### Immune system Page 1

Immune system

The parts of the body that guard against pathogens (disease-causing

organisms, such as bacteria and viruses)

• Infection = An invasion of the body by a pathogen

• The body’s defenses against pathogens also defend against certain

cancers

• The immune system distinguishes pathogens from normal body cells

by the antigens present on each cell type

√ Antigens = Molecules (usually proteins, carbohydrates and

fats on the surface of a cell) that the immune system interacts

with, to determine which cells are the body's own cells and

which are not.

- Self antigens = Antigens that are made naturally as part

of the body

- The immune system does not attack cells

displaying only self antigens

- Foreign antigens = Antigens that are not a natural part

of the body (such as antigens of viruses and bacteria)

- The immune system attacks cells displaying

foreign antigens

### Immune system Page 2

White blood cells (WBC) (leukocytes)

The blood cells that are part of the immune system

• There are five basic types of WBCs, each with its own role in the

defending the body

WBC cell type Function

Neutrophils Phagocytosis

Eosinophils Phagocytosis

Basophils Secrete histamine

Monocytes Phagocytosis

√ (become macrophages)

Lymphocytes Roles in specific

√ (There are two types: immune system

B cells and T cells)

Fig 13.3; tables 13.2 and 15.2

Phagocytosis

One cell engulfing (eating) another cell

• Neutrophils and monocytes (macrophages) are the two most active

phagocytes

Fig 15.2

### Immune system Page 3

The “battlefields” where the body defenses fight most pathogens are usually the blood and the lymphatic system

Lymphatic system

A network of vessels, ducts, and nodes throughout the body that (a) return lymph (excess tissue fluid) back to the circulatory system, and (b) filter the lymph to cleanse it of pathogens

• Lymphatic vessels/ducts = The tubes that drain lymph from tissues

• Lymph nodes = Hollow structures located at the points where

lymphatic vessels converge

√ The lymph is filtered at the lymph nodes

√ Many WBCs are stationed at the lymph nodes

to destroy pathogens in the lymph

• All lymph vessels eventually converge into two large ducts that return the lymph to the blood in the subclavean veins of the thorax

Lymphatic organs

Organs that are part of the lymphatic system

• Tonsils = Filter/cleanse pathogens in the upper respiratory system

• Spleen = Filters/cleanses pathogens and old RBCs from the blood

• Thymus = Houses developing T cells (a type of lymphocyte WBC)

### Immune system Page 4

The body has two defensive systems:

• The innate immune system (the non-specific immune system)

• The adaptive immune system (the specific immune system)

The innate immune system (the non-specific immune system)

The defense system that makes the body less accessible and less hospitable to all pathogens. Its parts do **not** specializein fighting specific pathogen types. Instead, they defend against pathogens in general.

• Skin = Physically blocks pathogens from entering the body

• Phagocytes = WBCs that engulf pathogens

√ The three phagocytic WBCs: Neutrophils, Eosinophils, and

Monocytes/Macrophages

• Inflammation = The redness, swelling, and pain in injured

tissues

√ Injured cells release molecules that attract WBCs and activate

pain receptors

√ The redness and swelling are caused by basophil WBCs

releasing histamine, a molecule that dilates the capillaries (so

that more nutrients reach the injured site) and that makes the

capillaries leaky (so WBCs can exit the blood vessel to attack

pathogens in the injured tissue)

• Interferons = Proteins, made by infected cells, that inhibit viruses

from entering neighboring cells

• Fever = Elevated body temperature

√ Inhibits bacterial growth

√ Speeds up body defenses

• Complement = Blood proteins that lyse (tear open) pathogen cells

Fig 15.5, tables 15.1, 15.3, and 15.5

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The adaptive immune system (the specific immune system)

The defense system consisting of the lymphocyte WBCs. Each individual lymphocyte cell specializes in attacking one (and only one) specific pathogen type.

• There are two lymphocyte types: B cells and T cells

• B cells attack pathogens by making antibodies (Y-shaped proteins

that bind to the pathogen’s antigens)

√ B cells release antibodies which then circulate in the lymph

and the blood

√ All the B cells and their antibodies are together called the

“humoral immune system”

• T cells attack pathogens by injecting the pathogen cells with toxins

√ All the T cells together are called the “cell mediated immune

system”

• The adaptive immune system has “memory”: It attacks a pathogen

more quickly and more effectively if it has encountered that specific

pathogen before

√ This is why person is “immune” to a disease if they

have previously been exposed to it

√ This is also the basis for vaccinations against diseases. The

vaccination is a weak or non-living version of the

pathogen.

### Immune system Page 6

The humoral immune system (B cells and their antibodies)

• Each B cell makes and coats its surface with antibodies that can bind to the foreign antigens of a pathogen

√ B cells differ from each other in regards to which pathogen type their antibodies bind to. There are thousands of different B cells types, each specializing in fighting a different pathogen from all the other B cells. Therefore, no matter which pathogen infects the body, there will be B cells with antibodies that can bind to that pathogen’s antigens.

• When a B cell encounters the pathogen whose foreign antigens fit into the B cell’s antibodies, that B cell divides repeatedly

√ This produces millions of identical clones of the original

B cell. All the clones have antibodies against the foreign

antigens of the same pathogen

• In about two weeks, the cloning is completed. The B cells release their antibodies, which circulate in the blood and the lymph to attack

the pathogen

• The circulating antibodies bind to the foreign antigens on the pathogen cells

√ The antibodies agluttinate (link together) the pathogen cells, which helps the body eliminate them by reducing their mobility

√ Complement proteins lyse (tear open) the antibody-coated

pathogen cells

• Memory B cells = B cell clones that retain their antibodies

√ Memory cells remain ready to divide in future encounters

with the pathogen

√ Memory B cells provide a rapid and strong defense if the same pathogen is encountered again. The person is

“immune” to that pathogen

Figs 15.7, 15.8, 15.10, 15.11, 15.12, 15.21, 15.23; Table 15.4

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The cell mediated immune system (T cells)

• When a macrophage engulfs and digests a pathogen, the pathogen’s

foreign antigens become displayed on the surface of the macrophage

• Each T cell is programmed to attack one (and only one) foreign

pathogen

√ T cells differ from each other in regards to which pathogen they attack. There are thousands of different T cells types, each specializing in fighting a different pathogen from all the other T cells. Therefore, no matter which pathogen infects the body, there will be T cells that can attack it

• A T cell becomes activated only when it encounters a macrophage

displaying the specific foreign antigen for that T cell

• When a T cell becomes activated, the T cell divides repeatedly

√ In about a week, the cloning is completed. This produces

millions of identical clones of the original T cell. All the clones are programmed to attack the same pathogen

• T cells come in three types:

√ Cytotoxic T cells = They attack the pathogen directly by

injecting it with toxic substances

√ Memory T cells = They remain ready to divide in future

encounters with the pathogen

√ Helper T cells = They make B and T cells divide

Figs 15.13, 15.16, 15.21, 15.22

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Detrimental immune system reactions

• Autoimmune diseases = Any disorder caused by the immune system

attacking self antigens in specific tissues or organs

√ Examples: Multiple sclerosis, rheumatoid arthritis, lupus

• Allergies = Excessive immune responses to harmless antigens in the

environment

√ Effects = Rash (hives), watery eyes and nose, itching, asthma

√ Anaphylactic shock = A life-threatening allergic response to

allergens that enter and circulate within the body

• Rejection of organ transplants

Figs 15.23, 15.14, and 15.25; tables 15.10 and 15.11

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Immunosuppression

Medical drugs or diseases that weaken or eliminate the immune

system

• Drugs that suppress the immune system are given to patients with

autoimmune diseases or to patients who receive organ transplants

√ Glucocorticoids lower overall immune system activity

√ Other immunosuppressive drugs inhibit T cell and B cell

division

√ Immunosuppressive drugs reduce organ rejection and

autoimmune disease symptoms, but the drugs increase

patient’s susceptibility to pathogenic diseases

• Stress weakens the immune system by glucocorticoid hormones

• AIDS (Acquired immune deficiency syndrome) = A viral disease in

which the HIV virus destroys Helper T cells