Welcome students of T.Y.B.Sc.

The title of the unit is Unit

2: Immune cells and organs,

module name, structure, functions

and properties of immune cells.

Part three. I'm Dr.

Carolina Fernandes from P.E.S.'s

RSN College of Arts and

Science, Farmagudi, Ponda, Goa.

The outline of this module is

as under. The learning outcomes:

The student will be able to

describe Neutrophil, Eosinophil,

Basophil, Macrophage, Mast cell,

Dendritic cell and understand the

role of these cells in immune system.

The cells responsible for both nonspecific

and specific immunity are the

leukocytes or white blood cells.

They originate from pluripotent

stem cells in the fetal liver and in

the bone marrow of the animal host.

The average adult has approximately 7,400

leucocytes per millimeter cube of blood.

This value shifts substantially

during infectious and allergic

responses of the host,

The complete blood count

and the differential count,

which determines the relative

number of each type of blood cell,

are used clinically to assist

in the diagnosis of disease,

and infection. They cooperate with each

other first to recognize the pathogen

as an invader and then destroy it.

Blood consists of cellular

and non cellular components

active in the immune response.

The most numerous cells in human

blood are the erythrocytes,

also called red blood cells.

They are non nucleated cells.

They carry oxygen from the

lungs to the tissues.

They have a life span of 120 days

before it is phagocytosed and

digested by macrophages in the spleen.

About 0.1% of the cells in blood

are nucleated white

blood cells or leukocytes.

They have lifespans

ranging from a day for neutrophils, to

as long as 20 to 30 years,

for some T lymphocytes. The normal

adult blood cell counts is as

under. The types of leukocytes:

There are two types: Granulocytes

and Agranulocytes.

Granulocytes are of three types: Basophils,

Eosinophils and Neutrophils, and

Agranulocytes include monocytes,

macrophages, dendritic

cells and lymphocytes which include T cells,

B cells and Natural Killer cells.

The granulocytes,

based on the nature of their granules,

are differentiated into three types:

The Neutrophilic PMNLs are produced

by hematopoiesis,

in the bone marrow,

released into the peripheral blood.

They circulate for seven to 10 hours

before migrating into the tissues.

They have a life span of only a few

days. They constitute 50% to 70% of

the circulating white blood cells.

They are most numerous and active

of the granulocytes.

They have multilobed nucleus and a

granulated cytoplasm. The granules

have no affinity for either

acidic or basic dyes.

They are the first to arrive

at a site of inflammation.

This transient increase in the

number of circulating neutrophils

is called leukocytosis,

and it is used medically as

an indication of infection.

The functions of neutrophils are

1. phagocytosis of microorganisms

and dead body cells.

They contain lytic enzymes and

bactericidal substances in granules,

which helps them to accomplish

intracellular digestion of foreign

material after it is phagocytosed.

The larger primary granules are

a type of lysosomes which

contain peroxidase, lysozyme,

defensins and various hydrolytic enzymes.

The smaller secondary

granules contain collagenase,

lactoferrin, cathelicidins, and lysozyme.

The neutrophils have receptors for

antibodies and complement proteins.

Second, use oxygen-dependent

and oxygen-independent pathways,

which generate additional

antimicrobial substances.

The third function, they do not

reside in the healthy tissue,

but circulate in the blood.

They then rapidly migrate.

to the site of tissue damage,

and infection,

and become the principal phago

cytic and microbicidal cells.

Eosinophilic PMNLs also called

Acidophils or Eosinophils have

a bilobed nucleus connected by a

slender thread of chromatin and

granules in the cytoplasm that

stain red with the acid dye Eosin.

Hence its name.

They are motile phagocytic cells which

migrate from the bloodstream into the

tissue spaces especially mucous membranes.

Their phagocytic role is significantly

less important than that of neutrophils.

The Eosinophils numbers are often

increased during allergic reactions.

The functions of Eosinophils:

They play a role in allergic reactions,

as they have granules containing histaminase,

and aryl sulfatase.

They release histamine,

heparin serotonin from mast cells

involved in inflammatory reaction.

They also play a role in the

defense against parasitic organisms

by secreting the contents of

eosinophilic granules, which damage

the parasite plasma membrane.

The Basophilic PMNLs has a bilobed nucleus,

and heavily granulated cytoplasm that

stains with the basic dye methylene blue.

They have an irregular shaped

nucleus with two lobes,

and granules that stain,

bluish black with basic dyes.

They are non phagocytic

granulocytes that function by

releasing pharmacologically

active substances from their

cytoplasmic granules that contain histamine,

prostaglandins,

serotonin,

and leukotrienes,

which play a major role in certain

allergic responses. Because these

physiological mediators influence the

tone and diameter of blood vessels,

they are called vasoactive mediators.

The Basophils possess high affinity

receptors for immunoglobulin E.

When coated with IgE antibodies,

binding of antigen to the IgE can trigger

the secretion of vasoactive mediators,

which play a major role in certain

allergic responses such as eczema,

hay fever,

and asthma. The monocytes and

macrophages are highly phagocytic and

make up the monocyte-macrophage system.

Monocytes are mononuclear leukocytes,

with an ovoid or kidney shaped nucleus

and granules in the cytoplasm that

stain gray blue with basic dyes.

They are produced in the bone

marrow and enter the blood.

They circulate for about 8 hours.

They enlarge,

migrate to the tissues to mature

into macrophages or dendritic cells.

The differentiation of a mono

cyte into a tissue macrophage

involves a number of changes

as under. They also have surface molecules

that function as toll-like receptors,

specialized scavenger receptors,

receptors for antibodies and serum

glycoproteins such as complement.

Both antibody and complement proteins

can coat microorganisms or foreign

material and enhance their phagocytosis.

This enhancement

is called opsonization.

The macrophages are dispersed

throughout the body.

Some take up residence in particular

tissues, becoming fixed macrophages,

others remain motile,

and are called free or wandering macrophages.

They travel by amoeboid

movement throughout the tissues.

Macrophages serve different

functions in different tissues,

and are named according to their

tissue location as under:

Activated macrophages are more

effective than resting ones in

eliminating potential pathogens because

they exhibit greater phagocytic

activity and increased ability to

kill ingested microbes, increased

secretion of inflammatory mediators,

increased ability to activate T cells,

secrete various cytotoxic proteins

to eliminate a range of targets.

They express Class II MHC molecules

which function as antigen-

presenting cells for TH cells.

Thus, macrophages and TH cells

facilitate each other’s activation

during the immune response,

The mast cells are derived from

the Mast cell precursors.

They are formed in the bone

marrow by hematopoiesis.

They are released into the blood

as undifferentiated cells.

They do not differentiate

until they leave the blood

and enter the tissues.

The mast cells are found in a

wide variety of tissues, such as

skin, connective tissues of various

organs and mucosal epithelial

tissue of the respiratory, genito,

urinary and digestive tracts.

Like circulating basophils,

they have large numbers of cytoplasmic

granules which contain histamine and

other pharmacologically active substances.

Their functions: they play an important

role in the development of allergies.

They possess high affinity

receptors for immunoglobulin

E, that is associated with allergic responses.

The dendritic cells were the

first cells of the immune system,

discovered in 1868 by Paul Langerhans.

They acquired its name as they

are covered with long membranous

extensions that resemble the

dendrites of nerve cells.

They constitute only 0.2% of the

white blood cells in the blood.

They play an important role

in nonspecific resistance.

They are present in the skin and

mucous membranes of nose,

lungs and intestines.

They readily contact invading pathogens,

phagocytose and process antigens,

and display foreign antigens on

their surface.

This process is known as

antigen presentation.

The dendritic cells can recognize

specific pathogen-associated-

molecular patterns,

PAMPs on microorganisms that enable

the dendritic cells to distinguish

between potentially harmful

microbes and other host molecules.

The PAMPs are produced only by

microorganisms, that are perceived by

the phagocytic cells of the innate

immune system as molecular signatures

of infection. After the

pathogen is recognized,

the dendritic cell’s pattern

recognition receptors

PRRs bind the pathogen and phagocytose it.

The dendritic cells then migrate

to the lymphoid tissues

where, as activated cells they

present the antigen to the T cells.

This triggers the activation of T

cells for specific immune response.

There are four types of dendritic cells: Each

Dendritic cell arises from

hematopoietic stem cells

via different pathways

and in different locations:

The Langerhans Dendritic cells

are in the epidermal layers of skin,

the interstitial dendritic cells in

the interstitial spaces of virtually

all organs except the brain.

The monocyte derived

dendritic cells arise from

monocytes that have migrated

from the bloodstream into the

tissues. From the tissues,

they can move through the lymph

to the lymph nodes or cross back

into the bloodstream and use it as

an avenue of transport to lymphoid tissue.

The plasmacytoid-derived dendritic

cells arise from plasmacytoid cells.

They have roles in innate immune defense

and as antigen presenting cells.

The dendritic cells all share display

of class I and Class II MHC molecules,

and CD80, CD 86 as well as CD 40.

The dendritic cells are versatile.

They have distinct functions,

1.Antigen capture of

intruding or foreign antigens.

2. They present antigen to the T cells.

The follicular dendritic cells:

do not arise in bone marrow,

have completely different functions.

They do not express Class II MHC molecules,

therefore,

do not function as antigen presenting

cells for TH cell activation. They are

named for their exclusive location

in organized structures of the

lymph node called lymph follicles,

which are rich in B cells.

They do express membrane receptors

for antibody,

which allows efficient binding

of antigen-antibody complexes.

These are the references and credits.