**Section 1**

**Introduction to Hematology**

**A. TRANSITION GRID**

Information concerning Chapter 1, “Introduction” and Chapter 2, “Cellular Homeostasis” may also be referenced in the following hematology textbooks.

***Clinical Laboratory Hematology, 3e Chapter 1 Chapter 2 Chapter 3***

McKenzie, 2nd editionChapter 1 Chapter 2 Chapter 3

**B. OBJECTIVES**

**Chapter 1—Introduction**

*Levels I and II*

1. Compare the reference intervals for hemoglobin, hematocrit, erythrocytes, and leukocytes in infants, children, and adults.
2. Identify the function of erythrocytes, leukocytes, and platelets.
3. Describe the composition of blood.
4. Explain the causes of change in the steady state of blood components.
5. Describe reflex testing, and identify the laboratory’s role in designing reflex testing protocols.
6. Define hemostasis and describe the result of an upset in the hemostatic process.
7. Identify hematology and hemostasis screening tests.
8. List the three components of laboratory testing and correlate errors with each component.

**Chapter 2—Cellular Homeostasis**

*Level I*

1. Describe the location, morphology, and function of subcellular organelles of a cell.
2. Describe the lipid asymmetry found in the plasma membrane of most hematopoietic cells.
3. Differentiate the parts of the mammalian cell cycle.
4. Define R (*restriction point*) and its role in cell-cycle regulation.
5. Define *apoptosis* and explain its role in normal human physiology.
6. Classify and give examples of the major categories of initiators and inhibitors of apoptosis.
7. List the major events regulated by apoptosis in hematopoiesis.

*Level II*

1. Explain the significance of SNPs, introns, exons, UTRs, and post-translational protein modifications.
2. List the components and explain the function of the ubiquitin-proteosome system.
3. Define *cyclins* and *Cdks* and their role in cell-cycle regulation; describe the associated Cdk partners and function of cyclins D, E, A, and B.
4. Define *CAK* (Cdk-activating kinase) and the two major classes of CKIs (cyclin-dependent kinase inhibitors) and describe their function.
5. Compare the function of cell-cycle checkpoints in cell-cycle regulation.
6. Describe/illustrate the roles of p53 and pRb in cell-cycle regulation.
7. Propose how abnormalities of cell-cycle regulatory mechanisms can lead to malignancy.
8. Define *caspases* and explain their role in apoptosis.
9. Differentiate the extrinsic and intrinsic pathways of cellular apoptosis.
10. Define and contrast the roles of pro-apoptotic and anti-apoptotic members of the Bcl-2 family of proteins.
11. Describe apoptotic regulatory mechanisms.
12. Give examples of diseases associated with increased apoptosis and inhibited (decreased) apoptosis.
13. Define *epigenetics*, and give examples of epigenetic changes associated with gene silencing.
14. Differentiate, using morphologic observations, the processes of necrotic cell death and apoptotic cell death.

**C. CHAPTER OUTLINES**

**Chapter 1—Introduction**

1. Overview
2. Introduction
3. Composition of Blood
4. Reference Intervals for Blood Cell Concentration
5. Hemostasis
6. Blood Component Therapy
7. Laboratory Testing in the Investigation of a Hematologic Problem
8. Summary
9. Review Questions
10. Companion Resources
11. References

**Chapter 2—Cellular Homeostasis**

1. Overview
2. Introduction
3. Cell Morphology Review
   1. Cell Membrane
   2. Cytoplasm
   3. Nucleus
4. Cellular Metabolism: DNA Duplication, Transcription, Translation
   1. Control of Gene Expression
   2. Protein Synthesis and Processing
   3. The Ubiquitin System
5. Tissue Homeostasis: Proliferation, Differentiation, and Apoptosis
   1. Proliferation: The Cell Cycle
      1. Stages of the Cell Cycle
      2. Molecular Regulation of the Cell Cycle
         1. Cyclins and Cyclin-Dependent Kinases
         2. Regulation of Cell-Cycle Kinase Activity
      3. Cell-Cycle Checkpoints
   2. Differentiation
      1. Epigenetics
      2. Translational Regulation
   3. Apoptosis
      1. Necrosis versus Apoptosis
      2. Molecular Regulation of Apoptosis
         1. Role of Caspases and the Initiation of Apoptosis
         2. Role of Bcl-2 Proteins
      3. Apoptosis and the Hematopoietic System
6. Abnormal Tissue Homeostasis and Cancer
7. Summary
8. Review Questions
9. Companion Resources
10. References

***Note:*** *Statements in the following sections identified with asterisks suggest Level II competencies*

**D. ACTIVE LEARNING SUGGESTED ACTIVITIES**

*{Background information on each suggested activity is provided in the* ***Introduction/Teaching Tips*** *section at the beginning of this Instructor’s Resource Manual.}*

1. **Clear the Mud** At the end of class, pass out index cards to all students and ask each of them to write down any topic, current or past, that is still unclear. Have students place their respective index cards into a container on the instructor’s desk. As students leave, they should randomly pick an index card from the container, research the topic, and prepare an answer or explanation to the “muddy point” written on the card. The instructor may choose to ask a few students to present their explanation during the next class period.

2. **Diagrams**

a. Using the information provided in Chapter 2, have the learners create their own explicit diagram of the:

• Cell structure

• Stages of the cell cycle

• \*\*Hematopoietic precursor cell model

3. **Group Discussion**

a. Create a group discussion on the topic of the Medical Ethics concerning stem cell transplants.

4. **Mystery Box**

a. Create a mystery box with the different blood components and corresponding reference ranges. Be sure to include at least

• Leukocytes

• Erythrocytes

• Thrombocytes

• Plasma

• Whole blood

• 4.5–11.0 x 109/L

• 4.5–5.5 x 1012/L

• 150–450 x 109/L

• 55 percent of blood volume

• 5–6 liters in adults

• And so on

5. **One-Minute Paragraph** Have learners submit a one minute paragraph on the:

a. Composition of blood

b. \*\*Abnormal tissue homeostasis and cancer

6. **Short Story** Have the learners, individually or as a group, write:

a. The story of “The Life and Development of a Cell”

b. A “Murder Mystery of a Cell”

7. **Think-Pair-Share**

a. \*\*Discuss the value and need for “clinical” and “critical” pathways.

b. \*\*Discuss necrosis versus apoptosis.

8. **Thumbs Up/Thumbs Down** Remember to get immediate feedback on any topic during the class period, call for a quick “Thumbs Up or Thumbs Down.” Ask students to indicate if they comprehend the information presented by showing either a thumbs up, meaning they understand the information, or thumbs down, meaning more explanation or clarification is needed.

**E. LABORATORY ACTIVITIES**

1. Perform WBC and RBC counts on each learner in the class, and create a “class reference range” for WBC and RBC. You might want to have students read the section “Reference Interval Determination” in Chapter 41 if you include this activity.

**F. PRACTICE QUESTIONS**

1. List the components of whole blood and state the reference range for each. [Taxonomy 1]

2. Explain why “reflex testing protocols” are designed. [Taxonomy 1]

3. A patient experiencing a viral infection is likely to demonstrate an increase in which of the following? [Taxonomy 1]

a. erythrocytes

b. hematocrit

c. leukocytes

d. thrombocytes

4. Patient Aaron had an RBC count of 4.0 x 1012/L. Explain why a hospital in Alabama might consider this value “normal,” whereas a facility in Utah may recognize Aaron’s RBC as “below” normal. [Taxonomy 2]

5. In the text *Clinical Laboratory Hematology*,differentiate “precursor cells” from “maturing cells.” [Taxonomy 2]

6. Analyze each set of results and answer the following questions. [Taxonomy 2]

***A. B. C.***

WBC = 18.6 x 109/L WBC = 0.6 x 109/L WBC = 6.5 x 109/L

RBC = 3.50 x 1012/L RBC = 2.12 x 1012/L RBC = 4.79 x 1012/L

Hb = 10.2 g/dL Hb = 7.5 g/dL Hb = 16.4 g/dL

Hct = 31.1% Hct = 24.3% Hct = 49.6%

Plt = 202 x 109/L Plt = 89 x 109/L Plt = 543 x 109/L

Which set of results demonstrates a

a. leukocytosis

b. erythrocytopenia

c. thrombocytopenia

d. critically decreased H & H

e. leukopenia

f. thrombocytosis

7. Compare and contrast the processes of cell “self-renewal” versus “cell differentiation.” [Taxonomy 3]

8. Evaluate the following patient results and conclude which body function (mechanism) will be adversely affected. Explain why. [Taxonomy 3]

WBC = 0.8 x 109/L

RBC = 2.5 x 1012/L

Hb = 8.2 g/dL

Hct = 25.1%

Plt = 222 x 109/L

9. A 26-year-old male, type I diabetes mellitus patient is seen in the emergency department. The patient’s blood chemistry results confirm the need for renal dialysis. Explain the etiology for this patient’s hematology results. [Taxonomy 3]

WBC = 11.8 x 109/L

RBC = 3.2 x 1012/L

Hgb = 9.5 g/dL

Hct = 27.6%

Plt = 321 x 109/L