Biology 224
Human Anatomy and Physiology II
Week 5; Lecture 1; Monday
Dr. Stuart S. Sumida

Immune and other Defense Systems

Immune System

INTEGUMENT (Skin)

Protection
Insulation
Sensory

DEFENSIVE FEATURES OF INTEGUMENT

•Generally impermeable.

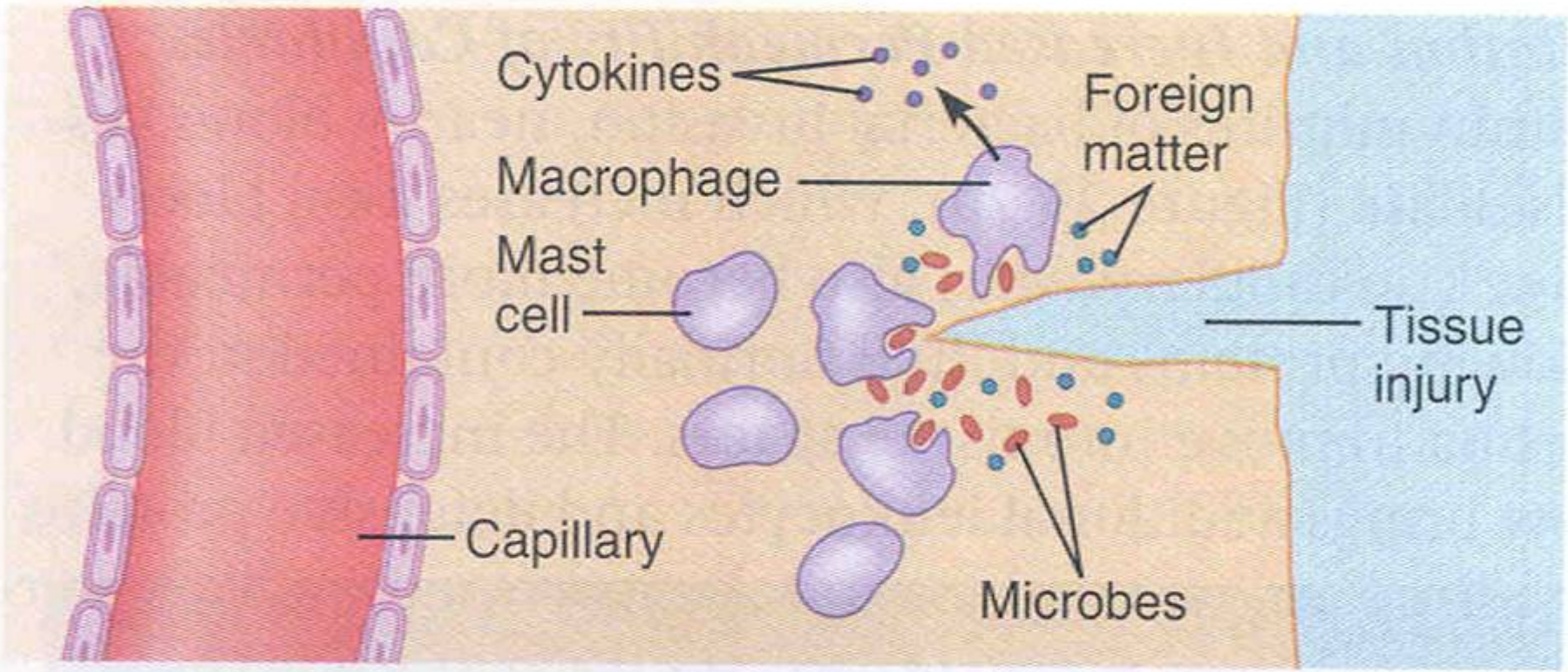
•Openings through it have sphincters or barriers in place.

•Slightly acidic: Inhibits bacterial growth.

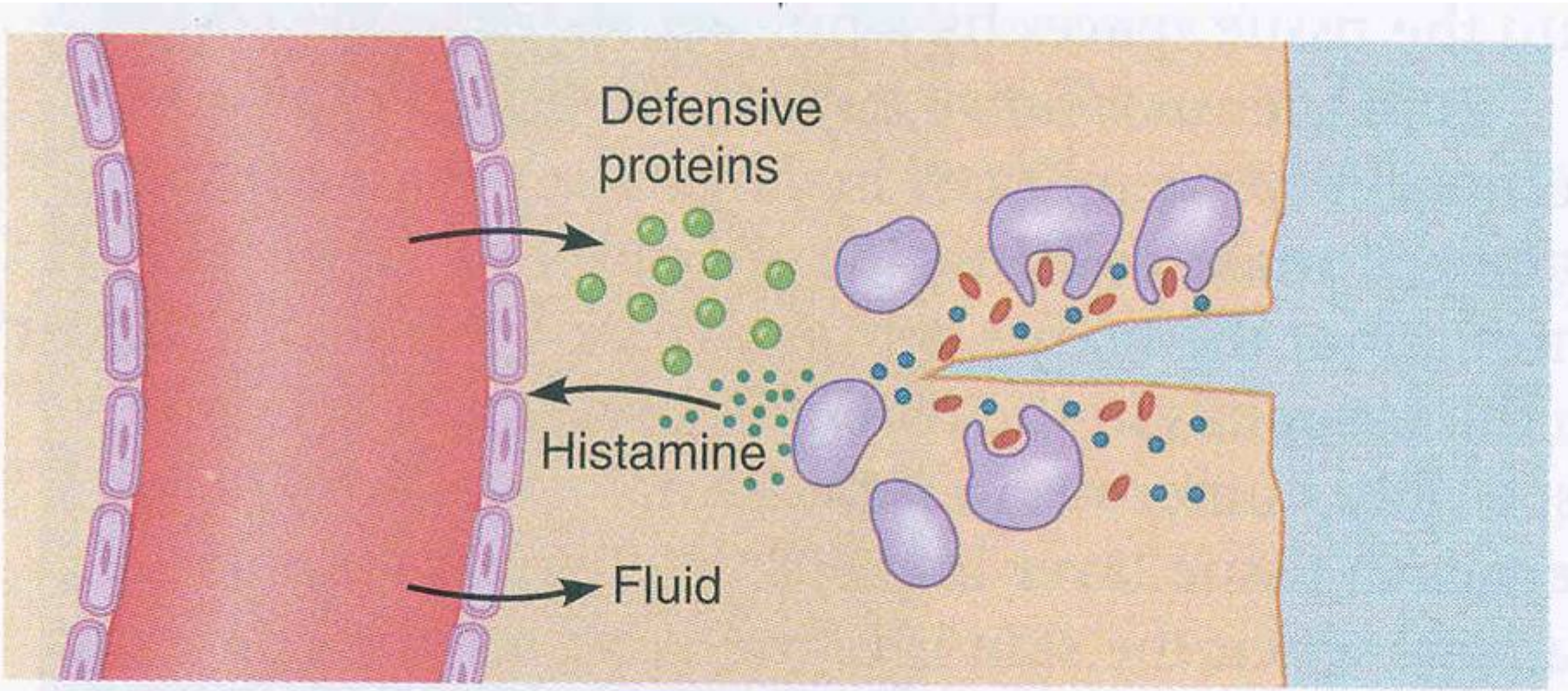
•Sweat/perspiration helps wash invaders out of pores.

•Openings (mouth and anus) have sphincters and associated mucous membranes (sticky secretions inhibit entrance of foreign matter.

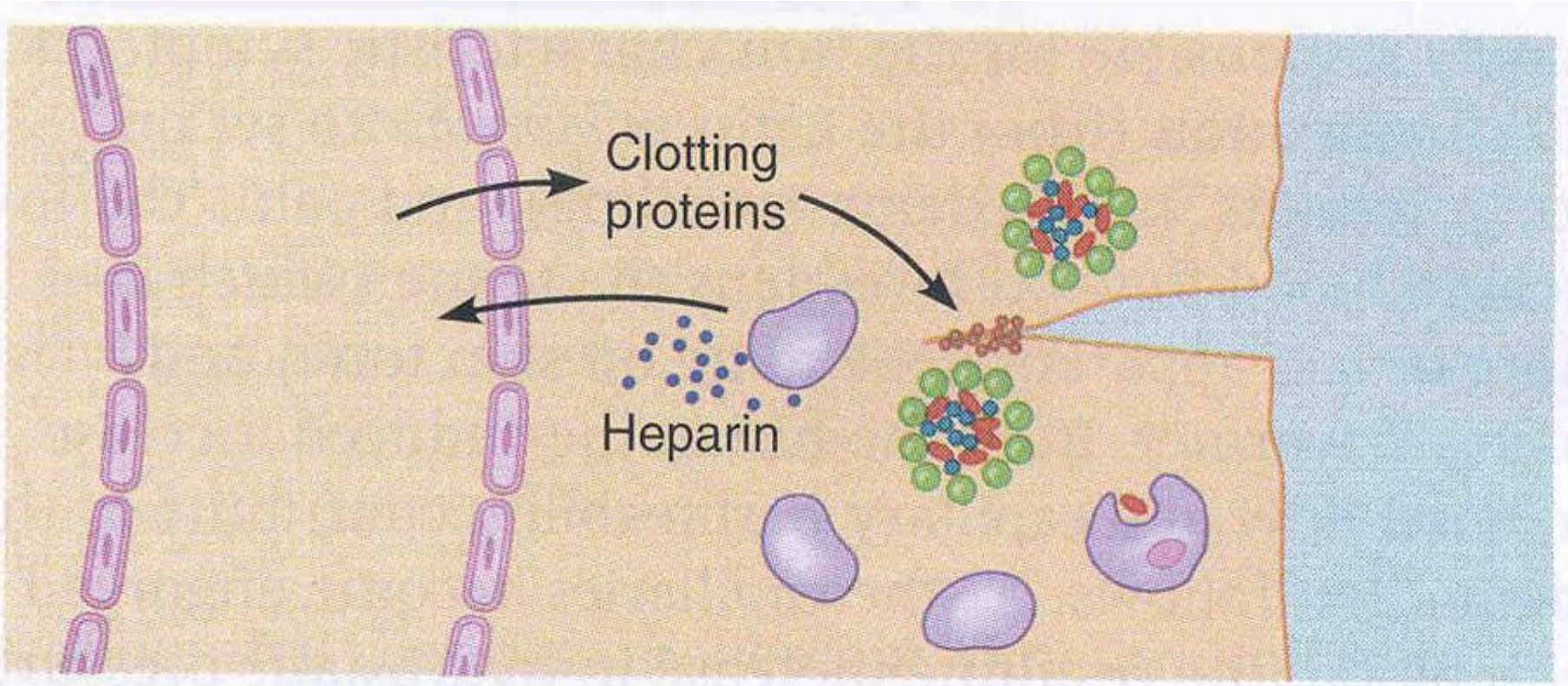
Stages of Superficial Inflammatory Response



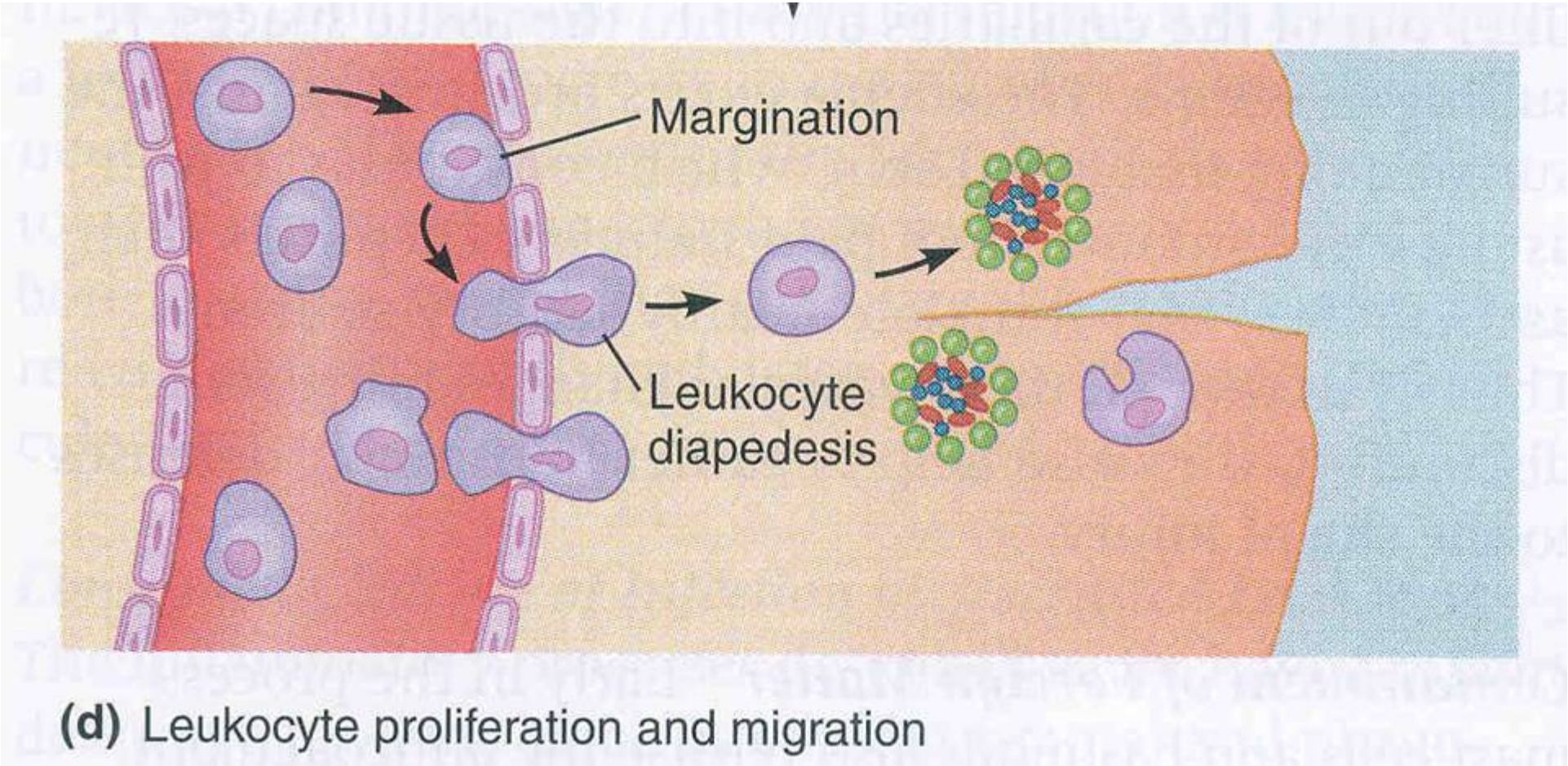
(a) Phagocytosis by nearby macrophages



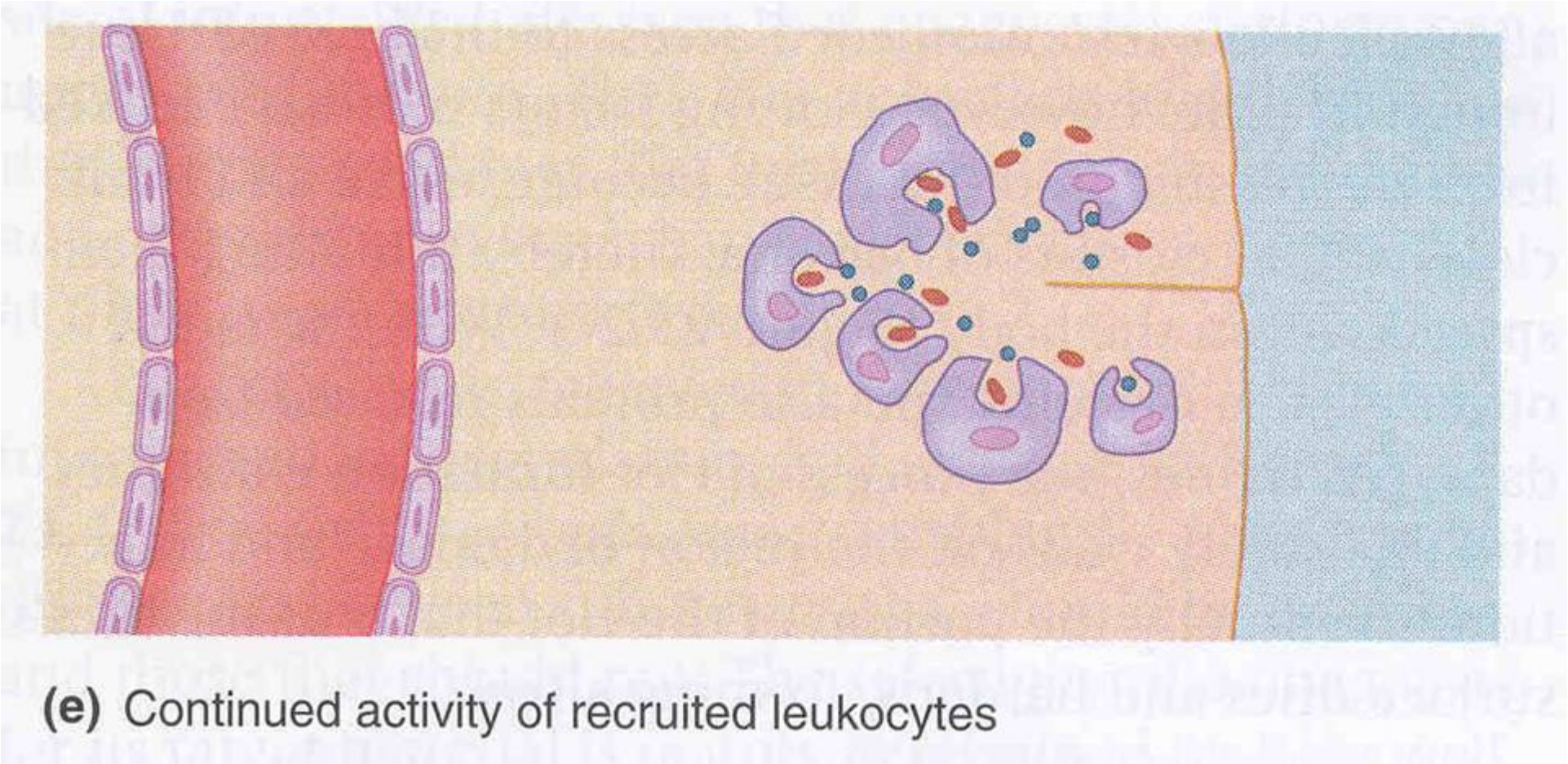
(b) Dilation and increased permeability of capillary



(c) Containment of bacteria and foreign matter



(d) Leukocyte proliferation and migration



(e) Continued activity of recruited leukocytes

SPECIFIC COMPONENTS OF IMMUNE SYSTEM: LYMPHOCYTES

- B-Lymphocytes (“B cells”)
- T- Lymphocytes (“T cells”)
- Natural Killer Cells (NK cells)
- Memory Cells
- Suppressor Cells

They have different functions in specific immunity

B-LYMPHOCYTES

•Mature in bone marrow, then carried to lymphoid tissue via blood stream and lymphatic circulation.

•This process of maturation and migration takes place throughout life.

•Other lymphocytes can be generated via mitosis of B lymphocytes resident in lymphoid tissues.

T-LYMPHOCYTES

•Immature lymphocytes leave bone marrow during fetal and early neonatal life.

•Go to thymus gland.

•Mature there before they go on to other lymphoid tissues.

•These are T-lymphocytes.

•Also, and lymphocyte that is derived from one of these original T-lymphocytes via mitosis is also a T-lymphocyte.

SPECIFIC IMMUNITY

The body must be able to recognize the difference between “self” and “nonself.”

(Any lymphocytes with antibodies that recognize one’s own body tissue as an antigen ar ekilled during fetal life.)

ANTIGENS

A foreign substance or organism.

Any substance against which an antibody is produced.

More specifically, antigens are proteins or polysaccarides on the cell surface of an invading organism.

ANTIBODIES

- Proteins produced by lymphocytes in response to an antigen.
- They bind to specific sites on antigen surfaces.
- Antibodies don't kill organisms. However, they:
  - can inactivate an invader, and
  - initiate the process of activating phagocytic cells and other natural killers.
- Can combine with bacterial toxins or viruses to prevent attachment to target cells ("inactivation").
- There is a SPECIFIC antibody for any one given type of individual invader.

STAGES OF SPECIFIC IMMUNE RESPONSE

(1) Antigen encounter and recognition by lymphocytes.

(2) Lymphocyte activation.

(3) Attack.

(1) Antigen encounter and recognition by lymphocytes

Specific lymphocytes are programmed to recognize a specific antigen.

This usually happens in a lymphoid organ, bloodstream, or lymph vessel.

(This could take quite some time…)

(2) LYMPHOCYTE ACTIVATION

Once a lymphocyte has recognized an antigen, it undergoes numerous cycles of mitotic divisions, making more of the same.

Some of the newly produced cells carry out the attack; others influence the activation and function of the attack cells.

(3) ATTACK

B-lymphocytes have specific receptors on their cell membrane – ANTIBODIES – that bind with invading materials/organisms.

ANTIBODY STRUCTURE

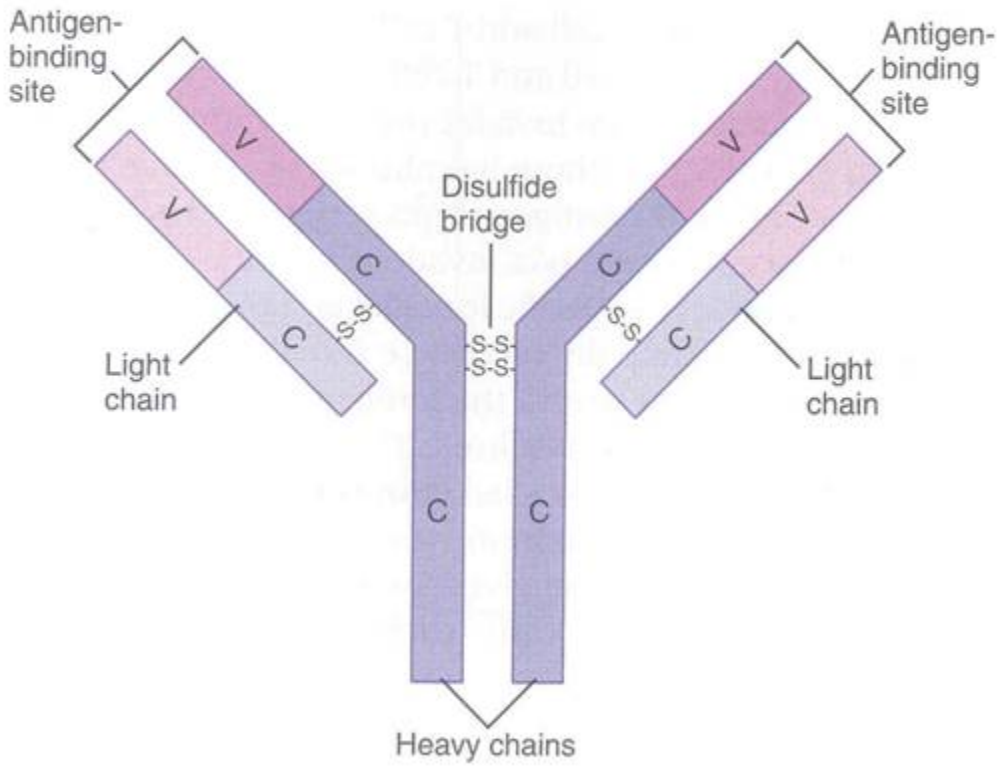
(Remember, they belong to group of plasma proteins called “globulins.”)

Made up of four polypeptides (amino acid chains).

Two longer and larger, two shorter and smaller.

Have the shape of a letter “Y”.

Intersection of arms and base of “Y shape” is flexible, allowing deformation of antibody when it attaches to an antigen.



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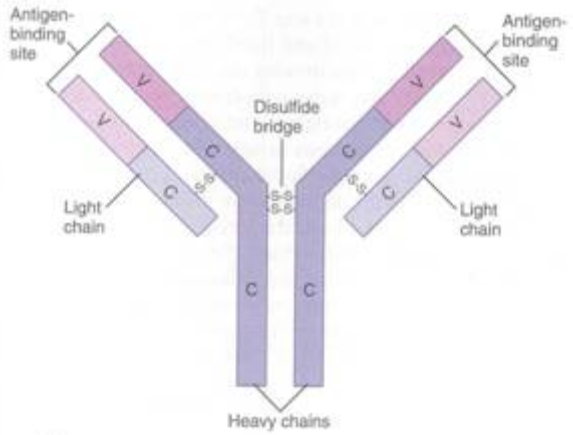
VARIABLE REGION OF ANTIBODIES

- At the tip of the arms of the Y-shape.

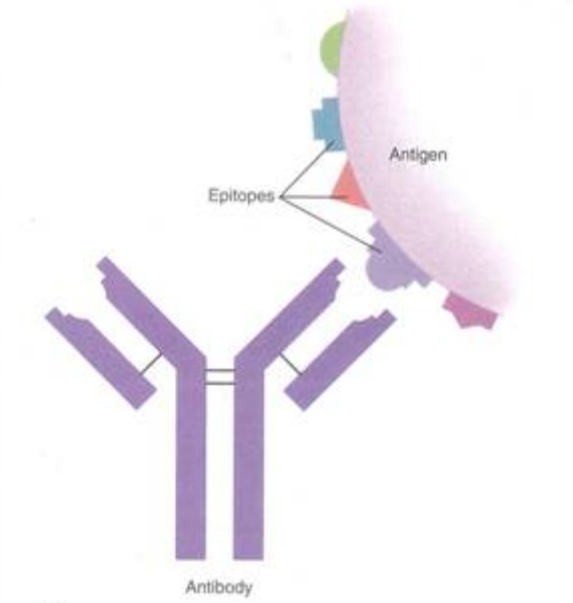
- Variable region has the potential to bind with particular classes of antigens.

- Once a raw antibody is stimulated to fit to a specific antigen, it can then react with ONLY that antigen. This is known as SINGLE SPECIFICITY.

- Can fit as precisely as a lock-and-key to an antigen.

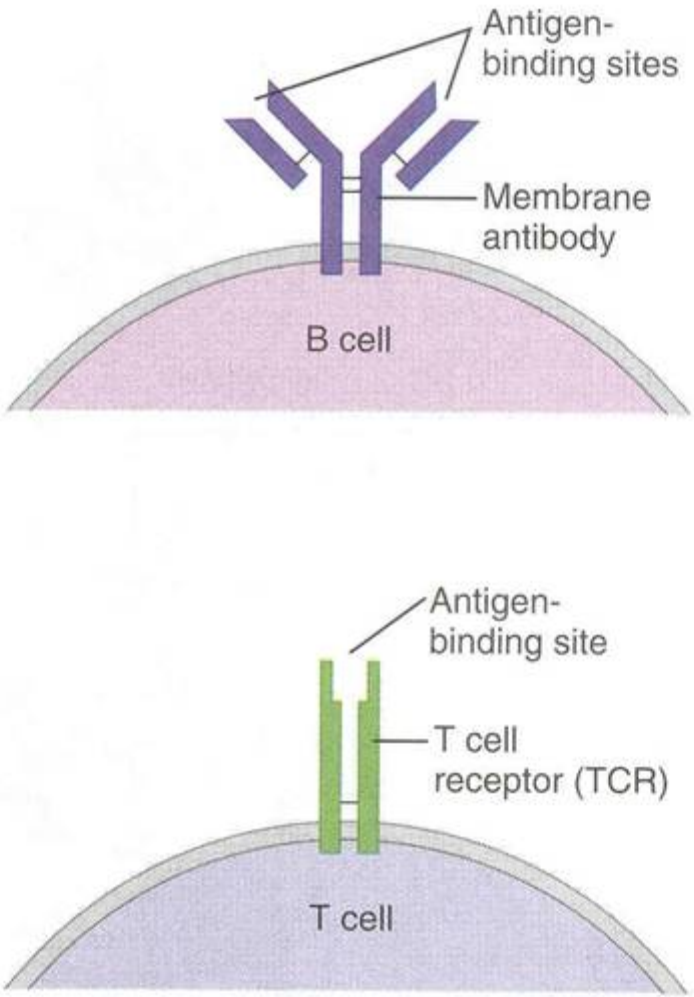


(a)



(b)

The basis of antigen-antibody specificity.
(a) Each antibody molecule consists of two identical heavy chains and two identical light chains linked by disulfide bonds. The combined structures of the variable (V) regions form the antigen-binding sites of the molecule, which vary from antibody to antibody. (b) A schematic representation of how the complementary physical structures of an antigen's epitope and the antibody's antigen-binding site constitute antigen-antibody specificity.



B cell and T cell antigen receptors. Antigen receptors on B cells are called membrane antibodies (or membrane immunoglobulins); antigen receptors on T cells are called T cell receptors (TCRs). Each lymphocyte has about 100,000 identical receptors specific for a particular antigen.

TYPES OF ANTIBODIES

Because they are involved in immune response, they are called immunoglobulins, abbreviated Ig…

SUMMARY OF IMMUNOGLOBULINS

Type	Location (if restricted)	Function/Notes
IgA	Mucous membranes of pharynx—saliva, tears, gut secretions, mother's milk.	Protection at opening of gut tube and nearby. A way for mother to pass on immunity to infant.
IgD		No well understood; may be important in lymphocyte differentiation.
IgE	Widespread	Immediate allergic responses. Bind to mast cells to release histamines and othr inflammatory substances
IgG	Most common; can pass out of blood vessels (can pass through placenta)	Produced in great quantity subsequent to initial exposure to a particular antigen.
IgM	Largest,	Secreted at initial exposure to antigen; activte complement.
Complement	~ 20 different types of proteins and other molecules.	Supportive role in immune responses; enhance (complement) defensive systems.

UNDERSTANDING HIV and AIDS

PRIMARY IMMUNE RESPONSE

•B-lymphocyte – antigen contact induces mitosis (plasma cells) for more antibody carrying cells. Antibodies released to circulatory systems.

SECONDARY IMMUNE RESPONSE

•Some “activated B-lymphocytes” become plasma cells.
•Some remain smaller, but retain antigen-recognition ability. (B memory cells)

•Next time similar antigen is encountered, response is MUCH FASTER due to resident and waiting memory cells.

T-LYMPHOCYTES

- Do not produce antibodies.

- Function in “cell-mediated immunity.”

- “NATURAL KILLER” cells destroy viruses.
    - Secrete “lymphokines” which attract phagocytic cells.
    - Secrete “perforin” which eats holes in the cells membrane or viral coat of invaders.

- “Helper T cells”:
    - Induce macrophages to destroy other antigens
    - STIMULATE B-LYMPHOCYTES TO PRODUCE ANTIBODIES. (Can help hundreds of B-lymphocytes mature by releasing “B-cell growth factor.”)

- “Suppressor T Cells” prevent overreaction of the system. (Inhibit B-lymphocye production.)

HUMAN IMMUNODEFICIENCY VIRUS (HIV)

- A retrovirus (RNA-based).
- Once integrated into host, can remain dormant for years.
- Preferentially enters and DISABLES HELPER T-LYMPHOCYTES.
- Without these, B-lymphocytes can’t mature to make antibodies, and natural killer cells can’t function fully.

Thus, an infected person can’t produce antibodies against even the simples of invaders.