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CHAPTER TWO
LIVING CELLS

1) During exocytosis membrane-bound vesicles migrate from the Golgi apparatus to the _____.

A) Lysosome
B) Smooth endoplasmic reticulum
C) Cell wall
D) Plasma membrane
E) More than one answer is correct

Ans D

2) Notable features of eukaryotes include all of the following except _____.

A) Rapid cell division
B) Larger size
C) A complex internal structure
D) An endomembrane system
E) Organelles

Ans A

3) Gram-negative bacteria lack _____.

A) Cell walls
B) Peptidoglycans in the cell wall
C) An outer coat of lipid bound proteins
D) DNA
E) Carbohydrate containing polymers in the cell wall

Ans E

4) The plasma membrane _____.

A) Provides support
B) Is present only in eukaryotes
C) Controls the flow of substances in and out of the cell
D) Is present only in prokaryotes
E) Both A and C are correct

Ans E

5) Structural features that make phospholipids suited for their biological role are:

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A) A hydrophilic head group
B) Branched carbon chains
C) A hydrophobic group
D) A and C are correct
E) None of the above is true

Ans D

6) The grainy appearance of prokaryotic cytoplasm is due in part to _____.

A) A large number of ribosomes
B) Plasmids
C) Nucleolus
D) DNA
E) RNA

Ans A

7) Which of the following types of molecules is not hydrophilic
A) Sodium chloride
B) Glucose
C) Amino acids
D) Fats
E) Both A and B are correct.

Ans D

8) The basic structure of biological membranes is provided by what class of compounds?

A) Proteins
B) Lipids
C) Carbohydrates
D) Steroids
E) Peptidoglycans

Ans B

9) Which of the following is not true of the nucleus?

A) It is found in both eukaryotes and prokaryotes
B) It contains the cell's "genetic blueprint"
C) It exerts a profound influence over all cellular metabolic functions
D) It contains chromatin fibers
E) It is bounded by membrane

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Ans A

10) Which of the following statements is not true of the endoplasmic reticulum?

A) It often constitutes more than half of the cell's total membrane
B) It exists in two forms: rough and smooth
C) Rough ER is responsible for protein synthesis
D) Smooth ER is responsible for lipid synthesis
E) Rough ER ribosomes are responsible for biotransformation.

Ans E

11) Which of the following is not true of eukaryotic ribosomes?

A) They are macromolecular machines
B) They function in the biosynthesis of proteins
C) They contain ribosomal RNA
D) They consist of two unequally sized subunits
E) They are attached to the smooth ER

Ans E

12) Which of the following statements is not true of the Golgi apparatus?

A) The analogous plant structure is referred to as a dictyosome
B) It has two faces
C) The cisterna or forming face usually projects toward the ER
D) It is involved in the packaging and secretion of cell products
E) It is usually located near the plasma membrane

Ans E

13) Which of the following statements is not true of the lysosome?

A) It functions in intercellular digestion
B) Both ER and Golgi apparatus are involved in its formation
C) It is capable of degrading most biomolecules
D) It is involved in the packaging and secretion of cell products
E) It is involved in pathological conditions such as gout and rheumatoid arthritis

Ans D

14) Acid hydrolases are found in _____.

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A) Ribosomes
B) Lysosomes
C) Golgi Apparatus
D) Dictyosomes
E) Smooth ER

Ans B

15) The main role of peroxisomes is _____.

A) Anaerobic respiration
B) Aerobic respiration
C) Lipid oxidation
D) Generation and destruction of peroxides
E) Carbohydrate oxidation

Ans D

16) Biological machines are derived from which class of compounds
A) Fats
B) Proteins
C) Carbohydrates
D) Ribosomes
E) B and C

Ans B

17) Which of the following organelles is involved in aerobic metabolism?

A) Mitochondria
B) Peroxisomes
C) Glyoxysomes
D) Ribosomes
E) Lysosomes

Ans A

18) Respiratory assemblies are responsible for the synthesis of _____.

A) ATP

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B) NADH
C) GTP
D) Hydrogen peroxide
E) ADP

Ans A

19) The two membranes of the mitochondria create two separate compartments called the intermembrane space and the _____.

A) Cristae
B) Matrix
C) Lumen
D) Cisternae
E) Vesicle

Ans B

20) Which of the following statements is not true of the mitochondrial matrix?

A) It contains enzymes responsible for nucleotide metabolism
B) It contains circular DNA molecules
C) It contains all of the necessary compounds for protein synthesis
D) It has a gel-like consistency
E) It has a high concentration of enzymes and ions

Ans A

21) The excluded volume of a cell varies between _____ and _____%.

A) 5–10
B) 10–20
C) 20–40
D) 40–50
E) 0–5

Ans C

22) Plastids are plant structures similar to what organelle found in animals?

A) Ribosomes
B) Leucoplasts
C) Golgi apparatus

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D) Peroxisomes
E) None of the above is correct

Ans E

23) The stroma of plastids is analogous to what structure of mitochondria?

A) Grana
B) Matrix
C) Inner membrane
D) Outer membrane
E) Cisternal space

Ans B

24) Which of the following help make up the cytoskeleton?

A) Microtubules
B) Microfilaments
C) Intermediate fibers
D) B and C are correct
E) All are correct

Ans E

25) Mitochondria and _____ consume molecular oxygen.

A) Plastids
B) Ribosomes
C) Peroxisomes
D) Lysosome
E) Golgi apparatus

Ans C

26) Which of the following is present only in prokaryotic cells?

A) Nucleus
B) Endoplasmic reticulum
C) Plasma membrane
D) Nucleolus
E) None of the above is correct

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Ans E

27) Biotransformation is defined as:

A) The preparation of water-insoluble substances for excretion
B) Oxidation of organic molecules
C) Transformation of food molecules to ATP
D) Reactions occurring within a living system
E) Conversion of harmless compounds to toxins

Ans A

28) In place of a nucleus a prokaryotic cell has a _____.

A) Mesosome
B) Nucleoid
C) Centrosome
D) Nucleosome
E) Reticulosome

Ans B

29) Which of the following eukaryotic organelles is a key regulator of apoptosis?

A) Mitochondria
B) Flagella
C) Chloroplasts
D) Cilia
E) Ribosomes

Ans A

30) Which of the following is not a role of transmembrane proteins?

A) Transport of ions
B) Structural support
C) Transport of nutrients
D) Receptors
E) Enzymes

Ans B

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31) Which of the following is not a membrane protein?

A) Channel protein
B) Carrier protein
C) Receptors
D) Integral proteins
E) Motor proteins

Ans E

32) Examples of eukaryotic signal molecules are:

A) Neurotransmitters
B) Hormones
C) Cytokines
D) Both A and B are correct
E) All of the above are correct

Ans E

33) Which of the following is not a phase of the information processing mechanism?

A) Reception
B) Transduction
C) Response
D) Transformation
E) Both A and C are correct

Ans D

34) Which of the following is not a component of the endomembrane system?

A) Plasma membrane
B) Endoplasmic reticulum
C) Golgi apparatus
D) Lysosomes
E) Ribosomes

Ans E

35) The carbohydrate coat of a cell is called the:

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A) Extracellular matrix
B) Glycocalyx
C) Cell cortex
D) Fibroblast
E) Both A and C are correct

Ans B

36) The perinuclear space is:

A) The space between the nucleus and the cytoplasm
B) The space between the membranes of the nuclear envelope
C) The space between the nucleus and the nucleous
D) The space between DNA and histones
E) Both A and B are correct

Ans B

37) Which of the following organelles are involved in autophagy?

A) Mitochondria
B) Lysosomes
C) Chloroplasts
D) Golgi apparatus
E) Both B and C are correct

Ans B

38) Which of the following molecules is <u>not</u> an example of a type of eukaryotic signal molecule?

A) Neurotransmitter
B) Hormone
C) Cytokinin
D) Endotoxin
E) Both A and B are correct

Ans D

39 Of the approximately100 trillion cells in the human body how many are actually human cells?

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A) All of them
B) 50 Trillion
C) 90 Trillion
D) 10 Trillion
E) 80 Trillion

Ans D

40) Analysis of the RNA of prokaryotes reveals that there are _____ distinct types of prokaryotes.

A) One
B) Two
C) Three
D) Four
E) Five

Ans B

41) Which of the following are microbiota

A) Bacteria
B) Fungi
C) Archea
D) A and B
E) A, B and C

Ans E

42) Which of the following are techniques used by the body to protect itself against indigenous microbiota

A) Impenetrable epithelial tissue
B) Immune system cells
C) Antimicrobial proteins
D) Beta defensins
E) All of the above

Ans E

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43) Which of the following is a superorganism

A) Streptococcus
B) Lactobacillus
C) Homo sapiens
D) Corynebacterium
E) Klebsiella

Ans C

44) The endocytic cycle is

A) A means of remodeling plasma membrane
B) A form a signal transduction
C) Cycling of sodium and potassium ions through the cell membrane
D) Continuous recycling of membrane through endocytosis and exocytosis
E) A and D

Ans A

SHORT ANSWER

46) Define the term organelle?

Ans An organelle is large subcellular compartment in a eukaryotic cell that is specialized for a specific task.

47) Define the term eukaryotes.

Ans Eukaryotes are composed of cells that have a nucleus and other membrane-bound compartments.

48) What is an integral protein?

Ans An integral protein is a protein that is embedded within a membrane.

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49) What is a peripheral protein?

Ans A peripheral protein is a protein that is not embedded within a membrane but is attached by covalent or noncovalent bonds to a membrane protein or lipid.

50) What is a ligand?

Ans A ligand is a molecule that binds to a protein or receptor.

51) What is the function of a motor protein?

Ans Motor proteins are nucleotide binding components of protein complexes that function as biological machines. Nucleotide hydrolysis drives precise changes in the conformation of the biological machine that permit the accomplishment of the machines task.

52) What is meant by the term macromolecular crowding?

Ans Macromolecular crowding refers to the large number of different proteins at low concentrations within the interior of cells.

53) What is an endotoxin?

Ans An endotoxin is a toxic molecule that is released from membrane-bound lipids when a pathogenic Gram-positive bacterial cell disintegrates.

54) Define the term hormone.

Ans A hormone is a signaling molecule produced by glandular cells that influences the behavior of distant target cells.

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55) What is the slime layer?

Ans The slime layer, also known as biofilm, is a disorganized accumulation of polysaccharides that form when bacteria adhere to surfaces.

56) Explain why the term “crowded” rather than “concentrated” is used to describe the densely packed molecules on the interior of living cells?

Ans Macromolecules of each type usually are present in low numbers. The concentration of any one macromolecule is low but adds to the overall number of molecules. This results in crowding.

57) Describe how noncovalent interactions promote the self-assembly of supramolecular structures in living organisms.

Ans Intricately shaped functional groups on the surface of biomolecules, form noncovalent interactions with biomolecules with complementary structures. These interactions facilitate the formation of supramolecular structures that have properties that are similar (e.g., hydrogen bonding) or complementary (e.g., oppositely charged ions). As these noncovalent interactions form, more of the molecules’ surfaces are drawn closer to each other, making further interactions possible. Large numbers of noncovalent interactions stabilize the complexes formed from these molecules.

58) How do lysosomes participate in the life of the cell?

Ans In their roles in endocytosis (destruction of biomolecules) and autophagy (worn out cell components) lysosomes digest biomolecules of all types. In addition, lysosomes destroy the components of foreign cells and other exogenous extracellular materials.

59) What functions does the cytoskeleton perform in living cells?

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Ans The highly developed framework of the cytoskeleton performs the following functions in eukaryotic cells: (1) maintenance of overall cell shape, (2) facilitation of coherent cellular movement, (3) provision of a supporting structure that guides the movement of organelles within the cell, and (4) service as a platform for enzyme and signal cascade complexes.

60) What roles do plasma membrane proteins play in living cells?

Ans Among the roles of plasma membrane proteins are transport, response to stimuli, cell-cell contact, and catalytic functions.

61) What are two essential functions of the nucleus?

Ans The nucleus is the repository of the cell's hereditary information. The nucleus also exerts a profound influence over all of the cell's metabolic activities through the expression of that information.

62) Describe the functions of the Golgi apparatus.

Ans The Golgi apparatus processes, sorts, and packages protein and lipid molecules for distribution to other regions of the cell or for export.

63) List three environmental signals detected by primary cilia.

Ans Examples of environmental signals detected by primary cilia include urine flow, wound healing, and sight.

64) Describe the function of kinesins and dyneins in intraflagellar transport.

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Ans The kinesins are motor proteins that move particles along the outer pair of micotubules of cilia and flagella toward the cell periphery. Dyneins move molecules along microtubules in the opposite direction.

ESSAY QUESTIONS

65) Humans have been described as superorganisms consisting of human cells in combination with a larger number of microorganisms. Explain. Is this a symbiotic relationship? What effect can the consumption of antibiotics have on this relationship?

Ans It would appear to be obvious that a human consists of only human cells. It should be recognized, however, that human cells are thousands of times larger than the smaller prokaryotic organisms that cohabit the body. The human body is in a symbiotic relationship with most of its nonhuman inhabitants because it provides a stable source of warmth, moisture and nutrients. In turn, some of these microorganisms defend against invading pathogens, and perform special services such as aiding food digestion and providing us with essential nutrients. The importance of symbiotic organisms can be seen in the effect of mistreatment with antibiotics that disrupts the normal intestinal flora, allowing the overgrowth of pathogenic bacteria normally kept in check by beneficial organisms.

66) Biological membranes are held together by weak noncovalent forces. Why is it important that weak forces hold membranes together? What would happen if membrane structure involved stronger covalent bonding?

Ans Although individual bonds are weak, large numbers of such interactions provide considerable stability. The greater strength of covalent bonds would prevent the most essential feature of biological membranes, the capacity of membrane components to move within the membrane. For example, membrane proteins must be able to diffuse through the membrane to perform their functions.

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67) What effect does macromolecular crowding have on the traditional analysis of reaction rates?

Ans The interior of cells was once thought to have a soup-like consistency thereby justifying the belief that reactant and product diffusion is a factor that influences reaction rates. It has since been learned that the cell is actually a thick gel in which reactant diffusion has little effect on reaction rates. Instead, the enzymes in several biochemical pathways have been found to exist in structures where they are arranged so that a reaction product is released into the active site of the enzyme catalyzing the next reaction.

68) Eukaryotic cells are much larger cells than prokaryotic cells. What factors of internal structure make this increase in size possible?

Ans Eukaryotic cells are larger than prokaryotes because their increased structural complexity makes possible better use of raw materials and disposal of waste, and allows an efficient integration of metabolism that sustains the cell. In addition, eukaryotic cells possess numerous mitochondria, which provide the large amounts of energy required for maintaining such a high level of complexity.

69) Comment on the statement that the cytoplasm is just a soup containing organelles.

Ans The "soup" model was the original view of a cell in which reactions are diffusion controlled with many water-soluble molecules randomly moving through the cytoplasm until they reach their target sites. A more careful examination of the interior of a cell shows that cytoplasm is actually a semisolid gel in which there is very little free diffusion.

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70) The interior of living cells is highly organized and this organization is maintained over long periods of time. Entropy, a measure of the disorder or randomness of the system, predicts that highly organized systems should become progressively disorganized. How does a living cell evade entropy?

Ans Entropy is a spontaneous process. In the absence of energy and nutrients a cell would indeed become progressively disorganized (i.e. it would die). Entropy can be evaded (at least locally) by the input of energy. The cell uses the energy derived from the oxidation of nutrient molecules to reverse the spontaneous effects of entropy. It is only when this energy generation breaks down that disorder increases and the cell dies.

71) The surface of the eukaryotic cell is coated with carbohydrate groups attached to protein and lipid molecules. What structural feature of the carbohydrate molecule accounts for this phenomenon?

Ans Carbohydrate molecules, which can be composed of an almost infinite variety of arrangements of several different sugars, allows the encoding of a vast amount of information. As a result, the cell surface contains a large number of molecules (e.g., glycoproteins and glycolipids) whose complex structure allow them to perform a diverse array of functions. For example, hormone receptor proteins bind only to a specific hormone and not other molecules.

72) Mitochondria are one of many types of organelles. What features of mitochondria argue most strongly for their descent from a free living ancestor?

Ans Numerous features of mitochondria resemble those of prokaryotic cells. Examples include their size, shape, and capacity to undergo binary fission. Mitochondria also possess circular DNA molecules and perform protein synthesis with components that resemble their prokaryotic counterparts.

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73) In eukaryotes the DNA remains within the nucleus and RNA, synthesized within the nucleus, is used to transfer information to the rest of the cell. Why use RNA for this purpose and why not just use DNA directly?

Ans DNA, the master template of the cell's genetic information, resides within the nucleus where its is protected from damage such as cleavage by nucleases. If RNA molecules are damaged or destroyed new copies can be made quickly by transcription from DNA.

74) In density gradient centrifugation the products are removed from the bottom of the centrifuge tube. Why not remove them from the top of the tube?

Ans If the layers in a centrifuge tube were withdrawn from the top of the centrifuge tube, there would be unavoidable mixing, thereby destroying the integrity of the sample. By draining slowly from the bottom through a small hole this problem is avoided.

CALCULATIONS

75) The dimensions of a prokaryotic ribosome are approximately 14 nm x 20 nm. If ribosomes occupy 20% of the volume of a bacterial cell calculate how many ribosomes are in a typical cell such as E. coli. Assume that the shape of a ribosome is approximately that of a cylinder. A typical bacterial cell volume is 1.6 um^3.

Ans The volume of a ribosome is calculated as follows:

$\pi r^2 h = (3.14)(0.007\ \mu m)^2(0.02\ \mu m) = 3 \times 10^{-6}\ \mu m^3$

The volume of a bacterial cell is 1.6 μm^3. The number of ribosomes that can fit in a bacterial cell is $1.6/3 \times 10^{-6} = 5 \times 10^5$, because they occupy only 20% of the cell's volume, divide 5 x 10^5 ribosomes in a cell by 5 to give 1×10^5 ribosomes per bacterial cell.

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76) The *E. coli* cell is 2 μm long and 1 μm in diameter, while a typical eukaryotic cell is 20 μm in diameter. Assuming that the E. coli cell is a perfect cylinder and the eukaryotic cell is a perfect sphere, calculate the surface-to-volume ratio for each cell type [cylinder volume $V = \pi r^2 h$; cylinder area $A = 2\pi r^2 + 2\pi rh$; sphere volume $V = 4/3(\pi r^3)$; sphere area $4\pi r^2$].What do these numbers tell you about the evolutionary changes that would have to occur to generate an efficient eukaryotic cell considering that most biochemical processes depend on membrane-bound processes.

Ans The volume of the *E. coli* cell is given by $V = \pi r^2 h = (3.14)(0.5\ \mu m)^2(2\ \mu m) = 1.57\ \mu m^3$.

The surface area is: $A = 2\pi r^2 + 2\pi rh$

$= (2)(3.14)(0.5\ \mu m)^2 + (2)(3.14)(0.5\ \mu m)(2\ \mu m) = 1.57\ \mu m^2 + 6.28\ \mu m^2 = 7.85\ \mu m^2$.

The *E. coli* surface-to-volume ratio = $7.85\ \mu m^2/1.57\ \mu m^3 = 5.0\ \mu m^{-1}$.

The volume of the eukaryotic cell is $V = (4/3)(3.14)(10)^3 = 4189\ \mu m^3$.

The surface area of the eukaryotic cell is $4\pi r^2 = 4(3.14)(10)^2 = 1256\ \mu m^2$.

The eukaryotic cell surface-to-volume ratio = $1256\ \mu m^2/4189\ \mu m^3 = 3.0\ \mu m^{-1}$.

The eukaryotic cell has a much smaller surface-to-volume ratio than does the *E. coli*. In order to import enough material to sustain the functions of the cell, the membrane must become more efficient. Eukaryotes have significantly greater membrane transport capacity because of membrane transport proteins that are more sophisticated and present in exceptionally large numbers and extensive membrane folding, which increases the surface-to-volume ratio. Note that the loss of the prokaryote cell wall allowed membrane folding.

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