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HEMATOLOGY AND BLOOD TRANSFUSION

WHITE BLOOD CELLS

DEFINITION

- White cells found in blood due to the absence of hemoglobin produced by the BM and/or lymph nodes/lymphoid tissue

- **Reference values**
  - Total WBC - absolute
    - Adults -> 3 - 10 X 10^9/L
    - Neonate (fetus - term) –>1 - 25 X 10^9/L
    - Infant (1 year) -> 6 - 18 X 10^9/L
    - Child (4 - 7 years) -> 6 - 15 X 10^9/L
    - Child (8 - 12 years) –> 4.5 - 13.5 X 10^9/L

CLASSIFICATION

- Mononuclear cells
  - Lymphocytes
  - Monocytes
- Poly-morphonuclear cells
  - Neutrophils
  - Basophils
  - Eosinophils

DIFFERENTIALS

WBC	PERCENTAGE	COUNT (x 10^9/L)
NEUTROPHILS	40 -75%	2.5 – 7.5
LYMPHOCYTES	20 – 50%	1.5 – 3.5
MONOCYTES	2 – 10%	0.2 – 0.8
EOSINOPHILS	1 – 6%	0.1 – 0.6
BASOPHILS	0 – 1%	0 – 0.1

NEUTROPHIL

- 60-70% of all WBCs
- Anatomy
  - 10-12 microns in diameter
  - 3-5 nuclear lobes
  - Fine, pale inconspicuous granules
- Physiology
  - Respond first to bacteria
  - Damage by chemotaxis
  - Phagocytosis
  - After engulfing a pathogen releases several enzymes:
    - Lysozyme

EOSINOPHIL

- Large cytoplasmic granules that are orange-ish in color
- It has 2 nuclear lobes
- 2-4% of all WBCs
- Anatomy
  - 10-12 microns in diameter

BASOPHIL

- Large cytoplasmic granules that stain purplish indigo hence obscuring the visibility of the nucleus
- 0.5-1% of all WBCs
- Anatomy:
  - 8-10 microns in diameter
  - Bilobed or irregular nucleus

MONONUCLEAR CELLS/AGRANULAR LEUKOCTES

- Largest lymphocyte; abundant cytoplasm; folding of nucleus
- Anatomy
  - 14-19 microns
  - Indented or kidney-shape
  - Cytoplasm is foamy

LYMPHOCYTES

- They are small and large lymphocytes differentiated by their size and the amount of their cytoplasm
- 20-25% of all WBCs
- Anatomy
  - Either 7 microns or 15 microns
  - Nucleus is large and dark stained, round or indented
  - Cytoplasm forms a pale blue rim around the nucleus

FUNCTIONS OF LYMPHOCYTES (GENERALLY RESPONSIBLE FOR PROTECTION AGAINST INFECTIONS AND INFLAMMATIONS)

- Neutrophil:
  - 1st line of defense against acute infection
  - Main cell involved in acute inflammation
  - Actively motile, phagocytic and able to kill and digest many organisms
  - After engulfing a pathogen it releases many chemicals including lysozymes, strong oxidants and defensins which are easily measurable and detectable
- Eosinophil
  - Motile and phagocytic
  - Attracted to sites of antigen-antibody reactions and phagocytizes them
  - Main cell involved in allergies and parasitic infections
  - Release histamine

- Basophil
  - Not phagocytic
  - Found in association with eosinophils
  - Mature into mast cells and release histamine, heparin, and serotonin stimulate inflammation
  - Involved in hyper-sensitivity reaction
- Lymphocytes:
  - Motile and play a key role in the immunological functions of the body.
    - T cells (thymus-dependent)
      - Majority; involved in CMI
    - B cells
      - Synthesis of immuno-globulins and antibodies.
- Monocytes
  - Enlarge and differentiate into fixed and wandering macrophages
  - Phagocytize bacteria and protozoa
  - In severe malaria one will have monocytosis
  - Acts as scavenger cells removing microbes and cellular debris
  - Contribute to immunologic functions of the body

WHITE CELL DISORDERS

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CASE 1

- A 7 year old presents with a swollen jaw for a week; the mass rapidly increase in size after attempted dental extraction; the cervical lymph nodes are enlarged
- Lab tests?
  - Total blood count
    - WBC of 25 X 10^9/L
    - Hb - 8 g/dL
    - Platelet - 100X10^9/L
  - Differential WBC count
    - Neutrophils – 80%
    - Lymphocytes – 15%
    - Monocytes – 3%
    - Eosinophils – 1%

WHITE CELL CHANGES

- Quantitative or qualitative
- Affect the granulocytic and non-granulocytic series
- Reactive and neoplastic changes

OBJECTIVES

- Classify leukocyte disorders
- Describe the causes of the disorders
- Describe the pathogenesis, lab investigations, findings and interpretation
- Link the findings to clinical conditions, leukemoid reaction
- Classify leukemias, lab findings and investigations

DISORDERS

- They are based on either
  - Qualitative (rare) – to assess these one could do cytokine assays or viewing under the microscope; For CD4+ cells, **Ellispot** test is done.
    - Functional
    - Morphological
  - Quantitative
    - Neutrophilia
    - Eosinophilia
    - Monocytosis
    - Lymphocytosis
    - Eosinophilia
    - Neutropenia
    - Lymphopenia

NEUTROPHILIA

- Infections (bacterial)
- Tissue injury – burns, surgery, infarct
- Hemorrhage/Hemolysis
- Malignant neoplasia
- Stress – convulsions, labor
- Inflammation – gout, arthritis, RF
- Metabolic emergencies – DKA, uraemia
- Corticosteroid use

EOSINOPHILIA

- Allergies
- Parasites especially Ascaris
- Tumor necrosis + Hodgkin`s lymphoma
- Collagen disease
- Dermatological disease – psoriasis, pemphigus
- Tropical eosinophilia

MONOCYTOSIS

- Chronic bacteria infection – TB, brucella, syphilis
- Parasites – leishmania donovani, Trypanosomiasis, Malaria
- Leukemia/lymphoma – Hodgkin`s Lymphoma, CLL, AML
- Granulomatous disease – Sarcoidosis, ulcerative colitis.

LYMPHOCYTOSIS

- Infectious mononucleosis
- Pertussis
- Viral infections – granulomas + EBV, CMV, infectious hepatitis
- Chronic bacteria infection
- Chronic lymphocytic leukemia, Non-hodgkins lymphoma
- Thyrotoxicosis

NEUTROPENIA

- BM failure
- Overwhelming sepsis
- Leukemia
- Infections
- Drugs – antibiotics, NSAIDs, chemicals, cytotoxics
- Megaloblastic anemia
- Hypersplenism

LYMPHOPENIA

- Thymic hypoplasia
- High dose steroids
- Low CD4 in AIDS
- Viral infections
- Advance Hogkins lymphoma
- Miscellaneous – DXT, Terminal renal failure

BASOPHILIA

- Chronic mylogenous Leukaemia (CGL
- Recovery phase of acute infection/inflammation
- Primary proliferative polycythaenia (PPP)
- Miscellaneous – lymphoma,myxoedema, chicken and small pox, hypersensitivity reactions

Leukamoid Reaction

Definition – when a leukocytosis is so marked that it mimics blood findings of leukaemia

- =total wbc > 50 x 109/l

Leukamoid (contd)

- Causes;
- 1 – Acute infections especially in childrens like
- TB, pneumonia, meningitis, pertussis
- 2 – Intoxications eg eclampsia, severe burns, mercury poisoning
- 3 – Malignancies with b.marrow metastases
- 4 – Severe haemorrhage/haemolysis

Leukamoid (contd)

- Laboratory features;
- 1 – TBC –v.high wbc >50
  raised Plt
- 2 – PBF –lymphocytic/granulocytic or both
  If granulocytic then left-shifted
  toxic granulations & Dohle bodies in
  neutrophils
  nucleated rbcs raised

Leukamoid (contd)

- Lab. Features
- 3 – NALP – score raised-

SUMMARY: LAB METHODS OF EVALUATING WBCS

- Complete blood count (CBC)
- Peripheral blood film (PBF)
- Buffy coat preparation - severely myelo-suppressed patients
- BMA (Bone Marrow Aspiration)
- Fine Needle Aspiration of an enlarged gland