MLAB 1415 - Hematology MLAB 1415.401 Course Syllabus

Description
The study of blood cells in normal and abnormal conditions. Instruction in the theory and practical application of hematology procedures, including quality control, quality assurance, safety, manual and/or automated methods as well as blood cell maturation sequences, and normal and abnormal morphology with associated diseases.

Semester Offered
Fall only
Credits 4
Lecture Hours 2
Lab Hours 6
Extended Hours 0
Contact Hours 128
State Approval Code 5110040000
Instructor Name Antiquene Nichols
Semester/Year Fall 2024

Meeting Time and Location
MLAB 1415 - Online—students are expected to spend at least 3-4 hours per week** reading, reviewing, and participating in assigned activities for successful completion of this course.

Alternate Operations During Campus Closure

In the event of an emergency or announced campus closure due to a natural disaster or pandemic, it may be necessary for Panola College to move to altered operations. During this time, Panola College may opt to continue delivery of instruction through methods that include, but are not limited to: online learning management system (CANVAS), online conferencing, email messaging, and/or an alternate schedule. It is the responsibility of the student to monitor Panola College's website (www.panola.edu) for instructions about continuing courses remotely, CANVAS for each class for course-specific communication, and Panola College email for important general information.

Student Basic Needs

Unexpected circumstances may arise, but Panola College offers various resources to support students. If you need mental health services or are facing challenges with transportation, affording class materials and supplies, or accessing food regularly—issues that may impact your class performance—please visit panola.edu/resources.

Class Attendance

Regular and punctual attendance of classes and laboratories is required of all students. When a student has been ill or absent from class for approved extracurricular activities, he or she should be allowed, as far as possible, to make up for the missed work. If a student has not actively participated by the census date, they will be dropped by the instructor for non-attendance. This policy applies to courses that are in-person, online, hybrid, and hyflex.

Attendance in online courses is determined by submission of an assignment or participation in an activity. According to federal guidelines, simply logging into a distance learning course without participating in an

academic assignment does not constitute attendance. Distance learning is defined as when a majority (more than 50%) of instruction occurs when the instructor and students are in separate physical locations. Students must engage in an academic activity prior to the course census date.

When an instructor feels that a student has been absent to such a degree as to invalidate the learning experience, the instructor may recommend to the Vice President of Instruction that the student be withdrawn from the course. Instructors may seek to withdraw students for non-attendance after they have accumulated the following number of absences:

Fall or spring semesters:

3 or more class meeting times per week - 5 absences

2 class meeting times per week - 3 absences

1 class meeting per week - 2 absences

The student is responsible for seeing that he or she has been officially withdrawn from a class. A student who stops attendance in a class without officially withdrawing from that class will be given a failing grade; consequently, the student must follow official withdrawal procedures in the Admissions/Records Office.

Please note: Health Science and Cosmetology courses may require more stringent attendance policies based on their accreditation agencies. Please see the addendum and/or program handbook for further information concerning attendance.

Pregnant/Parenting Policy

Panola College welcomes pregnant and parenting students as a part of the student body. This institution is committed to providing support and adaptations for a successful educational experience for pregnant and parenting students. Students experiencing a need for accommodations related to pregnancy or parenting will find a Pregnancy and Parenting Accommodations Request form in the Student Handbook or may request the form from the course instructor.

Artificial Intelligence (AI) Course Policy

Broader use of Generative AI permitted within the course.

The use of artificial intelligence (AI) tools, including ChatGPT, is permitted in this course for students who wish to use it. Students must cite AI-generated material that informs their work. Using an AI tool to generate content without proper attribution qualifies as academic dishonesty.

Instructional Goals and Purposes

Hematology is the study of blood cells in normal and abnormal conditions. Students will be instructed in the theory and practical application of hematology procedures have including quality control, quality assurance, safety, manual and/or automated methods as well as blood cell maturation sequences, and normal and abnormal morphology with associated disease.

Learning Outcomes

1. Apply principles of safety, quality assurance and quality control in Hematology.
2. ***Evaluate*** specimen acceptability.
3. Compare and contrast hematology values under normal and abnormal conditions.
4. ***Perform*** and explain principles and procedures of tests to include sources of error and clinical significance of results.
5. ***Evaluate*** normal and abnormal cell morphology with associated diseases.

Specific Course Objectives (includes SCANS)

After studying all materials and resources presented in the course, the student will be able to:

1. **Chapter 4- Hematopoiesis***
   (1a-i., 1b-iv, 2c-i,ii)
   a. ***Identify*** phases and site of origin for cellular development of active hematopoietic tissue in Embryo and fetus:
      i. Mesoblastic phase

ii. hepatic phase (extramedullary)
iii. medullary/myeloid phase.

a. Define hematopoiesis:
   i. Theory of pluripotent stem cell development
   ii. Stem cell kinetics: Generative cell cycle
   iii. Regulatory growth factors and inhibitors.
b. ***Identify*** phases and site of origin for cellular development of active hematopoietic tissue in Infant and young child:
   i. All red marrow spaces (all cell lines)
   ii. Thymus fully developed (T lymphs)
   iii. Secondary lymphoid tissue (T and B lymphs)
c. ***Identify*** phases and site of origin for cellular development of active hematopoietic tissue in Adults:
   i. Red marrow (axial skeleton and proximal ends of long bones)
   ii. Primary and secondary lymphoid tissue (T and B lymphs)
d. Explain the role of other organ systems in hematopoiesis:
   i. Mononuclear phagocyte system
   ii. Spleen (structure, blood flow, function)
   iii. Liver (structure, blood flow, function)
   iv. Lymph nodes (structure, blood flow, function)
   v. Thymus (structure, blood flow, function)
e. State the physical findings commonly present in hematologic disease:
   i. Splenomegaly
   ii. Hypersplenism
   iii. Hepatosplenomegaly
   iv. Lymphadenopathy
f. ***Describe*** key terms used to assess bone marrow structure and function:
   i. Myeloid to erythroid ratio (M:E)/erythroid to granulocyte ratio (E:G)
   ii. Erythropoiesis
   iii. Granulopoiesis
   iv. Megakaryopoiesis
   v. Non-hematopoietic cells
   vi. Cellularity: fat (yellow marrow) to cell (red marrow) ratio
   vii. Aplastic marrow
   viii. Hypo/Hyperplastic marrow.
g. Explain mechanisms that regulate and modulate granulopoiesis:
   i. Regulatory growth factors and inhibitors
   ii. Kinetics
   iii. Life span
   iv. Circulation
h. List nutritional and regulatory factors with associated with erythropoiesis:
   i. Erythropoietin (EPO)
   ii. Iron
   iii. Vitamins (B12/ folate)
   iv. Intrinsic factor
i. List the maturation sequence of developing erythrocytes
j. ***Describe*** the distinctive features used to characterize developing cells:
   i. Overall cell size
   ii. Cell Nucleus Shape
   iii. Relative size
   iv. Staining reaction
   v. Chromatin pattern
   vi. Presence or absence of nucleoli
   vii. Staining reaction and size of cytoplasm
k. List morphologic features used to differentiate developing leukocytes: •
   i. Overall cell size
   ii. Nucleus Shape
   iii. Nuclear to cytoplasmic ratio (N:C)

iv. Staining reaction
v. Chromatin pattern
vi. Presence or absence of nucleoli
vii. Relative amount of cytoplasm
viii. Cytoplasmic staining reaction
ix. Presence or absence of granules and staining reaction in cytoplasm

l. Name and describe the average percentage and cellular characteristics of the six mature leukocytes found in normal peripheral blood.

2. **Chapter 5- Erythrocytes: Erythropoiesis, Maturation, Membrane Characteristics, and Metabolic Activities**
(1a-i. 1b-iv. 2c-i,ii,iii)
   a. ***Identify*** phases and site of origin for cellular development of active hematopoietic tissue in Infant and young child:
      i. All red marrow spaces (all cell lines)
      ii. Thymus fully developed (T lymphs)
      iii. Secondary lymphoid tissue (T and B lymphs)
   b. ***Identify*** phases and site of origin for cellular development of active hematopoietic tissue in Adults:
      i. Red marrow (axial skeleton and proximal ends of long bones)
      ii. Primary and secondary lymphoid tissue (T and B lymphs)
   c. Compare and contrast polycythemia rubra vera, secondary polycythemia, and relative erythrocytosis:
      i. Etiology
      ii. Clinical features
      iii. Laboratory findings
   d. ***Describe*** the purpose of the metabolic pathways used by erythrocytes:
      i. Embden-Meyerhof
      ii. Hexose monophosphate shunt
      iii. Methemoglobin reductase
   e. Discuss components of the mature red cell that are essential for survival and function:
      i. Membrane composition and function
      ii. Lipids/Proteins
      iii. Maintain RBC shape, deformability, and permeability
      iv. Support system for surface antigens
      v. Transport and exchange of gases and ions (cationic pumps)
   f. Name the basic substances necessary for proper erythropoiesis.
   g. Explain the normal condition that stimulates the production of erythropoietin.
   h. Compare the terms secondary polycythemia and relative polycythemia.
   i. ***Describe*** the general characteristics, including the physical properties, of the erythrocyte membrane.

3. **Chapter 6- Erythrocytes: Hemoglobin**
(1a-i. 2c-i,ii)
   a. Explain the genetic inheritance of hemoglobin.
   b. Summarize the mechanisms by which normal hemoglobin is structured and synthesized in the developing red cell:
      i. Iron transport, uptake, and supply
      ii. Protoporphyrin IX (heme) formation
      iii. Globin synthesis and genetic control Chromosome 11 and 16
      iv. Embryonic hemoglobins (Gower 1, 11, Portland)
      v. Adult hemoglobins (Hb A, Hb A2, Hb F,)
   c. ***Identify*** the effect various conditions can have on an oxygen disassociation curve:
      i. pH (Bohr effect)
      ii. Temperature
      iii. CO2
      iv. 2,3-DPG
      v. Hb F and other variants
   d. ***Describe*** normal hemoglobin-oxygen function using the oxygen disassociation curve

e. Discuss the principles of hemoglobin electrophoresis (cellulose acetate, alkaline pH vs. citrate agar, acid pH)
    i. ***Perform/observe*** the procedure
    ii. Apply appropriate quality control procedures
    iii. Correlate results
f. Discuss the principles of hemoglobin quantification (Hb A, Hb A2, Hb F):
    i. ***Perform/observe*** the procedure
    ii. Apply appropriate quality control procedures
    iii. Correlate results
g. Explain the mechanism by which red cells are catabolized:
    i. Identify phased (extra/intravascular)
    ii. Trace the basic steps associated with each phase
h. Define terms associated with red cell destruction:
    i. Biliverdin
    ii. Bilirubin (conjugated/ unconjugated)
    iii. Urobilinogen
    iv. Urobilin
    v. Hemoglobin dimers
    vi. Haptogloblin
    vii. Hemopexin
    viii. Hemoglobinemia
    ix. Hemoglobinuria
    x. Hemosiderinuria
    xi. Methemalbumin

4. **Chapter 7- Erythrocytes: Morphology and Inclusions (1a-i.1b-ii,iii,iv,v,vi)**
    a. ***Describe*** methods used to identify and/or confirm the composition of various red blood cell inclusions.
    b. ***Describe*** the alterations in color that can be seen in an erythrocyte: polychromatic have hypochromatic
    c. Associate a given red blood cell morphology with routinely encountered conditions:
        i. Hereditary membrane abnormalities (spherocytosis, elliptocytosis, ovalocytosis have etc.)
        ii. RBC Enzyme abnormalities (G6PD and PK deficiencies)
        iii. Extracorpuscular (immune and non-immune) mediated RBC defects.
    d. Define common words used to describe red cell morphology and identify each on a peripheral smear:
        i. basophilic stippling
        ii. Cabot rings
        iii. Heinz bodies
        iv. Howell-Jolly bodies
        v. Hemoglobin C crystals
        vi. Pappenheimer bodies/siderotic granules
        vii. Hemoglobin crystals
        viii. Poikilocytosis
        ix. Rouleaux
        x. agglutination
        xi. acanthocyte
        xii. codocyte
        xiii. dacryocyte
        xiv. drepanocyte
        xv. echinocyte
        xvi. elliptocyte
        xvii. keratocyte
        xviii. schistocyte
        xix. spherocyte
        xx. stomatocyte
        xxi. malarial parasites

xxii. Hemoglobin H
e. Associate a given red blood cell morphology with routinely encountered conditions: Malaria
f. Name and describe the variations in the size of a mature erythrocyte.
g. Correlate at least one clinical condition with each of the erythrocytic size variations: normocytosis, macrocytosis, and microcytosis.
h. Define the term anisocytosis.

5. **Chapter 8- Leukocytes: The Granulocytic and Monocytic Series (1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**
   a. Explain the functions associated with granulocytes:
      i. Phagocytosis and killing
      ii. Allergic response (eosinophils and basophils)
      iii. Host defense against parasites (eosinophils)
      iv. Hypersensitivity mediator (basophils and mast cells)
   b. List the maturation sequence of neutrophils, eosinophils, and basophils
   c. Differentiate band neutrophils, segmented neutrophils, eosinophils, and basophils
   d. Define the terms marginating and circulating pools.
   e. Determine if a granulocyte is mature or immature
   f. Explain the term: shift to the left.
   g. Summarize structural and functional features that characterize monocytes and macrophages,
   h. State absolute monocyte reference values and relative reference values
   i. List the maturation sequence of monocytes and macrophages.
   j. Summarize structural and functional features that characterize monocytes and macrophages
   k. Discuss the length of time the neutrophils, eosinophils, and basophils spend in each marginating and circulating pool.
   l. ***Describe*** the nuclear and cytoplasmic characteristics of the neutrophils, eosinophils, and basophils throughout the maturation process.
   m. Explain the appearance and etiology of the various morphological abnormalities encountered in mature granulocytes (i.e. inclusions, hypo- and hyper-segmented).
   n. Define terms associated with an increase and decrease in granulocytes.
   o. Define the term leukocyte surface marker.
   p. Associate the various terms for macrophages depending on their anatomical site.
   q. ***Describe*** the general functions of macrophages.
   r. List the relative reference values for neutrophils, eosinophils, basophils and monocytes in normal peripheral blood.
   s. State the (neutrophilic) granulocytic reference range.
   t. ***Describe*** the general function of monocytes.
6. **Chapter 9- Leukocytes: Lymphocytes and Plasma Cells (1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**
   a. Summarize structural and functional features that characterize lymphocytes
   b. List the sites of formation and production of lymphocytes:
      i. Bone marrow
      ii. Thymus
      iii. Lymph nodes and secondary lymphoid tissue
      iv. Kinetics: Life span/ Migration
   c. ***Describe*** lymphocyte function:
      i. Humoral immunity (B lymphs and subsets)
      ii. Cell mediated immunity (T lymphs and subsets)
      iii. Natural killing and antibody dependent cellular cytotoxicity
   d. State lymphocyte absolute reference values with relative reference values
   e. Define lymphopenia/ lymphocytosis
   f. List the maturation sequence of lymphocytic cells and normal lymphocyte:
      i. Size
      ii. Nucleus
      iii. Cytoplasm
      iv. Heterogeneity
   g. Compare and contrast morphologic features of reactive lymphocyte
   h. ***Describe*** the use of monoclonal antibodies to differentiate lymphocytes by CD antigens:

    i. B lymphs and subsets
    ii. T lymphs and subsets
    iii. Plasma cell (immunoglobulin antibody production)
  i. List the causes of non-neoplastic disorders plasma cells.
  j. ***Identify*** key morphologic features for plasma cell.
  k. ***Describe*** the role of lymphocytes and plasma cells in the body defense mechanism against disease.
  l. Name and locate the two primary and three secondary lymphoid tissues.
  m. ***Identify*** the anatomical sites populated by T cells and B cells.
  n. Compare absolute and relative numbers in lymphocytes.
  o. Calculate the absolute value of a lymphocyte value.
  p. Compare the major types, normal reference value percentages, and quantities of lymphocytes at different ages ranging from birth to adulthood.
  q. Differentiate the functions of the three major categories of lymphocytes.
  r. ***Describe*** the appearance and cytoplasmic contents of Russell's bodies, Mott cells, and flame cells.
7. **Chapter 10- Basic Laboratory Assessment of Erythrocytes, Leukocytes, and Platelets (1a-i,iii.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**
  a. List the components of a complete blood count (CBC).
  b. Define abbreviations: RBC, WBC, Hgb, Hct, and retic.
  c. Compare and contrast the utility of absolute values with relative values
  d. Discuss the clinical utility of the RBC indices
  e. Use the RBC indices as a quality control mechanism for assessing the validity of the erythrocyte count, hemoglobin, and hematocrit values
  f. Calculate red blood cell indices when provided appropriate data.
  g. Explain sources of error of the red blood cell indices
  h. Correlate automated hemogram parameters with each other and with peripheral smear exam results.
  i. Perform standard reticulocyte assays:
    i. Supravital smear method with Miller disc
    ii. Supravital smear method without Miller disc
    iii. Automated flow cytometry methods
  j. State reference values that reflect variations in gender and age for the leukocyte counts in peripheral blood:
    i. Total leukocyte count
    ii. Absolute lymphocyte count
    iii. Absolute neutrophil count
  k. Perform routine methods to assess leukocytes (e.g. manual and automated white blood cell counts and differentials)
  l. List common factors that alter leukocyte values:
    i. Physiologic variation
    ii. Cellular abnormalities
  m. Enumerate and/or calculate absolute and relative leukocyte counts:
    i. Relative values
    ii. Absolute values
  n. Discuss the clinical utility of the absolute neutrophil count.
  o. Perform calculations associated with reticulocyte assays:
    i. Corrected
    ii. Absolute
    iii. Production index (RPI)
  p. Perform erythrocyte sedimentation rates:
    i. Wintrobe
    ii. Westergren and its modifications
    iii. Automated
  q. Determine the appropriate area of a peripheral blood smear to evaluate red blood cell morphology.
  r. Estimate the total white blood count from a smear.
  s. Correct leukocyte counts for the presence of nucleated red cells.

t. Identify and classify normal white blood cells on a properly stained Romanowsky blood smear.
u. Describe the measurement of microhematocrit.
v. Compare RBC, hemoglobin, and hematocrit values using the rules of three.
w. Define each of the erythrocyte indices: mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).
x. Apply the appropriate formulas and calculate the MCV, MCH, and MCHC when give the erythrocyte values.
y. Classify RBC morphology based on erythrocyte indices.
z. Name a classic application of the leukocyte alkaline phosphatase (LAP) test.
aa. Explain the purpose of the erythrocyte sedimentation rate (sed rate).

8. **Chapter 11- Classification and Laboratory Assessment of Anemias (1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**
   a. Define anemia.
   b. Define hypochromic (microcytic) anemia, including the causes.
   c. Compare and contrast laboratory findings in hypochromic anemias:
      i. Serum ferritin
      ii. Serum iron
      iii. Transferrin/ Total Iron Binding Capacity (TIBC)
      iv. Percent transferrin saturation
   d. State the clinical signs and symptoms of anemia:
      i. Hemoglobin
      ii. Hematocrit
      iii. RBC indices
      iv. Peripheral smear
      v. Reticulocyte count
      vi. Bone marrow evaluation
      vii. Red blood cell distribution width
   e. List the categories used in a morphological classification of the anemias.
   f. ***Describe*** the expected laboratory results seen in the various pathophysiologic classifications of anemia:
      i. Decreased red cell production
      ii. Increased red cell destruction: Ineffective erythropoiesis/ Hemolytic processes
      iii. Loss of red cells
   g. Briefly describe the usual complaints of an anemic patient.
   h. ***Describe*** the organization of anemias according to erythrocyte size and explain the limitations of such a system.
   i. Briefly explain the characteristics of categories of anemias using a pathological basis.
9. **Chapter 12- Acute and Chronic Blood Loss Anemia and Anemias associated with Systemic Disorders. (1a-i.2c-i,ii,iii)**
   a. ***Describe*** the etiology and physiology of acute blood loss.
   b. List the laboratory findings of acute blood loss
   c. ***Describe*** the etiology and physiology of chronic blood loss.
   d. List the clinical symptoms of acute blood loss
   e. ***Describe*** the laboratory findings associated with non-hematologic disorders:
      i. Chronic disorders and inflammation
      ii. Malignant diseases
      iii. Renal disease
      iv. Liver disease
      v. Alcoholism
10. **Chapter 13- Bone Marrow Failure Syndromes (1a-i. 1b-i,ii,iv,v,vi. 2c-i,ii,iii)**
    a. ***Describe*** bone marrow collection techniques:
       i. Aspiration
       ii. Core biopsy
    b. ***Describe*** the clinical features of hypoproliferative anemias
    c. ***Describe*** the laboratory findings of hypoproliferative anemias:
       i. Peripheral blood changes

    ii. Bone Marrow Changes
  d. Define aplastic anemia.
  e. Define pure red cell aplasia:
    i. Describe the clinical features
    ii. Describe the laboratory findings
  f. ***Describe*** the general characteristics of bone marrow syndromes.
  g. Define pancytopenia.
  h. List three iatrogenic substances that can cause acquired aplastic anemia.
  i. Name 4 viral infections that have been associated with acquired aplastic anemia.
  j. Briefly describe how the immune process causes acquired aplastic anemia.
  k. Discuss the laboratory findings in acquired aplastic anemia (pertaining to ALL cells lines).
  l. Explain the clinical signs and symptoms of Fanconi anemia.
  m. Name one treatment for Fanconi's anemia.
  n. ***Describe*** the characteristics of dyskeratosis congenital.
  o. Name three examples of pure red cell aplasia.
  p. Explain the laboratory findings in congenital dyserythropoietic anemia.
  q. ***Describe*** the characteristics of severe congenital neutropenia and cyclic neutropenia.
  r. Explain the characteristics of Shwachman-Diamond syndrome.
  s. ***Describe*** characteristics of congenital amegakaryocytic thrombocytopenia.
  t. Compare three types of congenital amegakaryocytic thrombocytopenia.
11. **Chapter 14- Disorders of Iron Metabolism and Heme Synthesis.**
    (1a-i. 2c-i,ii,iii)
  a. Compare absolute iron deficiency with functional iron deficiency.
  b. Compare primary overload disorders to secondary iron overload disorders.
  c. Name conditions that can contribute to iron deficiency anemia IDA.
  d. Name three of the most common groups vulnerable to IDA.
  e. ***Describe*** the physiology of iron metabolism, including the iron needs of children and normal dietary sources.
  f. ***Describe*** laboratory findings of IDA.
  g. Define terms: transferrin, hemosiderin, ferritin, total iron-binding capacity (TIBC).
  h. Describe the etiological basis of AOI.
  i. Explain the cause of AOI.
  j. Discuss the laboratory characteristics of AOI.
  k. Compare the characteristics of iron deficiency anemia with AOI.
  l. Explain the laboratory characteristics of sideroblastic anemia.
12. **Chapter 15- Macrocytic and Megaloblastic Anemias**
    (1a-i. 2c-i,ii,iii)
  a. Name the blood cell morphology associated with Vitamin B12/Folate deficiency.
  b. Discuss tests methods commonly used to assess megaloblastic anemia:
    i. Mean cell volume (MCV)
    ii. Blood and bone marrow smear evaluation
    iii. Serum B12
    iv. Serum folate
    v. Red cell folate
    vi. Anti-intrinsic factor antibodies
    vii. Anti-parietal cell antibodies
  c. Differentiate nonmegaloblastic macrocytosis from megaloblastic anemia:
    i. Peripheral blood and bone marrow characteristics
    ii. Serum vitamin B12 level
    iii. Serum folate level
    iv. Red cell folate level
  d. ***Describe*** clinical features of megaloblastic anemia
  e. Compare and contrast causes and laboratory features of the megaloblastic anemias
  f. State the hematologic abnormalities present in megaloblastic anemia:
    i. Peripheral blood changes
    ii. Bone marrow morphology
  g. Discuss the absorption and metabolism of vitamin B12 and folate

h. Name the two common causes and other less common causes of megaloblastic anemia.
i. List 4 etiological causes of vitamin B12 deficiency and describe two distinguishing clinical or laboratory characteristics for each.
j. Explain the etiology and pathophysiology, including the immune nature, of pernicious anemia.
k. ***Describe*** the clinical signs and symptoms of pernicious anemia.
l. Explain the usual management of and therapy for pernicious anemia.
m. Name the laboratory assays used to confirm folic acid deficiency and state the results associated with folic acid deficiency.

13. **Chapter 16- Hemolytic Anemias**
(1a-i.1b-ii,iii,iv,v,vi)
    a. Define the term hemolytic anemia.
    b. Discuss the principle of the Osmotic fragility test:
        i. Perform /observe the procedure
        ii. Apply appropriate quality control procedures
        iii. Correlate results
    c. ***Describe*** the hematologic findings associated with nonimmune hemolytic anemias:
        i. Malaria
        ii. Babesiosis
        iii. Thermal injury
        iv. Disseminated intravascular coagulation
    d. ***Describe*** the utility of flow cytometry in assessing red cell membrane defects
    e. ***Describe*** the clinical features and laboratory findings of red cell membrane defects:
        i. Hereditary spherocytosis
        ii. Hereditary elliptocytosis
        iii. Paroxysmal nocturnal hemoglobinuria (PNH)
        iv. Hereditary pyropoikilocytosis
    f. Discuss the four mechanisms of drug-induced hemolytic anemias.
    g. Identify mechanisms of immune-mediated hemolytic anemias
    h. ***Describe*** the clinical features and laboratory findings of autoimmune:
        i. Warm autoimmune hemolytic anemia (WAIHA)
        ii. Cold autoimmune hemolytic anemia idiopathic/secondary
        iii. Paroxysmal cold hemoglobinuria
    i. ***Describe*** the clinical features and laboratory findings of Alloimmune (isoimmune) hemolytic anemias:
        i. Acute hemolytic transfusion reaction
        ii. Delayed hemolytic transfusion reaction
        iii. Hemolytic disease of the fetus and newborn (HDFN)
    j. ***Describe*** the laboratory features of red cell enzyme abnormalities:
        i. Glucose-6-phosphate dehydrogenase (G6PD) deficiency
        ii. Pyruvate kinase (PK) deficiency
    k. Discuss the principles of G6PD assay, pyruvate kinase assay and staining Heinz bodies:
        i. Perform /observe the procedure
        ii. Apply appropriate quality control procedures
        iii. Correlate results
    l. Name at least three categories of intrinsic versus extrinsic hemolytic anemia.
    m. Name and discuss the five types or varieties of membrane defects.
    n. Name and briefly explain three categories of acquired hemolytic anemia.
    o. Name four mechanisms of drug-induced hemolytic anemias.
    p. Discuss immune mechanism related to acquired hemolytic anemia.
    q. Characterize the etiology of paroxysmal nocturnal hemoglobinuria.
14. **Chapter 17- Hemoglobinopathies and Thalassemias**
(1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)
    a. ***Describe*** the common denominator in hemoglobinopathies.
    b. Name the three major categories to classify hemoglobin defects.
    c. ***Describe*** the hemoglobin defect in thalassemia
    d. Define hemoglobinopathy
    e. ***Describe*** the clinical and laboratory findings of hemoglobinopathies:

i. Hb SS
ii. Hb AS
iii. Hb CC
iv. Hb SC

f. State the amino acid substitutions associated with sickle cell anemia and hemoglobin C disease
g. Outline laboratory findings that are typical of SCD
h. Discuss the principle of the solubility test for sickling hemoglobin:
   i. Perform /observe the procedure
   ii. Apply appropriate quality control procedures
   iii. Correlate results
i. Discuss the principles of hemoglobin quantification (Hb A, Hb A2, Hb F):
   i. Perform/observe the procedure
   ii. Apply appropriate quality control procedures
   iii. Correlate results
j. List the characteristic clinical and laboratory findings associated with thalassemia
k. Identify the electrophoretic patterns when provide appropriate data:
   i. Hb F
   ii. Hb A
   iii. Hb S
   iv. Hb C
   v. Hb A2
l. Compare the disease state and trait condition of a hemoglobinopathy.
m. ***Describe*** the clinical signs and symptoms of SCD.
n. Characterize the general signs and symptoms in the categories of pain, pulmonary complications, and stroke associated with SCD.
o. Identify globin chain defects causing SCD, hemoglobin D disease, and hemoglobin E disease.
p. Outline laboratory findings that are typical of SCD
q. Recognize and identify major clinical signs and symptoms and abnormal laboratory tests results including peripheral blood smear pictures that are typically associated with homo and hetero conditions of HbS, HbC, HbD, and HbE and compound heterozygous conditions involving HbS and other variant hemoglobins.
r. Briefly describe the value of the techniques of hemoglobin electrophoresis and deoxyribonucleic acid (DNA) analysis.

15. **Chapter 18- Disorders of Granulocytes and Monocytes (1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**
    a. Associate quantitative and qualitative leukocyte disorders with expected results:
       i. Bone marrow production and release
       ii. Rate of entry into peripheral circulating pools
       iii. Shifts between circulating and marginating pools
       iv. Rate of exit into tissues
    b. Define monocytosis and its causes.
    c. ***Describe*** qualitative and quantitative alterations of monocytes.
    d. State common causes of alterations in absolute and relative cell counts for the mature myeloid cells:
       i. Neutrophilia
       ii. Neutropenia
       iii. Eosinophilia
       iv. Eosinopenia
       v. Basophilia
    e. Explain the classification of nonmalignant leukocytic disorders:
       i. Quantitative changes
       ii. Qualitative changes
    f. Identify on blood smear morphologic changes in neutrophils that may accompany nonmalignant neutrophilic disorders:
       i. Shift to the left
       ii. Toxic granulation
       iii. Dohle bodies

iv. Vacuolization
v. Hyposegmentation
vi. Hypersegmentation

g. State characteristic abnormalities and clinical features for the qualitative/functional disorders of neutrophils:
i. Pelger-Huet anomaly
ii. Alder-Reilly anomaly
iii. Chediak-Higashi anomaly
iv. May-Hegglin anomaly
v. Chronic granulomatous disease (CGD)
vi. Myeloperoxidase deficiency

h. Define the terms leukocytosis and leukocytopenia.
i. List examples of general conditions that can cause leukocytosis.
j. List examples of common conditions that neutropenia.
k. List at least one representative condition in which a decrease in neutrophils, eosinophils have basophils, or monocytes can be found.

16. **Chapter 19- Disorders of Lymphocytes**
(1a-i.1b-v. 2c-i,ii,iii)
a. Differentiate between reactive and resting lymphocytes on Romanowsky stained smears
b. Identify causes of non-neoplastic disorders of lymphocytes.
c. List the causes of reactive lymphocytosis.
d. State the normal relative value reference range for lymphocytes in an adult.
e. State the absolute number of lymphocytes using the total leukocyte count and the relative number of lymphocytes.
f. Explain the difference between absolute lymphocyte count and a relative lymphocyte count.
g. Describe the etiology, epidemiology, clinical signs and symptoms, and laboratory data for infectious mononucleosis.
h. Describe and recognize the appearance of lymphocytes associated with infectious mononucleosis.
i. Name major immune deficiencies associated with T cells or B cells.

17. **Chapter 20- Characteristics of Leukemias, Lymphomas, and Myelomas**
(1a-i.1b-ii,iii,iv,v,vi)
a. ***Observe*** and/or perform procedures, apply appropriate quality control procedures, and interpret laboratory findings for laboratory procedures used in the identification, classification and differentiation of neoplastic disorders:
i. Complete blood count
ii. Hemograms
iii. Scatterplots and histograms

b. Correlate diagnostic blood and bone marrow findings to various sub-types of acute myeloid leukemia.
c. Define and differentiate the terms neoplasm and malignant.
d. Define and list categories associated with Neoplastic Disorders of Leukocytes:
i. Leukemias
ii. Myelodysplastic syndromes
iii. Myeloproliferative disorders
iv. Lymphoproliferative disorders

e. ***Describe*** general criteria to classify leukemias:
i. Cell maturity (Acute/Chronic)
ii. Cell lineage (Myeloid /nonlymphoid)
iii. Lymphoid

f. ***Describe*** the use of various diagnostic techniques used to assess neoplastic disorders of blood and bone marrow cells:
i. Cytochemical Stains
ii. Immunophenotyping
iii. Cytogenetics
iv. Molecular genetics

g. List major systems used to classify neoplastic disorders of leukocytes:

i. French, American-British (FAB) Cooperative Group
ii. World Health Organization (WHO)

h. Compare the characteristics of leukemia, lymphoma, and myeloma.
i. Define and compare acute and chronic leukemia.
j. Differentiate between acute and chronic myeloid (AML and CML) and lymphoid leukemias (ALL and CLL) based on clinical and hematologic findings.
k. List the traditional forms and the major types of leukemia
l. Explain the significance of the discovery of the human T-cell leukemia virus (HTLV) family and describe associated disorders.

18. **Chapter 21- Acute Leukemias**
(1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)
    a. List the clinical findings and laboratory results for acute leukemia
    b. Contrast the FAB with the WHO acute myeloid leukemia subgroups:
        i. FAB classification
            a. M0--acute myeloid leukemia with minimal differentiation
            b. M1--acute myeloid leukemia without maturation
            c. M2--acute myeloid leukemia with maturation
            d. M3--acute promyelocytic leukemia
            e. M4--acute myelomonocytic
            f. leukemia M5--acute monoblastic leukemia
            g. M6--acute erythroleukemia
            h. M7--acute megakaryoblastic leukemia
        ii. WHO classification
            a. AML with recurrent genetic abnormalities
            b. AML with myelodysplasia-related changes
            c. Therapy-related myeloid neoplasms
            d. AML, not otherwise specified
    c. List the WHO acute lymphocytic leukemia subgroups:
        i. B lymphoblastic leukemia/lymphoma, not otherwise specified
        ii. T lymphoblastic leukemia/lymphoma
    d. Compare and contrast the principles of various cytochemical stains and the cell lineages they react with:
        i. Myeloperoxidase
        ii. Tartrate resistant acid phosphatase (TRAP)
        iii. Iron staining (Sudan Black)
    e. ***Describe*** the fundamental characteristics of blood and bone marrow cell in acute leukemias.
    f. ***Coordinate*** factors related to epidemiology and long-term survival of AML patients.
    g. Discuss factors associated with the prognosis in AML.
    h. Discuss the purpose, advantages, and concerns related to allogeneic hematopoietic-cell transplantation.
    i. Discuss the epidemiology of acute lymphoblastic leukemia (ALL) in the United State.
    j. Summarize the pathogenesis of ALL.
    k. Name and briefly describe the FAB classification of ALL.
    l. Name and describe five life-threatening emergencies.

19. **Chapter 22- Lymphoid and Plasma Cell Neoplasms**
(1a-i.1b-v. 2c-i,ii,iii)
    a. List diagnostic features of PLL:
        i. Median age of onset and gender
        ii. Clinical finding of severe splenomegaly
        iii. Blood and bone marrow findings of PLL
        iv. markedly elevated white count with absolute lymphocytosis
        v. white cell differential predominantly of prolymphocytes
        vi. immunophenotypic profile
        vii. Survival rates
    b. Discuss classification based on proliferation of plasma cells and abnormal production of immunoglobulins:
        i. Multiple myeloma

ii. Waldenstrom's macroglobulinemia
iii. Plasma cell leukemia (PCL)
iv. Heavy-chain disease
v. Monoclonal gammopathy of undetermined significance (MGUS)

c. Classify the chronic lymphoid leukemias by T and B cell lineage:
i. Chronic lymphocytic leukemia (CLL)
ii. Prolymphocytic leukemia (PLL)
iii. Hairy cell leukemia (HCL)

d. List diagnostic features CLL:
i. Median age of onset
ii. Symptoms and clinical findings
iii. Blood and bone marrow findings of CLL
iv. Peripheral blood absolute lymphocytosis
v. Leukemic cell line of mature, small lymphocytes with monotonous Morphology and smudge/ basket cells
vi. Bone marrow lymphocytosis

e. List diagnostic features of Adult T-cell leukemia:
i. Human T-cell lymphotropic virus-1 (HTLV-1)
ii. Endemic areas
iii. blood and bone marrow findings of Adult T-cell leukemia
iv. Lymphoid cell line of small to large cells with cloverleaf/knotty nucleus

f. List diagnostic features of HCL:
i. Median age of onset and gender
ii. Clinical finding of severe splenomegaly
iii. Review blood and bone marrow findings of HCL
iv. Pancytopenia
v. Leukemic cell line of "hairy" cells
vi. Tartrate resistant acid phosphatase (TRAP) stain reaction
vii. "Dry "tap; marrow fibrosis and infiltrates

g. Define lymphoma and generally classify using key terminology:
i. Hodgkin
ii. Reed-Sternberg cells
iii. Rye modified cells
iv. Non-Hodgkin

h. Recognize lymphoma cells

i. Outline the laboratory tests used to diagnose and stage Hodgkin's lymphoma:
i. Complete blood count (CBC)
ii. Liver function tests
iii. Renal function tests

j. Review blood and bone marrow findings of Hodgkin's lymphoma:
i. Radiologic studies
ii. Physical examination
iii. Lymph node biopsy

k. Name disorders based on the proliferation of plasma cells and abnormal production of immunoglobulins

l. Compare the clinical findings and laboratory features of various plasma cell disorders

m. Compare the characteristics of leukemia and lymphoma.

n. Describe the general characteristics and laboratory data in multiple myeloma.

20. **Chapter 23- Myeloproliferative Neoplasms (1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**

a. Name the four diseases classified as myeloproliferative neoplasms (MPNs)

b. List the clinical and laboratory findings commonly found in MPD:
i. CML/CGL
ii. Leukocytosis with absolute neutrophilia and left shift maturation
iii. Absolute basophilia and eosinophilia
iv. Thrombocytosis
v. Bone marrow hypercellularity with granulocytic proliferation

vi. Leukocyte alkaline phosphatase (LAP) activity
vii. Philadelphia chromosome
viii. Cytogenetic (karyotype)
ix. Molecular (DNA) techniques
x. PV
xi. Increased red blood cell (RBC) mass
xii. Leukocytosis with mild left shift maturation and basophilia
xiii. Thrombocytosis
xiv. Bone marrow hypercellularity with all cell lines increased
xv. LAP activity
xvi. Red cell morphology (initial phase/ "spent" phase)
xvii. ET
xviii. Marked thrombocytosis with platelet aggregates and abnormal forms
xix. Megakaryocytic hyperplasia of bone marrow
xx. LAP activity
xxi. AMM
xxii. Leukoerythroblastosis with teardrop-shaped red cells
xxiii. Leukocytosis with left shift maturation to occasional immature myeloid cell
xxiv. Bone marrow fibrosis and relationship to megakaryocytic hyperplasia
xxv. LAP activity

c. Define polycythemia
d. ***Describe*** changes in the bone marrow and peripheral blood with polycythemia
e. Differentiate between absolute polycythemia and relative polycythemia
f. ***Report*** the general prognostic features of MPNs.
g. Name the subtypes of chronic myelogenous leukemia (CML)
h. ***Describe*** the epidemiology of CML.
i. Explain the use of leukocyte alkaline phosphatase (LAP) in the diagnosis of CML compared to a leukemoid reaction.
j. Characterize modes of treatment and prognostic features in CML.
k. State other names that might be used to refer to polycythemia rubra vera (PRV).
l. ***Describe*** the etiology of polycythemia rubra vera (PRV).
m. Name the most striking feature of PRV.
n. Describe the clinical signs and symptoms of PRV.
o. List the criteria for establishing a diagnosis of PRV.
p. State the other name for primary myelofibrosis.

21. **Chapter 24- Myelodysplastic Syndromes and Myelodysplastic/Myeloproliferative Neoplasms (1a-i.1b-ii,iii,iv,v,vi. 2c-i,ii,iii)**
    a. Discuss and compare features commonly shared by Chronic Myeloproliferative Neoplasms:
        i. Clinical manifestations
        ii. Pathophysiologic mechanisms
        iii. Blood and bone marrow findings
        iv. Transitional forms between stages
        v. Disease evolution with potential for blastic transformation
    b. List subgroups recognized by the World Health Organization (WHO) Cooperative Groups for the MDS classification
    c. List the Chronic Myeloproliferative Neoplasms by cell type:
        i. Granulocytes--Chronic myelogenous/granulocytic leukemia (CML/CGL)
        ii. Erythrocytes-- polycythemia vera (PV)
        iii. Megakaryocytes--essential thrombocythemia (ET)
    d. Define and describe cellular features that characterize the MDS:
        i. Dyserythropoiesis
        ii. Dysgranulopoiesis
        iii. Dysmegakaryocytopoiesis
22. **Instrumentation in Hematology**
    a. ***Identify*** basic concepts of electrical impedance, optical detection, radio frequency, and of light scatter plus cytochemical stain systems
        i. Discuss the principle

ii. List components
iii. Describe operation

b. ***Identify*** basic concepts of quality assurance for automated hematology cell counting systems
   i. Describe acceptable practices
   ii. Perform basic quality assurance
   iii. Assess data to ensure quality
   iv. Monitor quality assurance program
   v. Describe the limitations and list interfering substances

c. ***Identify*** and describe hemogram parameters
   i. Evaluate patient data
   ii. Describe the flagging system
   iii. Correlate scatter plots, histograms and data plots with the peripheral smear
   iv. Describe the mathematical calculations used to monitor instruments
   v. Recognize unexpected results

d. ***Discuss*** the principle of Automated reticulocyte counting
   i. Describe acceptable practices
   ii. Perform basic quality assurance
   iii. Assess data to ensure quality
   iv. Monitor quality assurance program
   v. Describe the limitations and list interfering substances

e.

23. **Lab #1:**
(1a-i.1b-ii,iii,iv,v,vi,2a-i.2b-i,ii,v,vi.2c-i,ii,iii.2e-i,ii,iii)
   a. ***Practice*** staining smears using Romanowsky dyes and/or Wright stain.
   b. ***Practice*** staining techniques according to established procedures:
      i. Manual
      ii. Automated
   c. ***Investigate*** staining problems using the troubleshooting process.
   d. ***Demonstrate*** the appropriate area of a peripheral blood smear to evaluate red blood cell morphology
   e. Differentiate between normal and abnormal RBC morphology
   f. Distinguish between normal and abnormal hematopoietic elements found within the peripheral blood
   g. ***Identify*** a normal red blood cell (RBC) on a stained slide. Describe (in words) the characteristics of a normal red blood cell.
   h. Explain the FUNCTION of the red blood cell in the body.
   i. Identify cells that are white blood cells (WBC) on a stained smear (not required to differentiate until next lab).
   j. ***Identify*** normal platelets on a stained slide.
   k. Understand the meanings and uses of the MCV, MCH, and MCHC on a Hematology analyzer report
   l. Define normochromic and normocytic as it pertains to red blood cells.
   m. ***Discuss*** the automated hemogram parameters used for erythrocyte evaluation:
      i. Hemoglobin
      ii. Hematocrit
      iii. mean cell volume (MCV)
      iv. Mean cell hemoglobin (MCH)
      v. Mean cell hemoglobin concentration (MCHC)
      vi. Red cell distribution width (RDW)
   n. Categorize red cells:
      i. Shape
      ii. Color
      iii. Inclusions
      iv. Distribution patterns
   o. ***Identify*** common RBC morphologies: hypochromia, polychromia, anisocytosis, poikilocytosis have acanthocytes, burr cells, sickle cells (drepanocytes), target cells, tear drop cells (dacryocytes) have stomatocytes, schistocytes, microcytosis, macrocytosis.)

24. **Lab #2**
    (1a-i.1b-ii,iii,iv,v,vi,2a-i.2b-i,ii,v,vi.2c-i,ii,iii.2e-i,ii,iii)
    a. List and define components of commonly used stains.
    b. ***Judge*** the acceptability of blood smears through microscopic evaluation and established criteria:
        i. Determine specimen acceptability
        ii. List appropriate anticoagulants
        iii. Identify acceptable ratio of anticoagulant to blood for specimens obtained from venipuncture and skin puncture
        iv. List reasons for rejecting specimens
    c. List red blood cell count and indices reference values that account for variations in gender and age.
    d. Correlate automated hemogram parameters with each other and with peripheral smear exam results
    e. Differentiate band neutrophils, segmented neutrophils, eosinophils, and basophils
    f. List morphologic features used to differentiate developing leukocytes
    g. ***Practice*** performing differential cell count on normal specimens
    h. Define lymphocytopenia.
    i. List approximate normal ranges for WBC, RBC, Hgb, Hct, Platelet.
    j. ***Read*** a CBC printout/report and interpret results. Given the reference ranges, determine if the patient's results are high, low, or normal.
    k. ***Identify*** RBCs, WBCs, and platelets on a slide.
    l. Differentiate the different WBCs on a slide: segmented neutrophils (segs), band neutrophils (bands), lymphocytes (lymphs), monocytes (monos), basophils (basos), and eosinophils (eos).
    m. Define leukocyte.
    n. Be able to describe (in words) the appearance/characteristics of the different WBCs (seg have band, lymph, mono, baso, eos).
    o. Define the requirements of a WBC differential.
    p. ***Perform*** a WBC differential on unknown slides and match the instructor within a given margin of error.
25. **Lab #3**
    (1a-i.1b-ii,iii,iv,v,vi,2a-i.2b-i,ii,v,vi.2c-i,ii,iii.2e-i,ii,iii)
    a. Independently read 3-5 slide differentials, matching the technologist within stated percentage.

Course Content

A general description of lecture/discussion topics included in this course are listed in the Learning Objectives / Specific Course Objectives sections of this syllabus.

Students in all sections of this course will be required to do the following:

1. Lecture Assignments
2. Lecture Quizzes
3. Lecture Exams
4. Lecture Final Exam
5. Pre-Lab Quizzes
6. Lab Assignments – in lab class
7. Post Lab Cases
8. Lab Practicals
9. Case Studies/Projects

Late assignments will be subject to a 15% penalty.

Methods of Instruction/Course Format/Delivery

This is a mainly online course so it will require a great deal of outside proactive work by the student. The instructor will provide guidance as needed. The student will be evaluated by assignments and quizzes outside of the classroom and during labs. The student will be required to come to a Panola College Testing Center to take all major examinations. Laboratories will take place on three pre-determined Saturdays during the semester and will be mandatory. During the laboratory the students will be evaluated by case studies, in-lab assignments, and lab practicals as assigned by the instructor.

Major Assignments/Assessments

The following items are assigned and assessed during the semester and used to calculate the student's final grade.

Course Grade

The grading scale for this course is as follows:

- **Lecture-- 2/3 of Final Grade**
  - Major Exams-- 40%
  - Quizzes-- 20%
  - Homework/Projects Assignments/Discussions-- 20%
  - Final Exam-- 20%
- **Laboratory— 1/3 of Final Grade**
  - Pre-Lab Quizzes-- 20%
  - Case Assignments/Projects-- 20%
  - In- Lab Assignments-- 40%
  - Practicals-- 20%

Texts Materials, and Supplies

Clinical Hematology	Required	9781496332288	Turgeon/6th	Wolters Kluer
Heme Notes	Required	9780803619029	Harmening/13th	FA Davis

Required Readings

Clinical Hematology, 6th Ed.	NO	Required	9781496332288
Heme Notes	NO	Required	9780803619029

Addendum

Laboratory Dates and Times:

Lab Information
υ Lab Dates:
υ September 21, 2024
υ October 26, 2024
υ November 9, 2024
υ December 7, 2024
υ Hematology Lab: 8:00am – 11:00am
υ Clinical Chemistry Lab: 11:00am - 1:00pm
υ Lunch Break: 1:00pm – 2:00pm
υ Clinical Micro Lab 2:00pm – 5:00pm
υ Immunohematology Lab: 5:00pm – 8:00pm

All Proctored Exams will require Proof of Identification

Other

- Courses conducted via video conferencing may be recorded and shared for instructional purposes by the instructor.
- For current texts and materials, use the following link to access bookstore listings: https://www.panolacollegestore.com.
- For testing services, use the following link: https://www.panola.edu/student-services/studentsupport/academic-testing-center.
- If any student in this class has special classroom or testing needs because of a physical learning or emotional condition, please contact the ADA Student Coordinator in Support Services located in the Charles C. Matthews Student Center or go to https://www.panola.edu/studentservices/student-support/disability-support-services for more information.
- Withdrawing from a course is the student's responsibility. Students who do not attend class and who do not withdraw will receive the grade earned for the course.
- Student Handbook: https://www.panola.edu/ (located on at the bottom under student)

SCANS Criteria

1. Foundation skills are defined in three areas: basic skills, thinking skills, and personal qualities.
    a. Basic Skills: A worker must read, write, perform arithmetic and mathematical operations, listen, and speak effectively. These skills include:
        i. Reading: locate, understand, and interpret written information in prose and in documents such as manuals, graphs, and schedules.
        ii. Writing: communicate thoughts, ideas, information, and messages in writing, and create documents such as letters, directions, manuals, reports, graphs, and flow charts.
        iii. Arithmetic and Mathematical Operations: perform basic computations and approach practical problems by choosing appropriately from a variety of mathematical techniques.
        iv. Listening: receive, attend to, interpret, and respond to verbal messages and other cues.
        v. Speaking: Organize ideas and communicate orally.
    b. Thinking Skills: A worker must think creatively, make decisions, solve problems, visualize, know how to learn, and reason effectively. These skills include:
        i. Creative Thinking: generate new ideas.
        ii. Decision Making: specify goals and constraints, generate alternatives, consider risks, and evaluate and choose the best alternative.
        iii. Problem Solving: recognize problems and devise and implement plan of action.
        iv. Visualize ("Seeing Things in the Mind's Eye"): organize and process symbols, pictures, graphs, objects, and other information.
        v. Knowing How to Learn: use efficient learning techniques to acquire and apply new knowledge and skills.
        vi. Reasoning: discover a rule or principle underlying the relationship between two or more objects and apply it when solving a problem.
    c. Personal Qualities: A worker must display responsibility, self-esteem, sociability, self management, integrity, and honesty.
        i. Responsibility: exert a high level of effort and persevere toward goal attainment.
        ii. Self-Esteem: believe in one's own self-worth and maintain a positive view of oneself.
        iii. Sociability: demonstrate understanding, friendliness, adaptability, empathy, and politeness in group settings.
        iv. Self-Management: assess oneself accurately, set personal goals, monitor progress, and exhibit self-control.
        v. Integrity and Honesty: choose ethical courses of action.
2. Workplace competencies are defined in five areas: resources, interpersonal skills, information, systems, and technology.
    a. Resources: A worker must identify, organize, plan, and allocate resources effectively.
        i. Time: select goal-relevant activities, rank them, allocate time, and prepare and follow schedules.
        ii. Money: Use or prepare budgets, make forecasts, keep records, and make adjustments to meet objectives.
        iii. Material and Facilities: Acquire, store, allocate, and use materials or space efficiently. Examples: construct a decision timeline chart; use computer software to plan a project; prepare a budget; conduct a cost/benefits analysis; design an RFP process; write a job description; develop a staffing plan.
    b. Interpersonal Skills: A worker must work with others effectively.
        i. Participate as a Member of a Team: contribute to group effort.
        ii. Teach Others New Skills.
        iii. Serve Clients/Customers: work to satisfy customer's expectations.
        iv. Exercise Leadership: communicate ideas to justify position, persuade and convince others, responsibly challenge existing procedures and policies.
        v. Negotiate: work toward agreements involving exchange of resources, resolve divergent interests.
        vi. Work with Diversity: work well with men and women from diverse backgrounds. Examples: collaborate with a group member to solve a problem; work through a group conflict situation, train a colleague; deal with a dissatisfied customer in person; select and use appropriate

leadership styles; use effective delegation techniques; conduct an individual or team negotiation; demonstrate an understanding of how people from different cultural backgrounds might behave in various situations.

c. Information: A worker must be able to acquire and use information.
    i. Acquire and Evaluate Information.
    ii. Organize and Maintain Information.
    iii. Interpret and Communicate Information.
    iv. Use Computers to Process Information. Examples: research and collect data from various sources; develop a form to collect data; develop an inventory record-keeping system; produce a report using graphics; make an oral presentation using various media; use on-line computer databases to research a report; use a computer spreadsheet to develop a budget.
d. Systems: A worker must understand complex interrelationships.
    i. Understand Systems: know how social, organizational, and technological systems work and operate effectively with them.
    ii. Monitor and Correct Performance: distinguish trends, predict impacts on system operations, diagnose deviations in systems' performance and correct malfunctions.
    iii. Improve or Design Systems: suggest modifications to existing systems and develop new or alternative systems to improve performance. Examples: draw and interpret an organizational chart; develop a monitoring process; choose a situation needing improvement, break it down, examine it, propose an improvement, and implement it.
e. Technology: A worker must be able to work with a variety of technologies.
    i. Select Technology: choose procedures, tools or equipment including computers and related technologies.
    ii. Apply Technologies to Task: understand overall intent and proper procedures for setup and operation of equipment.
    iii. Maintain and Troubleshoot Equipment: Prevent, identify, or solve problems with equipment, including computers and other technologies. Examples: read equipment descriptions and technical specifications to select equipment to meet needs; set up and assemble appropriate equipment from instructions; read and follow directions for troubleshooting and repairing equipment.