Introduction to Haematology

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Suggested reading

“Haematology at a Glance”
Atul Mehta & Victor Hoffbrand
Second Edition

Published by – Blackwell Science
ISBN 0-632-04793-3
Scope of Haematology

- Haematopoiesis
- Inherited and acquired anaemias
- Bone marrow failure
- Benign disorders of white cells
- Haematological malignancies
  - leukaemia, lymphoma, multiple myeloma
- Platelets, blood coagulation and haemostasis
- Blood transfusion
- Cytogenetics, flow cytometry, chemotherapy and stem cell transplantation

Haematology

- Study of blood and the blood forming elements (bone marrow, spleen, lymph nodes)
- Blood consists of cells (red cells, white cells, platelets) and plasma
- Plasma without fibrin is called serum (clotted blood)
Functions of Blood

- To deliver hormones, nutrients and oxygen to tissues
- To collect and dispose of waste from cellular metabolism
- To deliver specialised cells to tissues for protection against the external environment
- To prevent loss by coagulation when there is a breach in the vessel wall
Haematopoiesis

- Process by which blood cells are made
- Foetus - yolk sac, liver, spleen
- Infant - bone marrow (all bones)
- Adults - bone marrow (central skeleton)
- Liver and spleen can take over haematopoiesis in later life when there is marrow replacement (e.g. myelofibrosis)

Erythrocytes (red blood cells)

- Contain Hb which enables O₂ transport
- Erythropoietin controls red cell production
- Main source of energy is ATP (glycolytic pathway)
- Membrane is a bipolar lipid layer
- 10-15% of red cells die in the marrow (ineffective erythropoiesis) – this is increased in certain diseases e.g. thalassaemia
Erythropoietin (Epo)

- Controls production of red cells
- Produced in the peritubular complex of the kidney (90%) and the liver (10%)
- Epo stimulates red cell precursors to proliferate, differentiate and produce Hb
- Epo production is stimulated by decreased $O_2$ supply to the kidney receptor

Measurement of Erythropoiesis

- In their development, red cell precursors become smaller, lose their nuclei and develop Hb
- Reticulocytes are immature red cells which retain some RNA (stainable by supra-vital stains)
- Reticulocyte count increased with:
  - Haemorrhage
  - Haemolysis
  - Haematinic therapy
Erythropoiesis

[Diagram showing the developmental pathway of erythropoiesis from stem cells to Reticulocyte: Stem cell (Hemocytoblast) → Committed cell (Proerythroblast) → Developmental pathway (Phase 1: Ribosome synthesis, Phase 2: Hemoglobin accumulation, Phase 3: Ejection of nucleus) → Early erythroblast → Late erythroblast → Normoblast → Reticulocyte → Erythrocyte]

Reticulocyte
Platelets

- Stem cell $\rightarrow$ Megakaryocyte $\rightarrow$ Platelet
- Thrombopoietin
  - Produced in the liver
  - Increases megakaryocyte numbers
  - Increases divisions per megakaryocyte
- Platelet
  - Live for 10 days
  - 1 – 2 μ in diameter
  - Normal count $= 140 – 400 \times 10^9/l$

Megakaryocyte
Granulocytes

- Myeloblast $\rightarrow$ promyelocyte $\rightarrow$ myelocyte
  $\rightarrow$ metamyelocyte $\rightarrow$ mature granulocyte (neutrophil, eosinophil, basophil)

Granulocyte granules
  Primary
  Secondary

White Cell Function

- Protect body against infection

- Granulocytes and monocytes are phagocytes which ingest foreign organisms

- Phagocytes attracted to areas of infection by chemotactic substances
Neutrophils

- Most numerous white cell in adults
- Remains in circulation for 10 hours
- 50% of neutrophils attached to vessel wall (marginated pool)
- Enter tissues by responding to chemotaxis
- Have adhesion molecules on cell surface which react with endothelium
- Functions: migration, phagocytosis, killing
Lymphocyte

Common lymphoid stem cell gives rise to:
- NK cells
  - ~ 5% of lymphocytes in blood
- B cells
  - ~20% of lymphocytes in blood
  - Involved in humoral immunity (antibody production)
  - Mature in the bone marrow
- T cells
  - ~ 70% of lymphocytes in blood
  - Involved in cell mediated immunity
  - Mature in the thymus
  - T helper (CD4), T suppressor (CD8)
Monocyte

Monocytes

- Largest white cells in blood
- Circulate for 20-40 hours then enter tissues
- Remain in tissues for days or months
- Often increased in chronic infections such as TB
- Part of the reticuloendothelial system
Eosinophil

- Interleukin 5 controls production
- Bilobed nucleus
- Red orange staining cytoplasmic granules
- Increased with allergy and parasitic infestation
- Granules contain histamine
Basophil

- Related to mast cells in tissues
- Least numerous cells in peripheral blood
- Large dark purple granules which obscure nucleus
- Granules contain histamine and heparin