The identification of mature and immature blood cells in peripheral blood smears and bone marrow preparations is fundamental to the laboratory diagnosis of haematological disorders. Here, you may review the mature and immature white cells to gain more practice and confidence in their identification. Immature cells are found in peripheral blood in leukaemia.

Modified to printer-friendly form from Queensland University of Technology, Our Medical Science pages & University of California Davis School of Medicine

### Granulocytes

#### Bone Marrow

**Myeloblast**
- Cell size: 15 - 20 μm
- N:C ratio: High (80%) or more nucleoli
- Cytoplasm: Medium blue colour, medium rim
- Nucleus: Fine chromation, one or more nucleoli
- Note: Blast cells of each series are difficult to specifically identify morphologically, immunological markers and cytochemistry are used to identify specific blasts.

**Promyelocyte**
- Cell size: 15 - 25 μm
- N:C ratio: High (70%); decreasing
- Cytoplasm: Development of primary (non-specific) granules which are coarse, red-purple and may overlie both nucleus and cytoplasm
- Nucleus: Slight clumping nucleoli still visible
- Note: Promyelocytes are morphologically most variable.

**Myelocyte**
- Cell size: 12 - 23 μm
- N:C ratio: High
- Cytoplasm: Development of secondary (specific) granules, some primary granules may be visible
- Nucleus: Oval or round, further clumping, nucleoli no long visible
- Note: The term myelocyte infers it is a neutrophil myelocyte, also found are eosinophil myelocytes and basophil myelocytes.

**Eosinophil myelocyte**
- Cell size: 12 - 23 μm
- N:C ratio: 60 - 50%, decreasing
- Cytoplasm: Development of secondary (specific) granules (orange-brown colour), some primary granules may be visible
- Nucleus: Oval or round, with further clumping, nucleoli no long visible
- Note: When seen, indentation of nucleus (orange-brown), blue cytoplasm (often not seen)

**Basophil myelocyte**
- Cell size: 12 - 23 μm
- N:C ratio: High
- Cytoplasm: Development of secondary (specific) granules (overly nucleus), some primary granules may be visible
- Nucleus: Oval or round, further clumping, nucleoli no long visible
- Note: Very early basophil myelocyte on the left, later basophil myelocyte on the right (with a myelocyte).

**Myelocyte**
- Cell size: 12 - 15 μm
- N:C ratio: Ratio more reduced, 40%
- Cytoplasm: Some similar to mature cell
- Nucleus: Indentation of nucleus begins, heavy chromatin clumping, nucleoli not visible

**Eosinophil metamyelocyte**
- Cell size: 12 - 15 μm
- N:C ratio: Ratio more reduced, 40%
- Cytoplasm: Similar to mature cell
- Nucleus: Segmentated nucleus (normal up to 5 lobes)

**Basophil metamyelocyte**
- Cell size: 12 - 15 μm
- N:C ratio: Ratio more reduced 30 - 40%
- Cytoplasm: Development of secondary (specific) granules, some primary granules may be visible
- Nucleus: Oval or round, further clumping, nucleoli no long visible
- Note: Also referred as "band forms" or "stab cells".

#### Peripheral Blood

**Left - Nonsegmented neutrophil**
- Cell size: 10 - 16 μm
- N:C ratio: Ratio more reduced 30 - 40%
- Cytoplasm: Similar to mature cell
- Nucleus: Curved, without distinct lobes
- Note: Also referred as "band forms" or "stab cells".

**Right - Segmented Neutrophil**
- Cell size: 10 - 16 μm
- N:C ratio: Ratio more reduced 20 - 30%
- Cytoplasm: Fine specific granules, pink-tan cytoplasm
- Nucleus: Segmentated nucleus (normal up to 5 lobes)

**Eosinophil**
- Cell size: 10 - 16 μm
- N:C ratio: Ratio 30%
- Cytoplasm: Prominent specific granules (orange-brown), blue cytoplasm (often not seen)
- Nucleus: Segmentated nucleus, usually two lobes

**Basophil**
- Cell size: 10 - 14 μm
- N:C ratio: Ratio 30%
- Cytoplasm: Large irregular dark purple-black granules. These granules may dissolve during staining to give a "washed out" appearance as seen in the basophil on the right.
- Nucleus: Usually masked by granules, may be bilobed or non segmented.

### Monocytes

#### Bone Marrow

**Monoblast**
- Cell size: 12 - 20 μm
- N:C ratio: High (80%)
- Cytoplasm: Medium blue colour, cytoplasm frequently irregular with pseudopods
- Nucleus: Fine chromation, one or more nucleoli
- Note: Blast cells of each series are difficult to specifically identify morphologically, immunological markers and cytochemistry are used to identify specific blasts.

**Promonocyte**
- Cell size: 12 - 20 μm
- N:C ratio: 60 - 40%
- Cytoplasm: Medium blue-grey colour, cytoplasm frequently irregular with pseudopods
- Nucleus: Lace like chromatin, 1 or 2 nucleoli, nucleus elongated, folded.

#### Peripheral Blood

**Monocyte**
- Cell size: 12 - 20 μm
- N:C ratio: 50% or less.
- Cytoplasm: Blue-grey cytoplasm, fine red-purple granules may be seen. Vacuoles often present.
- Nucleus: Convoluted or kidney shaped, rarely round oval or band.
### Bone Marrow

<table>
<thead>
<tr>
<th>Lymphoblast</th>
<th>Prolymphocyte</th>
<th>Megakaryoblast</th>
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</table>
| **Cell size**: 15-20 µm  
**N:C ratio**: 90-80 %  
**Cytoplasm**: Medium blue, sometimes with a darker blue border  
**Nucleus**: Round or oval, delicate chromatin. Nucleoli 1-2  
**Note**: Blast cells of each series are difficult to specifically identify morphologically, immunological markers and cytochemistry are used to identify specific blasts. | **Cell size**: 15-18 µm  
**N:C ratio**: 80-60 %  
**Cytoplasm**: Medium blue, sometimes with a rim of darker blue  
**Nucleus**: Oval, condensed chromatin. Nucleoli 0-1  | **Cell size**: 15-20 µm  
**N:C ratio**: High, ratio 90-80 %  
**Cytoplasm**: Relatively small amount, iron granular, basophilic (intensely)  
**Nucleus**: Large oval, kidney shaped nucleus, fine chromatin structure, several nucleoli  
**Note**: Blast cells of each series are difficult to specifically identify morphologically, immunological markers and cytochemistry are used to identify specific blasts. |

### Peripheral Blood

<table>
<thead>
<tr>
<th>Lymphocyte</th>
<th>Reticulocyte</th>
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| **Cell size**: 8-15 µm (small, intermediate and large)  
**N:C ratio**: Ratio 80 % small, 50 % large  
**Cytoplasm**: Blue cytoplasm, paler in large lymphocytes. Clusters of azurophilic granules may be seen (see note).  
**Nucleus**: Round, dense chromatin. Nucleus may be clefted. Nucleoli are occasionally visible in mature lymphocytes.  
**Note**: In high magnification, the cytoplasmic cluster of dark granules in the lymphocyte in picture 3 actually seem to lie in a ‘vacuole’, i.e. it might represent a monula of Human Monocytic Ehrlichia !  
Single Ehrlichia are often seen in the cytoplasm of leukaemia cells inoculated with Ehrlichia, see CDC, Google. Tick bites are very common. New facts are that Ehrlichia species are found in ticks all over the world and that most Ehrlichia infections probably go unnoticed, only causing other infections, because of immune inhibition - it is very likely, also in previous eras, that inclusions of Ehrlichia were found now and then in WBCs, but nobody knew what it was and considered it to be a normal finding, just because it was so common ? | **Cell size**: ~7 µm  
**N:C ratio**: 40%  
**Cytoplasm**: moderate 1 acidophilia  
**Nucleus**: extruded at the orthochromatic stage. Reticulocytes are positively identified with supravital dyes (precipitating E.R.)  
**Note**: biconcave cell shape |

| Erythroblast | Basophilic (8%)  
**Cell size**: 15-20 µm  
**N:C ratio**: 75%  
**Cytoplasm**: intense dark blue (basophilic)  
**Nucleus**: Large round, chromatin slight clumping, nucleoli may not be visible | **Polychromatric (17,5%)**  
**Cell size**: ~ 15-18 µm  
**N:C ratio**: 60%  
**Cytoplasm**: slight basophilia  
**Nucleus**: Large round, chromatin darker, more condensed | **Orthochromatic (2.5%)**  
**Cell size**: ~ 10-15 µm  
**N:C ratio**: 40%  
**Cytoplasm**: slight acidophilia  
**Nucleus**: small, very dark blue-black (pyknotic)  |

### Tissues

| Plasma cell (in):  
**Cell size**: 8-20 µm  
**N:C ratio**: Ratio 40-30%  
**Cytoplasm**: Cytoplasm stains dark blue, with a lighter area near the nucleus (perinuclear halo)  
**Nucleus**: Round, eccentric (off centre) | **Bone Marrow**  
**Cell size:** ~ 15-20 µm  
**N:C ratio**: Ratio 90-80 %  
**Cytoplasm**: Relatively small amount, iron granular, basophilic (intensely)  
**Nucleus**: Large oval, kidney shaped nucleus, fine chromatin structure, several nucleoli  
**Note**: Blast cells of each series are difficult to specifically identify morphologically, immunological markers and cytochemistry are used to identify specific blasts. | **Peripheral Blood**  
**Cell size**: ~2-5 µm  
**N:C ratio**: ~40%  
**Cytoplasm**: Anuclear cytoplasmic fragments of a promegakaryocyte, staining pale blue; smaller platelets tend to be older, while large platelets tend to be young.  
**Note**: Platelets are highly variable, round-oval

### Thrombocytes / Platelets

**Cell size**: 2-5 µm

### Erythrocytes

**Cell size**: ~5 µm

### Normal distribution of white blood cells in peripheral blood:

- Neutrophile (granulocytes) 40-75%
- Lymphocytes 20-45%
- Monocytes 2-8%
- Eosinophile 1-4%
- Basophile 0-1%
Howell-Jolly bodies
Also known as: Howell’s bodies, Jolly’s bodies. Associated persons: William Henry Howell, Justin Marie Jolly
Description:
Spherical granules, 1-2 µ, seen in erythrocytes in slides of stained blood. They are thought to be nuclear particles. The bodies are seen in cases of congenital absence of the spleen; following splenectomy, in haemolytic anaemia, in pernicious anaemia, in thalassaemia, and in leukaemia.

Bibliography: