
| 1.4 | Why might so many of the “new” diseases first appear or be identified in the United States and Western European countries? | Methods for isolating and identifying the causative agents are more advanced in these countries |
| 1.6 | What general features of algae distinguish them from other  eukaryotic microorganisms? | Algae are photosynthetic and so can harvest the energy of light. |
| 1.7 | What type of cells make up molds and mushrooms? | Eukaryotic cells |
| 1.8 | How do protozoa differ from both fungi and algae? | They do not have a cell wall |
| 1.9 | Why can viruses be so much smaller than cells and still replicate? | Viruses use the machinery and enzymes of the cells they invade to replicate |
| 1.10 | How does a viroid differ from a virus? | Viroids consist only of RNA whereas viruses consist of protein and RNA or DNA |
| 1.11 | Why are prions visible here when normal cellular proteins are not? | The prions in the fig. consist of protein aggregates. |
| 1.12 | The members of which two domains cannot be distinguished microscopically? | *Bacteria* and *Archaea* |
| 1.13 | Why is a logarithmic scale necessary when comparing sizes of members of the microbial world? | The range in size of members of the microbial world is so great that their sizes can only be compared on a logarithmic graph |
| **Ch 2:** |  |  |
| 2.1 | How does the number of electrons in an atom compare to the number of protons? | They are the same. |
| 2.2 | How would the Lewis structure of hydrogen be different from that of carbon? | The symbol would be H and there would be only a single electron |
| 2.3 | Which of the ions in this figure is an anion, and which is a cation? | The anion is Cl- and the cation is Na+ |
| 2.4 | In terms of its bonding properties, why is carbon such an important element in biological systems? | Having 4 valence electrons allows it to bond covalently with many other atoms. |
| 2.5 | Why is the oxygen atom in a water molecule more electron-rich than the hydrogen atoms? | It has a greater attraction for electrons than does the H atoms |
| 2.6 | Explain why two identical atoms joined by a covalent bond cannot form a hydrogen bond. | Neither of the atoms is electronegative, a requirement for hydrogen bonding. |
| 2.7 | Why would it be important for certain molecules to be held together by hydrogen bonds instead of covalent bonds? | -The weak bonds can break and reform readily and do not require the action of enzymes. They form the basis for recognition between molecules. |
| 2.8 | Why does water expand as it freezes? | The water molecules move further from one another |
| 2.9 | If water were not polar, would it dissolve sodium chloride? Explain. | No; dissolving depends on the hydrogen bonding between water molecules and the polar salt. |
| 2.10 | Does the H+ concentration increase or decrease when the pH drops from 5 to 4? What about the OH– concentration? | The H+ concentration increases and the OH- decreases when the pH drops from 5 to 4 |
| 2.11 | Why are the bonds between the phosphate groups of ATP “high energy”? | The covalent bond joining the O and P in the first and second phosphate group and the same bond joining the second and third phosphate group. |
| 2.12 | What are the four major classes of macromolecules? | DNA, RNA, proteins and polysaccharides |
| 2.13 | Which portion of an amino acid is responsible for the unique properties of the molecule? | The side chain represented by the R group |
| 2.14 | What chemical groups characterize a hydrophobic amino acid? A hydrophilic amino acid? | Hydrophobic groups are C-H and C-S; Hydrophilic groups are C-OH and ionized amino and carboxyl groups. |
| 2.15 | Which form (l or d) is found in proteins? | The L form is found in proteins |
| 2.16 | What two chemical groups are involved in the formation of a peptide bond? | A carboxyl and amino group. |
| 2.17 | Which of the four levels of structure are especially important in determine the properties of a protein? | The primary structure |
| 2.18 | Which levels of protein structure determine the properties of domains? | The secondary structure which is determined by the primary structure |
| 2.19 | Describe two environmental conditions that can denature a protein. | Heat to temperatures near boiling and high pH |
| 2.20 | What is the major chemical difference between ribose and deoxyribose? | Ribose has a –OH group attached to carbon 2 whereas deoxyribose has a H atom |
| 2.21 | What is a structural isomer? | Two molecules that have the same atomic composition but the atoms are arranged differently, leading to different properties of the two molecules |
| 2.22 | When are the α and β forms not interconvertible? | Once the carbon atom is joined to another sugar molecule |
| 2.23 | What type of reaction would reverse the step shown in this diagram? | The addition of water; a hydration reaction |
| 2.24 | Where are the three polysaccharides shown found in nature? | Cellulose is found in the trunks of trees; glycogen is the storage form of glucose found in many animals and dextran is a storage form of glucose found in bacteria. |
| 2.25 | What are the three components of a nucleotide? | -the sugar ribose or deoxyribose, a purine or pyrimidine ( nucleobase ) and a phosphate molecule |
| 2.26 | Which of the nucleobases are found in DNA? In RNA? | In DNA, the nucleobases are adenine, guanine, cytosine and thymine. In RNA, uracil replaces thymine. |
| 2.27 | What parts of the nucleotides are joined together? | A bond forms between the sugar and phosphate |
| 2.28 | Which would require a higher temperature to denature—a DNA strand composed primarily of A-T base pairs or one that is the same length but composed primarily of G-C base pairs? | The number of hydrogen bonds joining each guanine to cytosine is more that joining adenine to thymine so a higher temperature is required to denature the DNA containing the higher G-C DNA |
| 2.29 | What characteristic of the fat in this figure makes it a triglyceride? | Three fatty acids are joined to the glycerol making it a triglyceride. |
| 2.30 | What about the structure of a phospholipid makes one portion hydrophilic and the other hydrophobic? | The polar head group contains primarily ionized atoms making it hydrophilic; the tail of the fatty acids consist of C-H groups, which confer hydrophobic properties on this portion of the molecule. |
| 2.31 | Why are steroids classified as lipids? | They are insoluble in water.. |
| **Ch 3:** |  |  |
| 3.1 | What are the two sets of magnifying lenses called, and how do these relate to total magnification? | Objective lens and ocular lens. The total magnification is the product of each lens' magnification. |
| 3.2 | Which type of microscope—a light microscope or an electron microscope—has the higher resolving power? | Electron microscope |
| 3.3 | What would the pencil in part (a) look like if oil were in the glass instead of water? | It would not look bent, because oil has the same refractive index as glass |
| 3.4 | How does a dark-field microscope increase contrast? | It illuminates the object from the side, and therefore the object stands out against a dark background |
| 3.5 | How does a phase-contrast microscope increase contrast? | It amplifies the slight difference between the refractive index of dense material and that of the surrounding medium |
| 3.6 | How does a DIC microscope increase contrast? | Like the phase contrast microscope, it amplifies the slight difference between the refractive index of dense material and that of the surrounding medium; it has a device that separates light into two beams that pass through the specimen and then recombine, causing the image to appear three dimensional |
| 3.7 | What is an epifluorescence microscope? | A fluorescence microscope that projects UV light onto the specimen rather than through it. |
| 3.8 | How is multiphoton microscopy different from confocal microscopy? | It uses lower energy light |
| 3.9 | Some electron micrographs are “color enhanced.” What does this mean? | The normally black and white image is artificially colored. |
| 3.10 | How is thin-sectioning different from freeze-etching? | In thin-sectioning, the specimen is treated with a preservative, dehydrated, and then embedded in plastic before cutting it into exceptionally thin slices  In freeze etching, the specimen is rapidly frozen, fractured by hitting it with a knife blade, and dried slightly under vacuum to allow underlying regions to be exposed, before the section is coated with a layer of carbon to create a replica of the surface. |
| 3.11 | In what way is scanning electron microscopy different from transmission electron microscopy? | In SEM a beam of electrons scans back and forth over the surface of the specimen. In TEM a beam of electrons either pass through the specimen or are scattered. |
| 3.12 | How does the resolving power of atomic force microscopy compare to that of electron microscopy? | 12. the resolving power of the atomic force microscope is much greater than that of an electron microscope |
| 3.13 | What is the purpose of heating the smear? | It fixes (attaches) the smear to the slide |
| 3.14 | Which step of the Gram stain is most critical with respect to timing? | Decolorization with alcohol |
| 3.15 | What characteristic of Mycobacterium cells makes them acid-fast? | They have a high concentration of mycolic acid, a waxy fatty acid. |
| 3.16 | How is the India ink capsule stain an example of a negative stain? | It stains the background, not the cells. |
| 3.17 | What color would Escherichia coli cells be with the endospore stain shown in the photo? | Pink |
| 3.18 | How can the flagella stain be helpful in identifying bacteria? | Bacteria that have flagella can have them in different arrangements, so the presence and distribution can be used as identifying features |
| 3.19 | How can fluorescent dyes and tags be used to identify bacteria? | Some fluorescent dyes bind to compounds found in only certain cells; also, a fluorescently labeled antibody can be used to tag unique proteins that identify a specific bacterium. |
| 3.20 | What are the two most common shapes of bacteria? | Rods and cocci |
| 3.21 | Why would aquatic microbes need maximal surface area? | They grow in dilute environments so they need a large surface area to absorb nutrients more easily |
| 3.22 | Why would aquatic microbes need maximal surface area? | The number of planes in which the cell divides. |
| 3.23 | How does the function of the cytoplasmic membrane differ from that of the cell wall? | The cytoplasmic membrane is the permeability barrier that defines the boundary of the cell whereas the cell wall provides the strength to keep the cell from lysing |
| 3.24 | Which part of the membrane is hydrophobic? | The region between the two phosopholipid layers, where the hydrophobic tails come together |
| 3.25 | What might happen in part (a) if the cell wall were weakened? | They are repelled by the hydrophobic interior of the membrane. |
| 3.26 | Which part of the membrane is hydrophobic? | The cell would burst. |
| 3.27 | Why is proton motive force a form of energy? | It is an electrochemical gradient, meaning that there's a separation of chemicals as well as electric charges (positively-charged protons and negatively changed hydroxyl groups), analogous to a battery. |
| 3.28 | What types of molecules do prokaryotic cells bring in? | Small molecules such as sugars and amino acids, which serve as nutrients. |
| 3.29 | Why is facilitated diffusion relatively uncommon in prokaryotes? | Because prokaryotes typically grow in dilute solutions, so nutrients must be moved against the concentration gradient. |
| 3.30 | Why would a cell secrete enzymes rather than bring intact macromolecules into the cell? | Macromolecules are too large to transport across the membrane, so instead cells secrete enzymes to break the molecules down, and they then transport the resulting subunits into the cell. |
| 3.31 | Why is peptidoglycan medically important? | It is unique to bacteria, so it provides a target for antimicrobial medications. |
| 3.32 | What connects the glycan chains in peptidoglycan? | Covalent bonds form between tetrapeptide chains of adjacent NAM molecules |
| 3.33 | Why is lipopolysaccharide medically significant? | The lipid A portion is recognized by the body's defense system, and the response can be life-threatening if too vigorous. The composition of the O-antigen varies, so it can be used to distinguish different bacteria. |
| 3.34 | Would lysozyme or penicillin affect M. pneumoniae? | No, because the bacterium lacks peptidoglycan. |
| 3.35 | What is the function of capsules and slime layers? | In many cases, attachment. Some capsules allow bacteria to avoid the host defense systems. |
| 3.36 | How can flagella affect a microbe’s ability to cause disease? | Flagella can propel bacteria through mucous layers that otherwise prevent invasion. |
| 3.37 | What is the role of flagellin? | It is the structural subunit that makes up the filament. |
| 3.38 | What mechanism causes a cell to tumble? | The switch from counterclockwise rotation of flagella to clockwise |
| 3.39 | Why would magnetotaxis benefit a cell? | They move downward, into the sediments where O2 levels are low |
| 3.40 | How does the structure and function of pili compare to that of flagella? | Both consist of subunits arranged helically to form a long molecule with a hollow core, but pili are considerably thinner and shorter. |
| 3.41 | What is the gel-like region formed by the chromosome called? | Nucleoid |
| 3.42 | What is the function of ribosomes? | Facilitates protein synthesis |
| 3.43 | How would storage granules benefit a cell? | They Allow an organism to store nutrients it has in relative excess |
| 3.44 | What is the function of an endospore? | It is a survival form; it survives heating, drying, and lack of nutrients. |
| 3.45 | Approximately how long does the sporulation process take? | About 8 hours |
| 3.46 | Which organelle contains the cell’s genetic information? | Nucleus |
| 3.47 | The lumen is which part of an organelle? | The inside |
| 3.48 | How is pinocytosis different from phagocytosis? | Pinocytosis takes in liquids; phagocytosis takes in in particulate matter. |
| 3.49 | What is the role of actin filaments? | Movement of the cell's cytoplasm |
| 3.50 | How is the structure of a eukaryotic flagellum different from its prokaryotic counterpart? | Eukaryotic flagella are composed of long microtubules and are technically inside of the cell because they are covered by the plasma membrane; prokaryotic flagella are composed of protein subunits anchored to the cell wall and membrane. |
| 3.51 | What is the function of nuclear pores? | They allow large molecules to be transported in and out of the nucleus |
| 3.52 | What were the first pieces of evidence that led scientists to conclude that mitochondria evolved from bacterial cells? | They have 70S ribosomes and divide by binary fission. |
| 3.53 | Chloroplasts evolved from which group of bacteria? | Cyanobacteria |
| 3.54 | What causes the bumpy appearance of the rough endoplasmic reticulum? | Ribosomes attached to the surface |
| 3.55 | How are the modified macromolecules transported from the Golgi apparatus to other sites? | In vesicles |
| **Ch 4:** |  |  |
| 4.1 | How does the process of binary fission relate to the generation time? | During binary fission, one cell divides to become two cells; those two divide to become four; those four divide to become eight, and so on. Generation time is the time that it takes a population to double in number, so it is the time required for the cell to divide. |
| 4.2 | Why would microbes in biofilms be more resistant to antibiotics and disinfectants than their planktonic counterparts? | The EPS shields the cells from the harmful chemicals. |
| 4.3 | What are extracellular polymeric substances (EPS)? | Hydrophilic polymers including polysaccharides and DNA. |
| 4.4 | What is the purpose of agar in the medium? | It is a gelling agent used to solidify media. |
| 4.5 | What is the purpose of obtaining isolated colonies? | To obtain a pure culture. An isolated colony likely contains only cells descended from a single cell, in which case it would be a pure culture. |
| 4.6 | During which phase is generation time measured? | Log (exponential) phase |
| 4.7 | What is the most commercially valuable secondary metabolite? | Antibiotics |
| 4.8 | Most pathogens fall into which group on this chart? | Mesophiles |
| 4.9 | What is plasmolysis? | Dehydration of the cytoplasm, causing it to shrink from the cell wall. |
| 4.10 | Which type of hemolysis characterizes Streptococcus pyogenes, the bacterium that causes strep throat? | Beta hemolysis |