Chapter 2: Cellular Homeostasis

Multiple-Choice Questions

Level I

1. Protein synthesis occurs predominantly in the:
    a. Cell membrane
    b. Nucleus
    c. Lysosome
    d. Cytosol

    Correct answer: D

(Objective 1)

2. The plasma membrane of blood cells is characterized by which of the following?
    a. Carbohydrate components (glycolipids, glycoproteins) embedded in the lipid bilayer
    b. The asymmetric distribution of the phospholipids
    c. The hydrophilic ends of the phospholipids directed toward the inside of the lipid bilayer
    d. The absence of peripheral proteins

    Correct answer: B

(Objective 2)

3. Which phospholipids are found predominantly in the outer layer of the lipid bilayer?
    a. Phosphatidylethanolamine and phosphatidylserine
    b. Phosphatidylethanolamine and phosphatidylcholine
    c. Phosphatidylserine and sphingomyelin

d. Phosphatidylcholine and sphingomyelin

Correct answer: D

(Objective 2)

4. In which phase of the cell cycle is a cell quiescent?

   a. The G1 phase

   b. The G0 phase

   c. The R phase

   d. The S phase

   Correct answer: B

(Objective 3)

5. The point in the cell cycle after which cell division is complete but before the next round of DNA synthesis is:

   a. The G2 phase

   b. The G0 phase

   c. The G1 phase

   d. The R phase

   Correct answer: C

(Objective 3)

6. In order to maintain _____, terminally differentiated blood cells must undergo _____.

   a. Cell cycle division; necrosis

   b. Tumor suppression; apoptosis

   c. Homeostasis; apoptosis

   d. Cell regeneration; necrosis

Correct answer: C

(Objective 5)

7. All of the following are initiators of apoptosis *except:*
    a. BCL-2
    b. Caspases
    c. TNF-alpha
    d. Fas Ligand

    Correct answer: A

(Objective 6)

8. Apoptosis plays a role in human development in all of the following *except:*
    a. Removal of interdigital webs of the hands and feet
    b. Formation of the blood vessels and the gastrointestinal tract
    c. Differentiation (divergence) of mast cells and basophils
    d. Selection of appropriate T and B lymphocyte clones

    Correct answer: C

(Objective 5)

9. Which of the following is a mechanism of apoptosis in hematopoiesis?
    a. Expansion of B cell clonal populations in response to infection
    b. Elimination of PMNs and eosinophils after an inflammatory response
    c. Production of RBCs in response to anemia
    d. Progression of acute leukemias

    Correct answer: B

(Objective 7)

10. Which cytoplasmic organelle's function is lipid synthesis?

    a. Smooth endoplasmic reticulum

    b. Golgi apparatus

    c. Mitochondria

    d. Ribosomes

Correct answer: A

(Objective 1)

11. Which phospholipids are predominantly found in the inner layer of the lipid bilayer?

    a. Phosphatidylethanolamine and phosphatidylcholine

    b. Phosphatidylethanolamine and phosphatidylserine

    c. Phosphatidylserine and sphingomyelin

    d. Phosphatidylcholine and sphingomyelin

Correct answer: B

(Objective 2)

12. In which phase of mitosis do the chromosomes align on opposite poles of the cell?

    a. Prophase

    b. Metaphase

    c. Anaphase and telophase

    d. Interphase

Correct answer: C

(Objective 3)

13. The (R) restriction point occurs during what phase in the cell cycle?

a. S
b. G_2
c. G_1
d. M

Correct answer: C

(Objective 4)

14. If an organism fails to regulate apoptosis, resulting in excessive apoptosis, which of the following processes might result?

a. Neurodegenerative disorder
b. Autoimmune disorder
c. Lymphoma
d. Carcinoma

Correct answer: A

(Objective 5)

Level II

1. The sections of a gene that contain the coding sequences for the final protein product are:

a. Exons
b. Introns
c. UTRs
d. Nucleosomes

Correct answer: A

(Objective 1)

2. Which of the following influence the stability of the mRNA and the efficiency of translation?

    a. Introns

    b. Untranslated regions

    c. Single-nucleotide polymorphisms

    d. Exons

    Correct answer: B

    (Objective 1)

3. To be considered a true polymorphism, a SNP must occur with a frequency of:

    a. >1%

    b. >5%

    c. >10%

    d. >25%

    Correct answer: A

(Objective 1)

4. Structurally abnormal proteins can be eliminated from the body by tagging them with _____ and sending them to the _____.

    a. Caspase; apoptosis pathway

    b. Ubiquitin; proteosome

    c. Cyclins; necrosis pathway

    d. CDKs; apoptosis pathway

    Correct answer: B

(Objective 2)

5. Which cyclin component is predominant in the G1 phase of the cell cycle?

    a. Cyclin A

    b. Cyclin B1

    c. Cyclin E

    d. Cyclin D

    Correct answer: D

(Objective 3)

6. What protein is responsible for activating phosphorylation of all kinases involved in the cell cycle?

    a. Cdk

    b. CAK

    c. Cyclin

    d. Cdk inhibitor

    Correct answer: B

(Objective 4)

7. Predict the effect of p16 on the cell cycle of dividing cells.

    a. Increases cell cycle progression

    b. Decreases cell cycle progression

    c. Causes no change in the cell cycle progression

    d. Initiates apoptosis

    Correct answer: B

(Objective 4)

8. At which checkpoint would detection of unreplicated DNA strands occur?

a. G1 checkpoint

b. G2/M checkpoint

c. S phase checkpoint

d. Metaphase checkpoint

Correct answer: B

(Objective 5)

9. Which regulatory protein is present in all stages of the cell cycle but has varying degrees of phosphorylation (activation) from phase to phase?

a. p53

b. Rb protein

c. p21

d. Cyclin D

Correct answer: B

(Objective 6)

10. Initiation of apoptosis occurs primarily with:

a. Activation of p53

b. Cleavage of appropriate caspases at timely intervals

c. Stimulus from an inflammatory response

d. Activation of BCL-2

Correct answer: B

(Objective 8)

11. Exposure to radiation would lead to activation of which caspase pathway?

a. Extrinsic pathway

b. Intrinsic pathway

c. Common pathway

d. None of the above

Correct answer: B

(Objective 9)

12. Predict the effect that the Bax:Bcl-2 complex will have on the apoptotic pathway.

a. The pathway is activated by Bax: Bcl-2.

b. The pathway is inhibited by Bax: Bcl-2.

c. The pathway is not affected by Bax: Bcl-2.

d. The pathway is activated and then is inhibited by Bax:Bcl-2.

Correct answer: B

(Objective 11)

13. Which of the following are apoptosis activators?

a. BCL-2

b. Mcl-1

c. Bcl-X_L

d. Bak

Correct answer: D

(Objective 10)

14. Malignancies can result from which of the following?

a. Accelerated apoptosis

b. Inhibited apoptosis

c. Normal occurrence of apoptosis

d. None of the above

Correct answer: B

(Objective 12)

15. Clearance of cytotoxic T cells after an immune response results from:

a. Accelerated apoptosis

b. Inhibited apoptosis

c. Normal occurrence of apoptosis

d. None of the above

Correct answer: A

(Objective 12)

16. All of the following are potential proto-oncogenes except:

a. Proteins that function as growth factor receptors

b. Proteins that bind DNA

c. Growth factors

d. Proteins that neutralize growth factor receptors

Correct answer: D

(Objective 7)

17. UTRs constitute which segments of mRNA?

a. Exons

b. Introns

c. 3' and 5' ends

d. Heteronuclear RNA

Correct answer: C

(Objective 1)

18. Disposal of damaged or misfolded proteins is carried out by which cell component?

a. Lysosome
b. Ubiquitin/proteosome system
c. Caspase/apoptosis system
d. Molecular chaperones

Correct answer: B

(Objective 2)

19. Cdks must be complexed with what molecule to drive one cell to the next cell-cycle stage?

a. DNA
b. Phosphorylating enzymes
c. mRNA
d. Cyclin

Correct answer: D

(Objective 3)

20. Which two proteins are critical for the effective function of the G1 checkpoint?

a. Cdk4 and Cdk6
b. Cyclin E

c. P21 and p57

d. P53 and Rb

Correct answer: D

(Objective 3, 5)

21. What feature distinguishes necrosis from apoptosis?

a. Necrosis requires ATP.

b. Necrosis is characterized by cellular shrinkage and chromatin condensation.

c. Necrosis induces inflammation.

d. Necrosis results in nuclear fragments of 185 base pairs.

Correct answer: C

(Objective 14)

Short-Answer Questions

1. Explain in detail how p53 and Rb can contribute to the onset of malignancy.

Answer: Rb is the protein product of the retinoblastoma susceptibility gene, which predisposes individuals to retinoblastomas and other tumors when only one functional copy is present. Rb is present throughout the cell cycle. Phosphorylations vary with each cell-cycle phase. In its hypophosphorylated (active) state, Rb has antiproliferative effects, inhibiting cell cycling. It does this by inhibiting transcription factors required for the transcription of genes needed for cell proliferation, rendering them nonfunctional. Hyperphosphorylation, on the other hand, neutralizes (inactivates) the Rb protein, thus promoting cell cycle division.

P53 acts as a molecular policeman; it monitors the integrity of the genome. It can activate and inhibit gene expression depending on the target gene. It is activated in response to DNA breakage,

and slows cell-cycle division to initiate DNA repair or apoptosis. It functions as a tumor suppressor gene, and it is the most common mutated gene in tumors.

(Objectives 6 and 7, Level II)

2. List three ways in which the caspase pathway can be activated. Explain the role of each, and indicate which arm of the caspase pathway will be activated.

Answer: The extrinsic pathway of apoptosis is triggered by extracellular "death" signals (TNF, Fas Ligand, and CD95). The intrinsic pathway of apoptosis is triggered by intracellular signals in response to stress, exposure to cytotoxic agents, and radiation.

(Objective 9, Level II)

3. Describe the apoptotic pathway.

Answer: Death receptor binding of death receptor to cell receptor → caspase recruitment → activation of initiator caspases → activation of effector caspases → cleavage of crucial cellular proteins → cell death.

(Objective 5, Level I)

4. Explain the role of epigenetic alterations in cancer development.

Answer: The most common epigenetic change in the development of cancer involves a methylation/demethylation of CpG dinucleotide bases. Cancer can involve demethylation of promoter regions of genes making them transcriptionally ready. Methylation can result in transcriptional silencing of the gene and loss of function of tumor suppressor genes. Deacetylation of key histones can result in gene silencing which may favor growth over differentiation.

(Objective 13, Level II)

5. List the four major phospholipids found in the plasma membrane of hematopoietic cells, and explain their unique distribution.

Answer: The four major phospholipids that are found in the plasma membrane are phosphatidylethanolamine (PE), phosphatidylserine (PS), phosphatidylcholine (PC), and sphingomyelin (SM). Most blood cells have an asymmetric distribution of these phospholipids, with PE and PS occurring in the inner layer and PC and SM occurring in the outer layer.

(Objective 2, Level I)