

Revisit Basic Blood and Hematopoiesis

SESSION OBJECTIVES:

Use these session objectives to test your knowledge of the important concepts presented in this chapter and as study topics to return to prior to your exams.

1. Recognize the cells present in peripheral blood and bone marrow by morphologic review.
2. Identify abnormal red blood cell morphology and understand how abnormal red blood cell morphology reflects underlying disease conditions.
3. Explain how to approach the evaluation of bone marrow histopathology to identify abnormal features.

OPTIONAL PRE-CLASS MATERIALS FOR THIS SESSION:

- Revisit these chapters of your histology workbook:
 - [Blood](#)
 - [Histology of Hematopoiesis and Peripheral Blood](#)
- This is an excellent resource to see various blood disorders: <https://medtraining.org/ltac3/Account/training.aspx?tr=92>
 - Login: LoginUW
 - Password: UW
 - Go to Disease Associations tab: Examine red and white blood cells affected by various disorders/diseases.
- Free online resource of [hematologic cytology](#)
- In class exercise: [PathPresenter](#)

A brief forward: This Pressbooks chapter both reviews and expands your hematopathology knowledge from the FMR and I&I Block. Many thanks to Dr. Corliss Newman, MD and Dr. Cat Pittack, PhD for contributing this material.

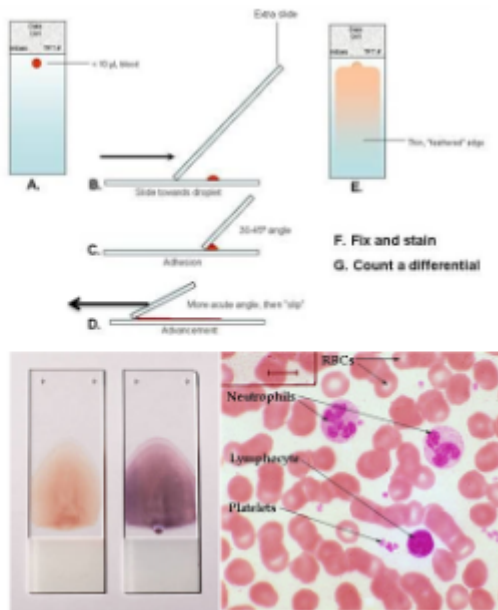
OVERVIEW:

The course pack will cover objectives 1 and 2. The lecture material will cover all 3 objectives. This includes a brief review of information covered in FMR, which you need to clearly understand to follow what we talk about in the Blood part of Blood/Cancer/Hormones!

BLOOD SMEAR PREPARATION:

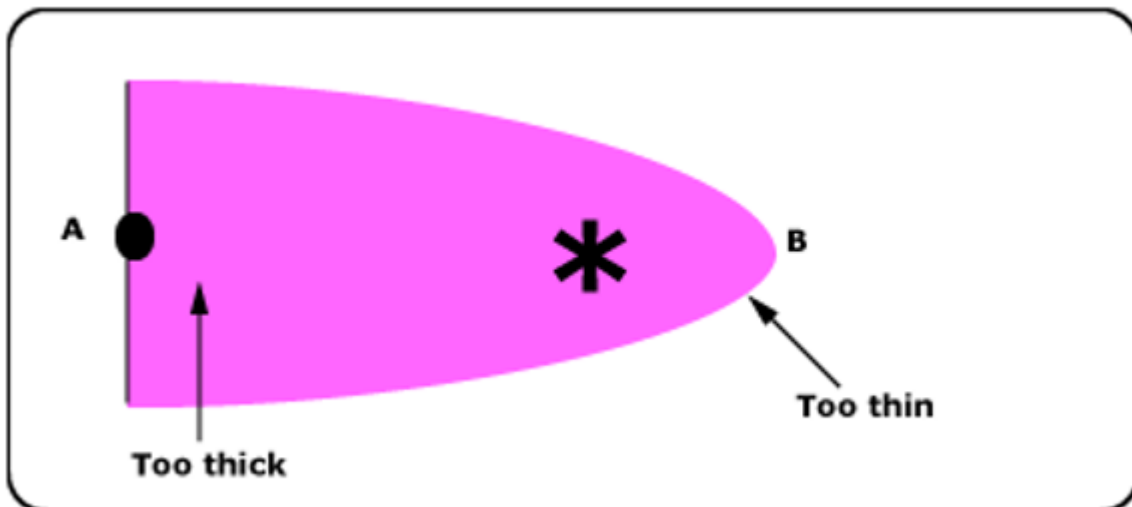
This schematic below depicts a well-made peripheral blood smear. A drop of blood is placed on the left-hand side of a clean glass slide at point A; a 2nd slide has then been brought into contact with that drop of blood and has been pushed towards the right, stopping at point B. As the 2nd slide is pushed towards the right, the blood behind that slide smears out behind the slide.

- Draw blood from a finger prick into a tube treated with an anticoagulant (EDTA).
- Place a small blood drop on a microscope slide and spread it out using a second slide.
- The smear or film is dried, fixed, and stained (with Wright's stain or others).
 - Acidic cell components stain blue and purple (basophilic)
 - Basic components stain pink (eosinophilic)



BLOOD SMEAR EXAMINATION:

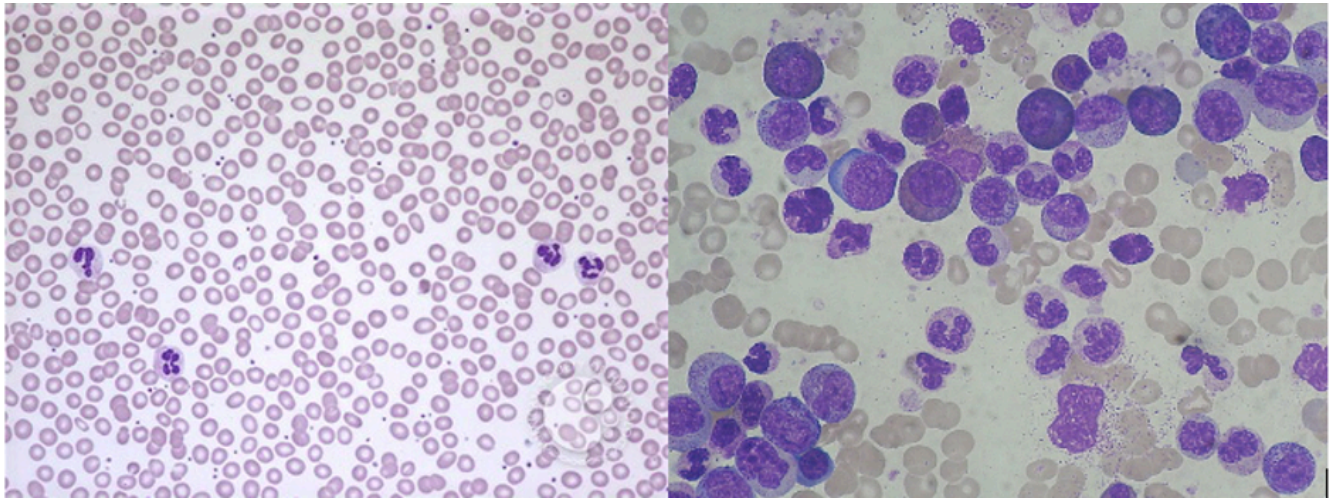
If you were to review the area near point A (below), it would be too thick and too darkly stained for interpretation, whereas the area at the very end of the smear, near point B (the “feather edge”) would be too thin, distorting the morphology of all cells in that area. The optimal area for viewing is just behind point B (shown by the asterisk), in an area where the red blood cells are just touching and demonstrate central pallor.



Once you have found the proper area of the smear to review (where red blood cells, RBCs) are individually separated from one another and fairly uniformly dispersed), you are ready to begin. Start at low magnification

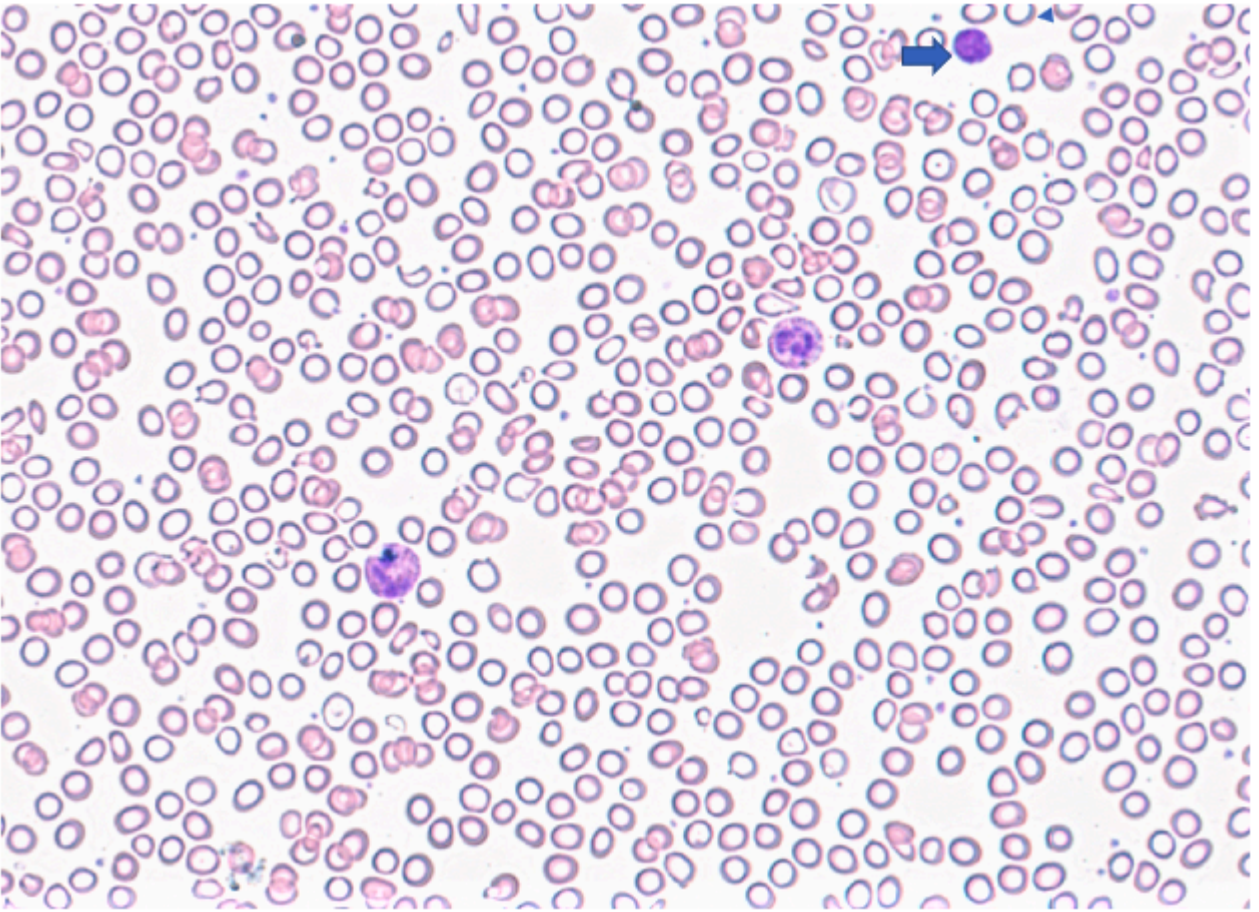
to assess the white blood cell (WBC) to RBC ratio. A high WBC count may indicate leukemia, while a low count suggests deficiency.

Below you will find several smears to examine. The left image (at low magnification) shows a microscopic view of a normal adult blood smear, while the right image (at high magnification) shows a blood smear from a patient with [chronic myeloid leukemia](#).



RED BLOOD CELL EXAMINATION:

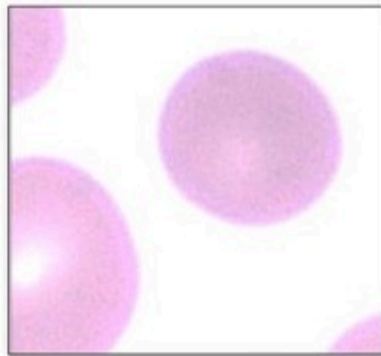
Generally, the first cell line one looks at when reviewing a blood smear are the RBCs. We look at the shape as well as how much of the cell is filled with hemoglobin. An RBC generally demonstrates central pallor of an area approximately 1/3 of the diameter of the RBC. If more than 1/3 of the RBC is pale (white) and not red, that can be indicative of iron deficiency.



Red blood cell morphology: RBCs can have various shapes, as outlined below, which can be indicative of underlying disorders. When RBCs have multiple different shapes on a blood smear, we call this “poikilocytosis”. Examples of variant RBC shapes include:



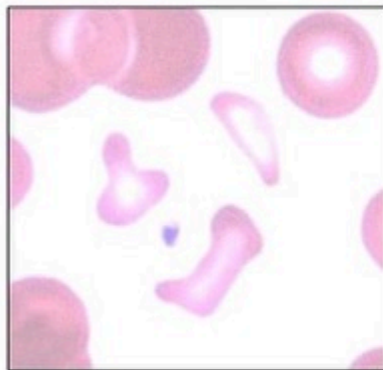
Elliptocyte



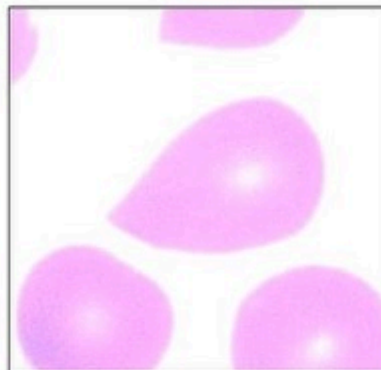
Spherocyte



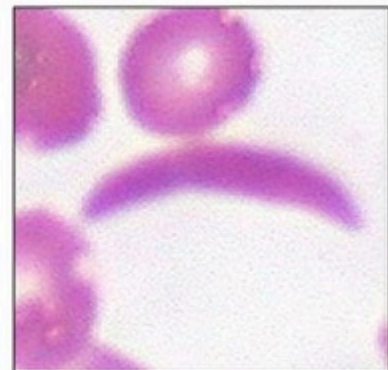
Stomatocyte



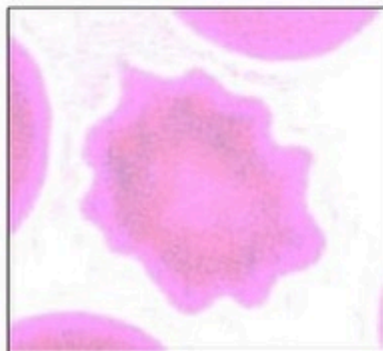
Schistocytes



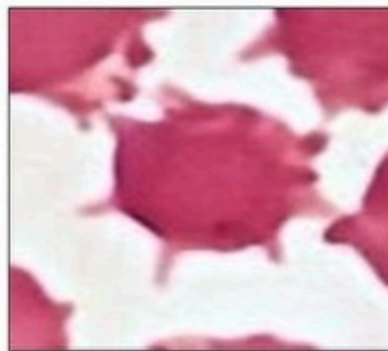
Tear drop cell
(dacryocyte)



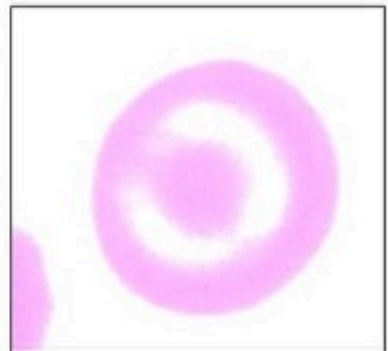
Sickle cell



Burr cell
(echinocyte)



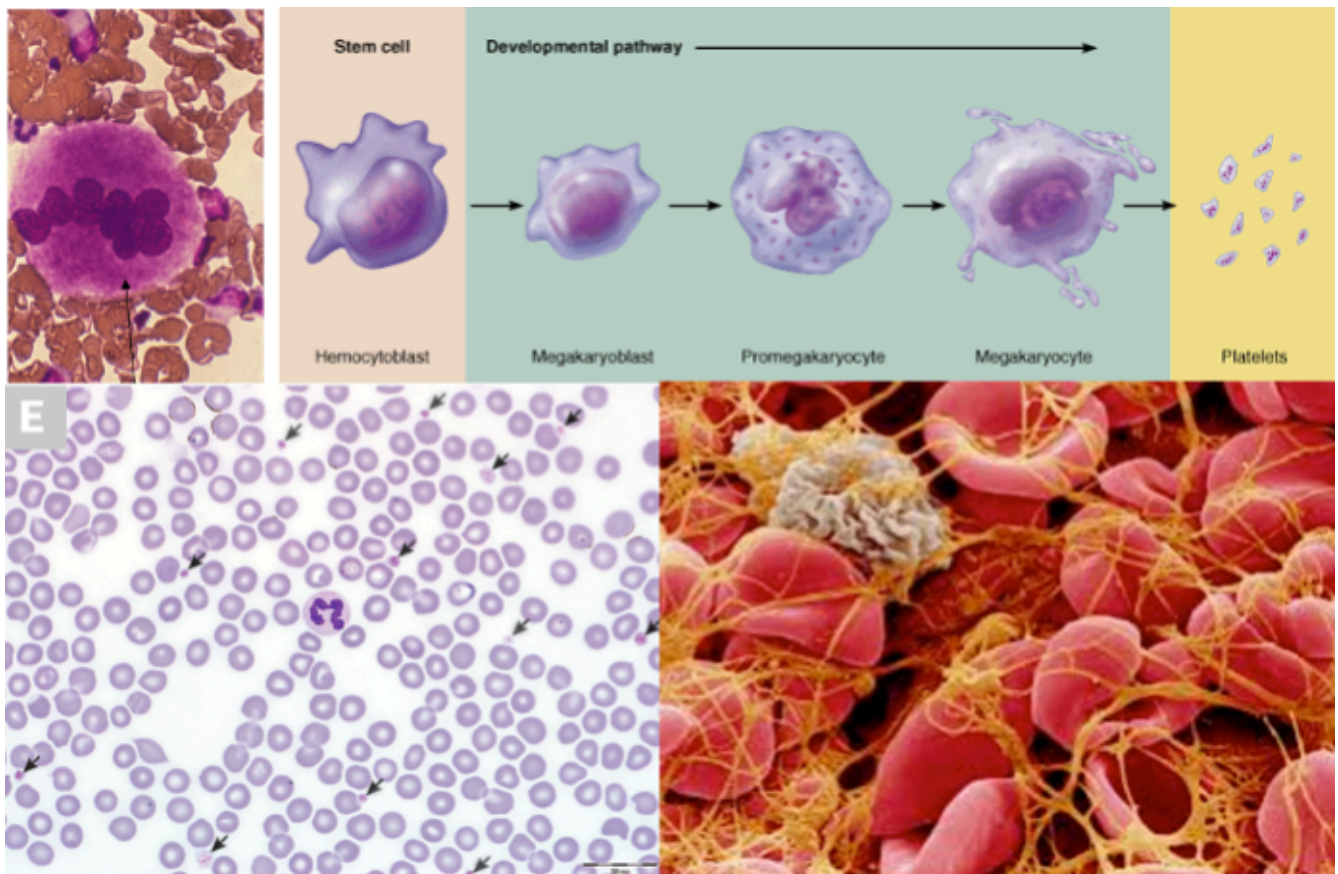
Spur cell
(acanthocyte)



Target cell
(codocyte)

PLATELET REVIEW:

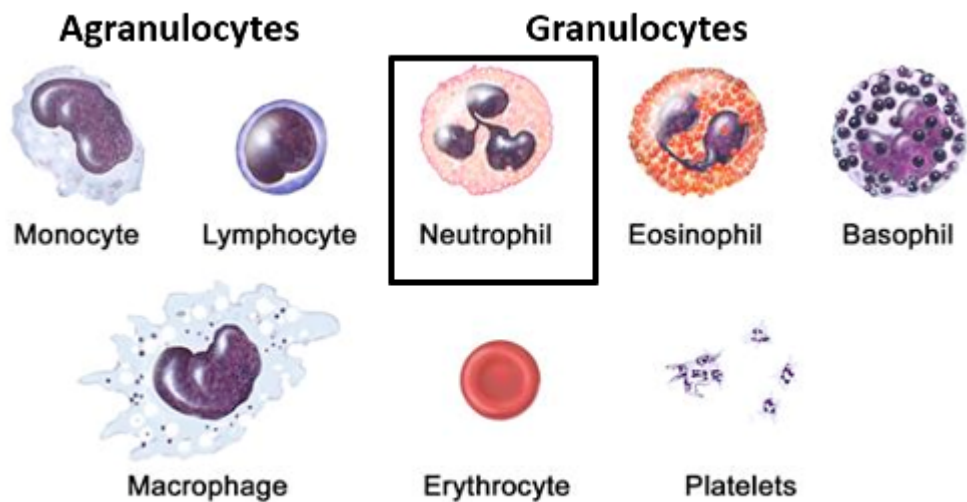
After looking at the RBCs, we then turn to reviewing the morphology and numbers of platelets. These small intravascular membrane-bound cell fragments (that are derived from megakaryocytes) contain granules important in blood clotting, adhesion of platelets to each other and to blood vessel walls, and repair of damaged vessels. Decreased platelets may suggest thrombocytopenia, while abnormal morphology could indicate a range of conditions.



WHITE BLOOD CELL REVIEW:

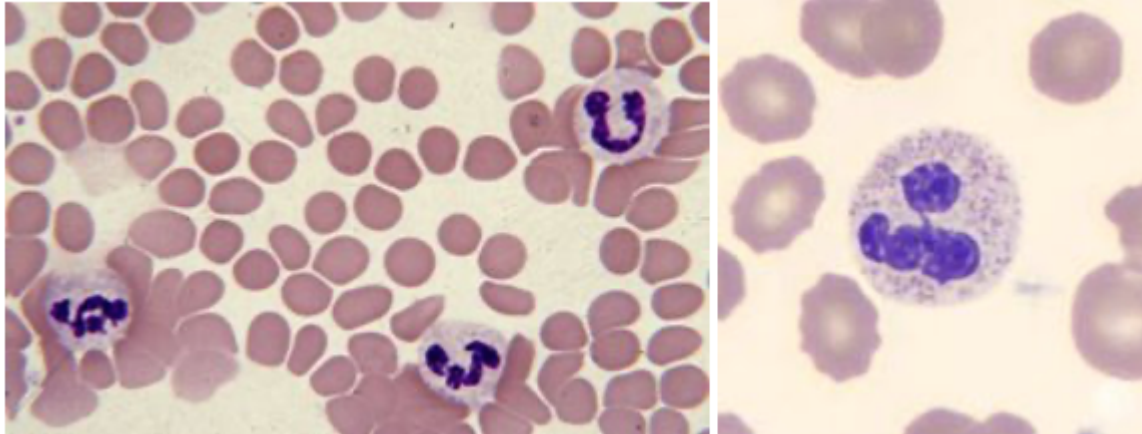
After examining RBCs and platelets, we turn to looking at the leukocytes, aka white blood cells (WBCs), which circulate in blood and migrate from the blood to sites of infection. The leukocytes in the blood are further subdivided morphologically on the basis of cytoplasmic granules:

- Cells that have cytoplasmic granules (granulocytes): Neutrophils, Eosinophils, and Basophils
- Cells that lack granules or have very few granules (agranular leukocytes): Lymphocytes and Monocytes

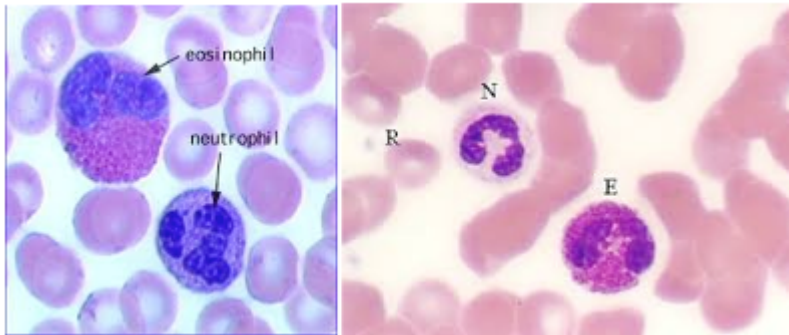


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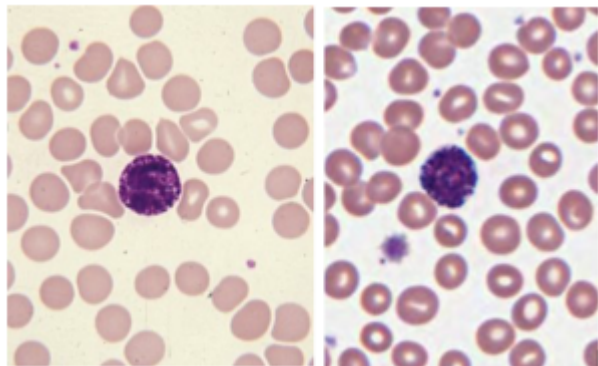
Polymorphonuclear leukocytes (aka PMNs, aka neutrophils): Determine whether they are present in expected numbers and evaluate their segmentation. The nucleus of a PMN usually has 3-5 segments. Hyper-segmented neutrophils (with >5 segments) can be seen with B12 and folate deficiencies.



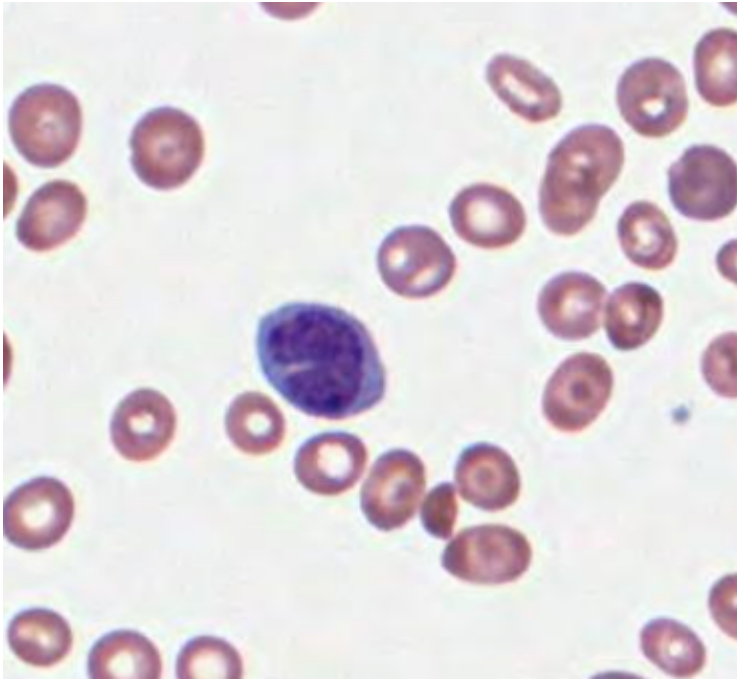
Eosinophils: Recognizable by their bright pink/red/magenta granules and bilobed nuclei, eosinophils typically indicate parasitic infections or allergies. Compare their granules to those of neutrophils which are much lighter.



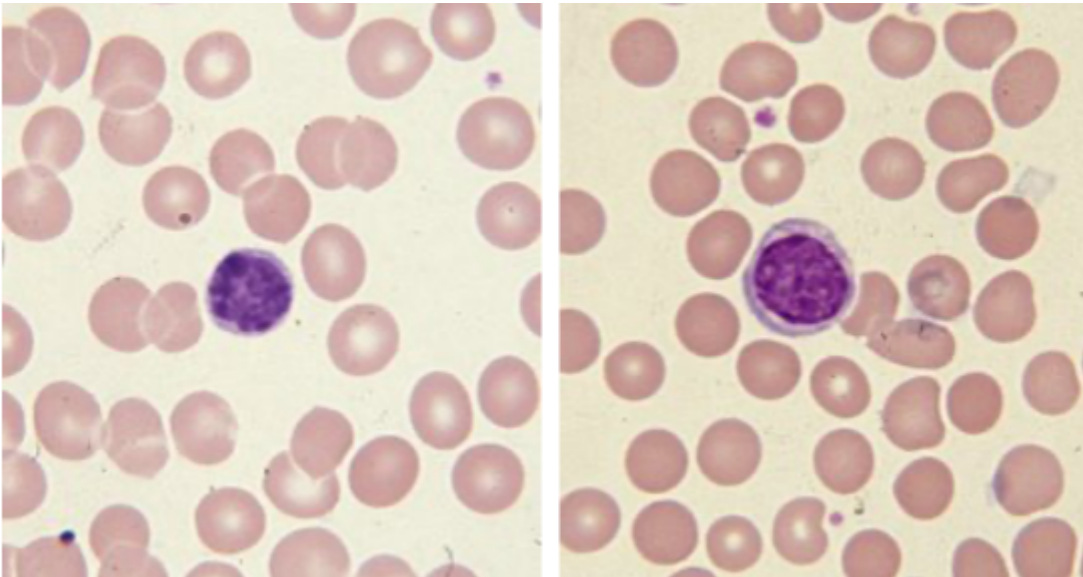
Basophils: Noted for dark blue/purple granules; their increase is concerning for myeloproliferative disease.



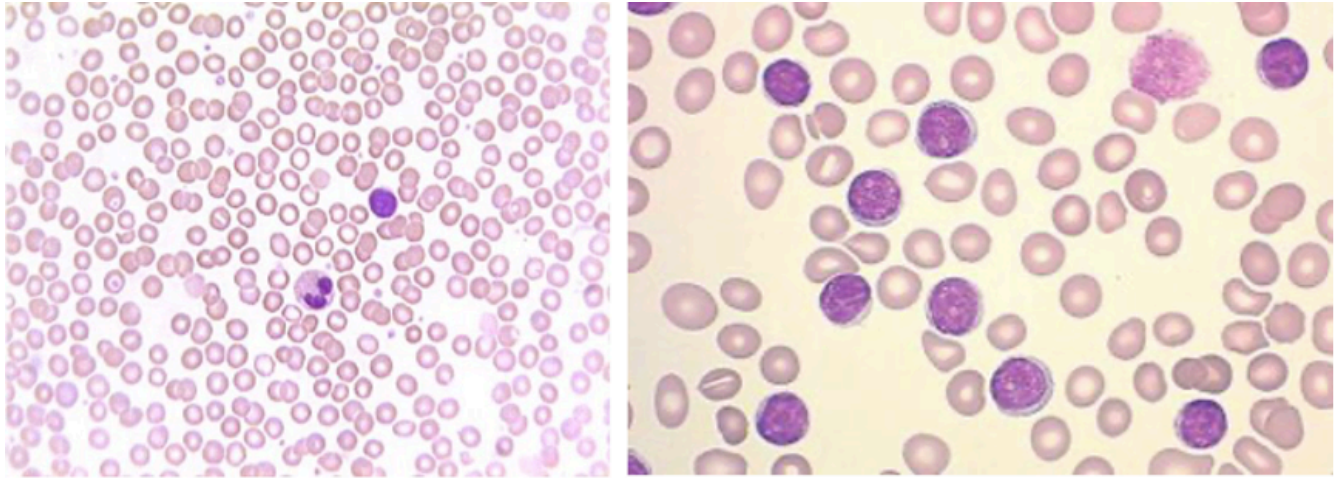
Monocytes: These cells generally have a large, kidney-shaped nucleus, abundant cytoplasm, and very few cytoplasmic granules. When these cells leave the blood vessel and migrate to areas of infection, they give rise to tissue macrophages.



Lymphocytes: These cells have few to no granules, are smaller than macrophages, and often smaller than neutrophils. Of note, a normal RBC is about the size of the nucleus of a mature circulating lymphocyte.



Below is a normal peripheral blood smear demonstrating a neutrophil and a lymphocyte. Adjacent is a photo showing lymphocytic leukemia. Note the abundance of lymphocytes in the 2nd photo.



Knowledge check: Identify each cellular structure and then click the question marks to check your answer.



An interactive H5P element has been excluded from this version of the text. You can view it online here:
<https://uw.pressbooks.pub/wwamihistopathology/?p=1341#h5p-76>

Today in class, you will be reviewing both blood smears and bone marrow biopsies. While bone marrow biopsies are examined similarly to blood smears, they also contain precursor cells that develop into mature circulating blood cells.

This Chapter's PDF

LINK

- Note: The interactive features of this chapter are not reproducible in this PDF format.