

SAMPLE PAGES FROM "MAPPING THE BODY WITH ART" MODULE 3: TISSUES



LEUKOCYTES (part 1): GRANULOCYTES

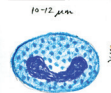
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BASOPHILS (5% of leukocytes in blood)



- 1) Normally, they that around in the blood, but they can be recruited into tissues if other cells "call" for them to come.
- 2) Are extremely similar to mast cells.
- 3) Vesicles are filled with histamine (and other chemicals). Histamine dilates blood vessels and makes them leak. (If this happens too fast and too strong, you get a sudden drop in blood pressure and you faint.)
- 4) Basophils have many IgE antibodies (from B cells) attached to them. IgE's trigger release of histamine when antigens bind to them.
- 5) Basophils also have the ability to "call" other white cells to come and help, including eosinophils, neutrophils and basophils.

MAST CELLS (not in blood)



- 1) Found only in tissues, not in blood. We meet them in loose connective tissue, sitting next to capillaries.
- 2) Are extremely similar to basophils.
- 3) They start the inflammatory process when endothelial cells are damaged.
- 4) Mast cells are covered with IgE antibodies (from B cells). When antigens bind to the IgE's, histamine is released.

EOSINOPHILS (2% of leukocytes in blood)



- 1) Attack parasitic worms and their eggs. (2 billion people in the world have some kind of worm infection. Some worms are not very harmful and people just live with them.)
- 2) Vesicles are filled with histamine, which neutralizes histamine (clean up from basophils).
- 3) Other vesicles have chemicals that are helpful for fighting, but can cause damage to body cells, too. For example, eosinophils have been shown to be very active during asthma attacks.

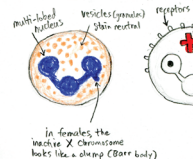
NEUTROPHILS (60-65% of leukocytes in blood)

These guys are so amazing that they need their own page... (They make several kinds of chemical weapons)

LEUKOCYTES (part 2): NEUTROPHILS

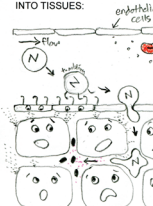
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NEUTROPHILS (60-65% of leukocytes in blood)



- 1) Our body makes about 100 billion per day.
- 2) We have 5 times as many neutrophils in reserve (in marrow mostly) as we do in circulation.
- 3) They float in blood until needed in tissues. When they get chemical signals that they are needed, they leave the vessels by squeezing through the cracks between the endothelial cells.
- 4) Lifespan: a few days.
- 5) "Put" is mostly dead neutrophils.

HOW THEY GET FROM BLOOD INTO TISSUES:



Neutrophils engulf pathogens by phagocytosis. Then they use chemicals to kill them.

Neutrophils make 3 oxygen-based weapons:

- 1) "Super-oxide" is an oxygen molecule, O_2 , with an extra electron stuck on by a special enzyme. The electron will go flying off like a bullet, striking the invader. Super-oxide is a very common "free radical" found in your body. It kills pathogens, but it can also damage your cells.
- 2) Hydrogen peroxide, H_2O_2 , yes, the same stuff that is in your First Aid kit for sterilizing wounds. The "bullet" here is the second O molecule.
- 3) HOCl, a form of "bleach" (hypochlorous acid). When the neutrophil is making a lot of this, your mucus turns green. (The enzyme that makes it is greenish in color). Green mucus suggests bacterial infection rather than viral.

Other strategies:

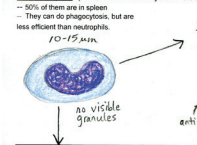
- 4) Digestive enzymes: Lysosomes filled with enzymes can merge (join) with the phagosome and dump enzymes all over the pathogen.
- 5) From: Neutrophils can hide (fit) from bacteria. Bacteria die without iron.

LEUKOCYTES (part 3): MACROPHAGES

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Monocytes in the blood can go into tissues and differentiate into either macrophages or dendritic cells.

MONOCYTES (about 5% of leukocytes in blood)



MONOCYTES (about 5% of leukocytes in blood)

- 80% of them are in spleen
- They can do phagocytosis, but are less efficient than neutrophils.

DENDRITIC CELL: Similar to macrophage except that it stays small, and is less involved in secreting cytokines (messenger molecules).

Dendritic cells are "professional" Antigen Presenting Cells (APCs). They eat pathogens by phagocytosis then put tiny pieces of the antigen on their plasma membranes so they can show them to T cells in the lymph nodes.

Many dendritic cells are found in the skin, the lining of the intestines, and in lymph nodes and spleen.

MACROPHAGES



Macrophages are found in all body tissues. In some tissues they go by other names:

- Skin: Langerhans cells
- Liver: Kupfer cells (Macrophages in the liver clear out bacteria and also eat old red blood cells)
- Lungs: "dust cells"
- Brain: microglia
- Bone: (osteoclasts?) This is being debated...

MACROPHAGES have basically 3 jobs:

- 1) Phagocytosis of:
 - 1- pathogens
 - 2- old red blood cells (by macrophages called Kupfer cells in liver)
 - 3- dirt, debris, all cellular messes
 - 4- old or sick neutrophils
- 2) Presentation of antigens to T cells (and B cells)

(An antigen is anything that is "not self")

Helper (T_H) 1 or 2

Regulatory (T_R) 1 or 2

Antigen Presenting Cell (APC)

Pieces of digested pathogen get attached to a "slot" called MHC, and then moved to the surface of the membrane where they can interact with T and B cells.

MHC = Major Histocompatibility Complex (histo = tissue) but think "My House Cleaning"
- 3) Release of cytokines (messenger molecules), especially the kind called "interleukins" (IL). Interleukins are numbered, such as IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-11, IL-12, IL-13, IL-14, IL-15, IL-16, IL-17, IL-18, IL-19, IL-20, IL-21, IL-22, IL-23, IL-24, IL-25, IL-26, IL-27, IL-28, IL-29, IL-30, IL-31, IL-32, IL-33, IL-34, IL-35, IL-36, IL-37, IL-38, IL-39, IL-40, IL-41, IL-42, IL-43, IL-44, IL-45, IL-46, IL-47, IL-48, IL-49, IL-50, IL-51, IL-52, IL-53, IL-54, IL-55, IL-56, IL-57, IL-58, IL-59, IL-60, IL-61, IL-62, IL-63, IL-64, IL-65, IL-66, IL-67, IL-68, IL-69, IL-70, IL-71, IL-72, IL-73, IL-74, IL-75, IL-76, IL-77, IL-78, IL-79, IL-80, IL-81, IL-82, IL-83, IL-84, IL-85, IL-86, IL-87, IL-88, IL-89, IL-90, IL-91, IL-92, IL-93, IL-94, IL-95, IL-96, IL-97, IL-98, IL-99, IL-100, IL-101, IL-102, IL-103, IL-104, IL-105, IL-106, IL-107, IL-108, IL-109, IL-110, IL-111, IL-112, IL-113, IL-114, IL-115, IL-116, IL-117, IL-118, IL-119, IL-120, IL-121, IL-122, IL-123, IL-124, IL-125, IL-126, IL-127, IL-128, IL-129, IL-130, IL-131, IL-132, IL-133, IL-134, 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