**HAEMATOLOGY 1  
DIAGNOSTIC PARAMETERS  
TERMINOLOGY AND REFERENCE RANGES**

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**PHYSIOLOGY**

**OBJECTIVES**

The student should be able to explain the origin, function and approximate intravascular life span of red cells, neutrophils and platelets and the function of monocytes, eosinophils and lymphocytes

The red cells, granulocytes, monocytes and platelets that circulate in the blood are produced in the bone marrow, being ultimately derived from multipotent haemopoietic stem cells. Red cells are produced under the influence of erythropoietin, which is mainly synthesized in the kidney; reduced oxygen supply to the kidney is a stimulus to erythropoietin synthesis. Bone marrow production of granulocytes and monocytes is under the influence of multiple cytokines such as the interleukins and granulocyte- and granulocyte-macrophage colony stimulating factors (G-CSF and GM-CSF). The production of platelets is under the influence of thrombopoietin. The main function of red cells is oxygen transport by haemoglobin. Oxygen delivery is facilitated by the sigmoid oxygen dissociation curve and by the fact that a lower pH, as in metabolically active tissues, lowers the oxygen affinity of haemoglobin and facilitates downloading of oxygen to tissues. Other functions of haemoglobin include transport of carbon dioxide and of nitric oxide. Haemoglobin also acts as a buffer.

The functions and life span of important blood cells are shown in the following table.

|  |  |  |
| --- | --- | --- |
| **Cell** | **Approximate intravascular life span** | **Major function** |
| Erythrocyte (red cell) | 120 days | Oxygen transport |
| Neutrophil | 7-10 hours | Defence against infection by phagocytosis and killing of micro-organisms |
| Monocyte | Several days | Defence against infection by phagocytosis and killing of micro-organisms |
| Eosinophil | A little shorter than neutrophil | Defence against parasitic infection |
| Lymphocyte | Very variable | Humoral and cellular immunity |
| Platelet | 10 days | Haemostasis |

###### TERMINOLOGY and THE CONCEPT OF NORMAL RANGES

**OBJECTIVES** Like many specialized subjects, haematology has its own specialised language. You need to be able to interpret this. You also need to understand how normal ranges are devised and how they are used to interpret blood counts.

The student should therefore be able to

* Recognize the terms commonly used in describing abnormalities in blood counts and films and explain what they mean
* Explain how to assess whether the result of a laboratory test is normal or abnormal

v HAEMATOLOGICAL TERMS — during this course you should learn what they mean and be able to explain this when you see them used in context, e.g. in a blood count report.

Write your answers in the boxes below

|  |  |
| --- | --- |
| **anisocytosis** |  |
| **poikilocytosis** |  |
| **microcyte** |  |
| **microcytic anaemia** |  |
| **microcytosis** |  |
| **macrocyte** |  |
| **macrocytic anaemia** |  |
| **macrocytosis** |  |
| **normochromic** |  |
| **normocytic** |  |
| **hypochromic** |  |
| **hypochromia** |  |
| **polychromasia** |  |
| **elliptocyte** |  |
| **spherocyte** |  |
| **target cell** |  |
| **sickle cell** |  |
| **fragment** |  |
| **rouleaux** |  |
| **agglutination** |  |
| **Howell-Jolly body** |  |
| **leucocytosis** |  |
| **leucopenia** |  |
| **neutrophilia** |  |
| **neutropenia** |  |
| **lymphocytosis** |  |
| **atypical lymphocyte** |  |
| **eosinophilia** |  |
| **monocytosis** |  |
| **thrombocytosis** |  |
| **thrombocytopenia** |  |
| **toxic granulation** |  |
| **left shift** |  |
| **hypersegmented neutrophil** |  |
| **reticulocytosis** |  |

**THE CONCEPT OF ‘NORMAL’ RANGES AND INTERPRETATION OF LABORATORY TESTS**

All you **HAVE** to know is

* Normal ranges conventionally describe the results observed in 95% of a healthy population
* Results falling outside the reference range are **PROBABLY** abnormal.

The second of these two statements is something of an oversimplification. The following will give you a better understanding of how normal ranges are derived and how they are used to interpret test results on patients.

**REFERENCE RANGES**

Reference ranges are descriptions of data derived from a sample of a reference population. A reference population has characteristics that have been carefully defined with regard to age and gender and, when relevant, other variables such as state of health, ethnic origin and physiological status (pregnant or not). In addition to these factors, haematological variables are also affected by altitude, cigarette smoking, alcohol intake and whether a tourniquet has been applied for a long time before taking the blood sample.

Reference ranges are commonly given as 95% ranges, i.e. figures that encompass 95% of the data from the reference sample. This is usually the central 95% of the data, i.e. 2.5% of data are excluded at each end of the range. If data have a Gaussian distribution the mean plus and minus 2 standard deviations gives a 95% range. Figure 1 (below) is a histogram of haemoglobin concentrations in 100 healthy women showing a Gaussian distribution.

If data has a non-Gaussian distribution then mathematical transformation of the data is required before analysis. For example, white cell counts have a logarithmic distribution and the mean and standard deviation of the logarithms of the data must be calculated in order to determine the geometric or log mean and the 95% range (Figure 2).

A ’normal range’ is a less strictly defined term than a ‘reference range’. ‘Normal range’ is generally used to mean a range derived from a healthy reference population. Another useful concept is a ‘health-related range’. For some laboratory measurements a 95% range derived from an **apparently** healthy population will include data from patients with a high risk of subsequently developing significant disease. This is so, for example, for measurements of cholesterol concentration. If subjects representing the upper 20% of data have a high risk of developing clinically evident coronary artery disease then it is more relevant to interpret data in the light of whether a laboratory result is predictive of future good health rather than whether it falls within the 95% limits for apparently healthy people.

The following **IMPORTANT POINTS** should be remembered when interpreting laboratory data:

* **A value within the normal range may be abnormal for that individual.** For example, a man whose Hb is usually 16.5 g/dl may suffer a gastrointestinal haemorrhage with a fall of Hb to 14 g/dl which is still within the normal range but is abnormal for him. If previous test results are available from a given individual it is always relevant to consider these when deciding if a result is likely to be abnormal for that particular person.
* **A value outside the normal range may be normal for that individual.** By definition, test results of 5% of healthy subjects are likely to fall outside the ‘normal range’ and if healthy subjects have multiple tests performed there are bound to be one or two which are ‘abnormal’.
* **Reference ranges for healthy and sick individuals usually overlap.** Calculating reference ranges representing 99% of the population reduces the chance of misclassifying a test result on a healthy subject as abnormal but there will be more abnormal results that are not recognised as such.
* **Some haematological variables are dependent on the precise instrument or methodology used.** It is therefore best to use a reference range derived for a particular instrument/method. Those given on the next page relates to a particular instrument. Results from various hospitals may differ slightly.

**Figure 1**

#### 

**Table 1**

**95% RANGES FOR CAUCASIAN ADULTS**

**Males Females**

WBC 3.6-9.2 x 109/l 3.5-10.8 x 109/l

RBC 4.25-5.77 x 1012/l 3.82-4.98 x 1012/l

Hb 13.5-16.9 g/dl 11.5-14.8 g/dl

PCV (Hct) 0.41-0.51 0.36-0.46

MCV 84-99 fl

MCH 27.5-32.7 pg

MCHC 30.9-34.8 g/dl

Platelet count 143-332 x 109/l 169-358 x 109/l

Neutrophils 1.7-6.1 x 109/l 1.7-7.5 x 109/l

Lymphocytes 1.0-3.5 x 109/l

Monocytes 0.2-0.6 x 109/l

Eosinophils 0.03-0.46 x 109/l

Basophils 0.02-0.09 x 109/l

Reticulocytes 20-130 x 109/l

**Figure 2**

**Table 2**

**95% RANGES FOR AFRICAN OR AFRO-CARIBBEAN**

**ADULTS** (when different from above)

**Males Females**

**Afro-Caribbean**

WBC 2.8-9.5 x 109/l 3.3-9.85 x 109/l

Neutrophils 1.0-5.8 x 109/l 1.4-6.5 x 109/l

Platelets 122-313 x 109/l 149-374 x 109/l

**African**

WBC 2.8-7.2 x 109/l 3.2-7.8 x 109/l

Neutrophils 0.9-4.2 x 109/l 1.3-4.2 x 109/l

Platelets 115-290 x 109/l 125-342 x 109/l

**Note:**

To revise terminology and see illustrations of all these abnormalities you can use the two CAL packages or Beginner’s Guide to Blood Cells.