To Process an antigen ?

Bustami

To modify it in some way, so that it can be "recognized" as foreign by a lymphocyte
B cell ← → T cell

Macrophage → Processing of antigen by macrophages involves phagocytosis and partial digestion of the antigens

Dendritic cells → Some dendritic cells are NOT phagocytic
→ they process antigen on the surface of their plasma membranes !!

Antigen Presenting cells → Process both exogenous & endogenous antigens

A macrophage → Phagocytoses
- Bacteria which have exogenous antigens on their surfaces
- virus-infected cells, cancer cells → have endogenous antigens on their surfaces

→ In order to be recognized as foreign by T cells → exogenous antigens must be processed & associated with MHC-II Proteins

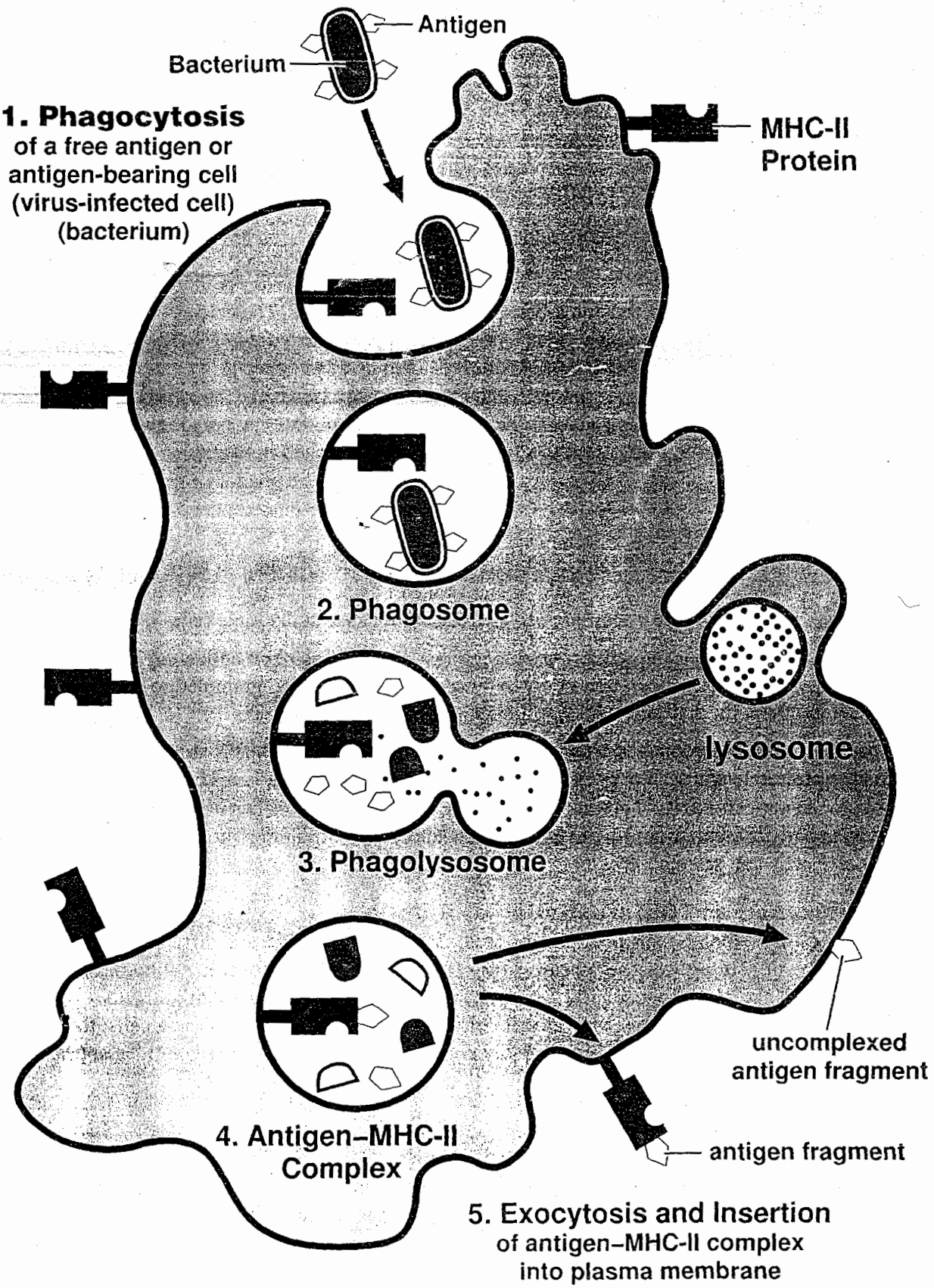
→ endogenous antigens must be processed & associated with MHC-I Proteins

The bacterial antigen fragments that associate with MHC-II proteins are presented to (recognized by) helper T cells (T4 cells), triggering activation of the helper T cells and the release of lymphokines such as interleukin-2 (IL-2), which helps to activate B cells. Uncomplexed antigen fragments are recognized by receptors on B cells, triggering their activation and transformation into antibody-secreting plasma cells.

Bustami

ANTIGEN PROCESSING

Example: A Macrophage Processing Bacterial Antigens



Antibody-mediated immunity

Effective against

- Extracellular pathogens (primarily Bacteria)
- Antigens dissolved in body fluids e.g bacterial toxins

Mechanism

Activation of B cells

→ B cells can respond to unprocessed antigen in lymph or interstitial fluid but the response is much more intense if the antigens are processed by macrophages or dendritic cells } Antigen presenting cell (APC)

Antigen recognition ? → refers to the binding of an antigen to B cell receptors → Each specific type of antigen BINDS only to those B cells that are programmed to secrete antibodies that attack (bind to) that same type of antigen.

⊛ **when B cells become activated** → they enlarge divide & differentiate into a clone (population of identical cells) of plasma cells ⟹ plasma cells secrete specific antibodies that circulate in the lymph and blood to reach the site of invasion WHERE THEY BIND TO THEIR ANTIGENS.

Memory B cells → Some of the activated B cells do not differentiate into plasma cells, they remain as memory B cells ⟶ they respond more rapidly & forcefully should the same antigen appear at a future time

When Bacteria penetrate the skin or mucous membrane → possible outcome ???

They may be (A) Phagocytosed & Killed by tissue macrophages,

① Process & display portions of the bacterial antigen on their surface complexed with MHC-II → The macrophage may present Antigen-MHC-II complex to B cells in nearby lymphatic tissue → Activation of B cell ------ plasma cell → antibodies / memory B cell

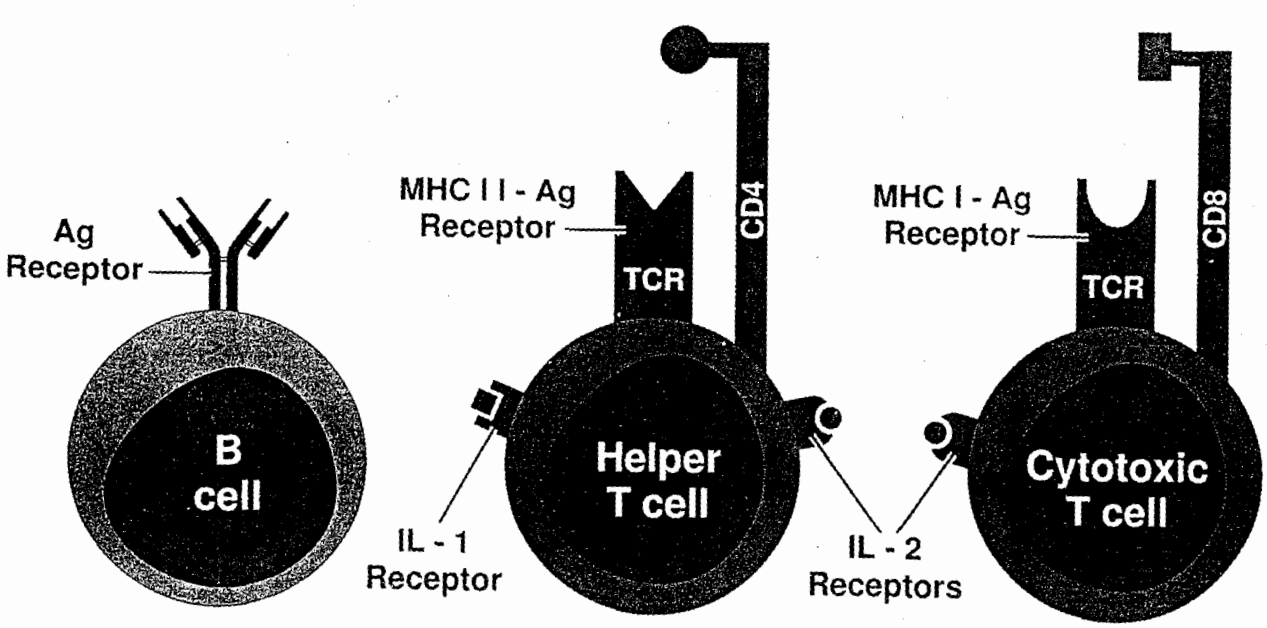
② MIGRATE along a lymphatic vessel carrying the antigen into a lymph node & present it to a B cell in a primary follicle ..... etc.

③ MIGRATE along a blood vessel carrying the antigen to the spleen & present it to a B cell in a follicle located in the white pulp

(B) Unphagocytosed bacteria
- enter a lymphatic vessel → lymph node → phagocytosed by bacteria that line sinuses of lymph node
- enter a blood vessel → spleen → phagocytosed by macrophages that line sinuses of spleen

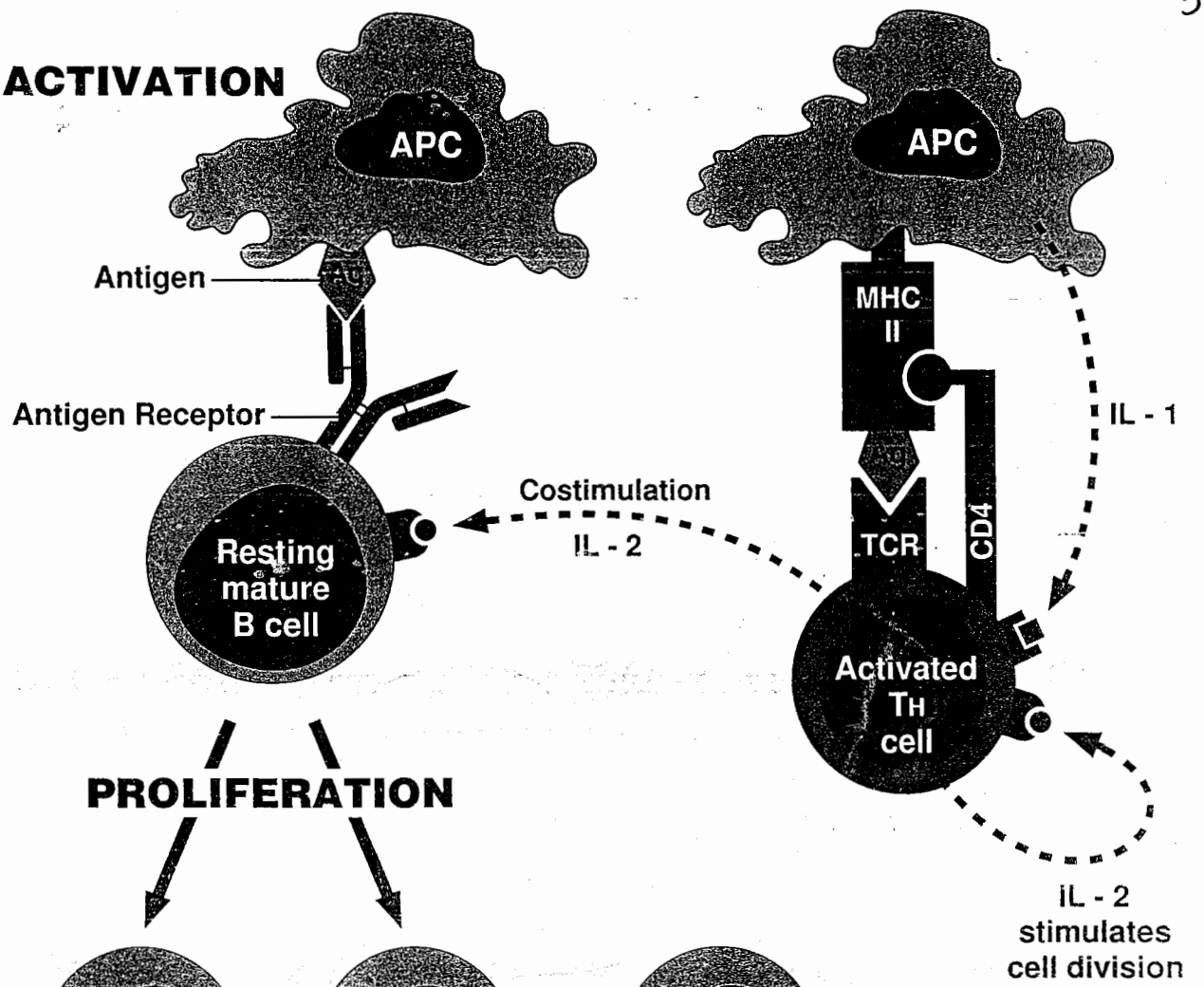
All of these outcomes may occur simultaneously

An immune response to the same antigen may be initiated in different lymphatic tissues of the body at the same time

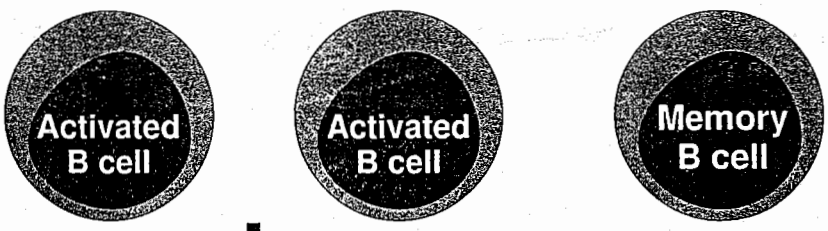


ANTIBODY-MEDIATED IMMUNITY

ACTIVATION

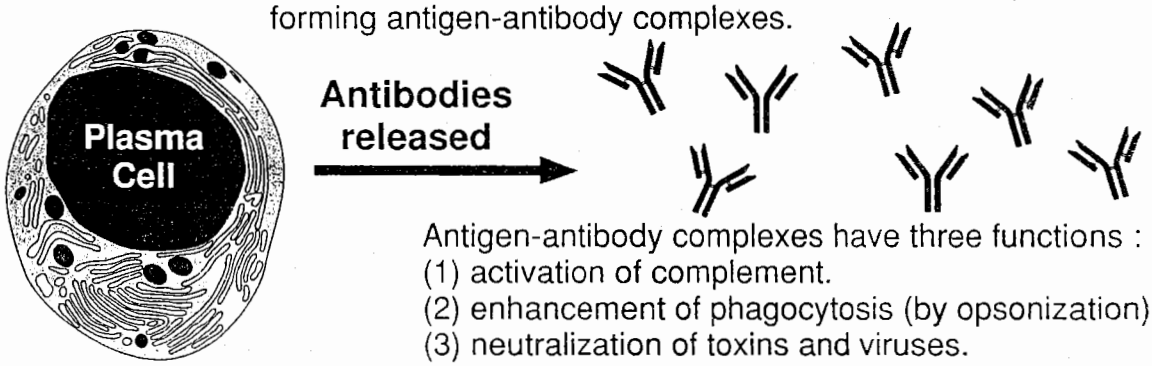


PROLIFERATION



DIFFERENTIATION

Antibodies travel via the blood to all regions of the body and bind to antigens of the kind that stimulated their production, forming antigen-antibody complexes.



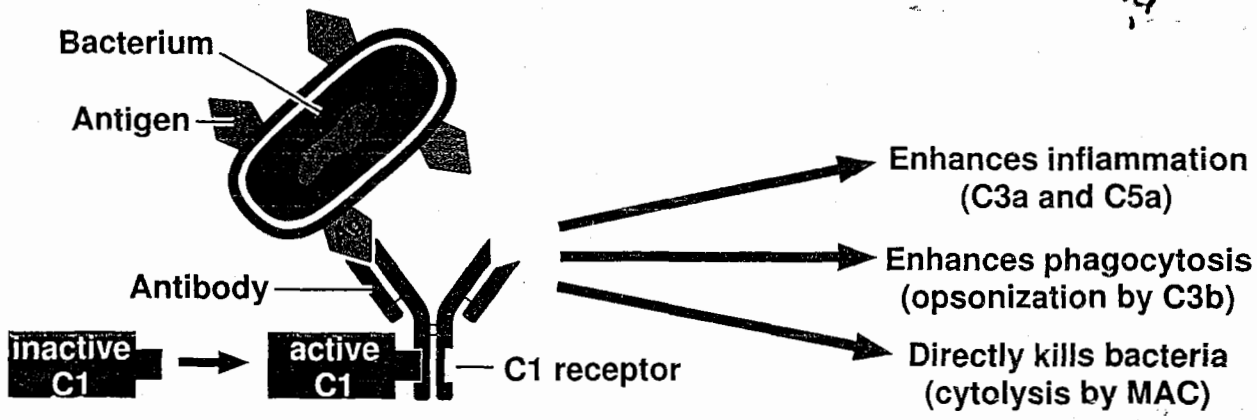
Antigen-antibody complexes have three functions :
(1) activation of complement.
(2) enhancement of phagocytosis (by opsonization).
(3) neutralization of toxins and viruses.

Costimulation Macrophages also present antigen to helper T cells. This stimulates the helper T cells to proliferate and secrete cytokines that costimulate the antigen-bound B cells. Helper T cells bind to the antigen–MHC-II complex and secrete IL-2 that acts as a costimulator to initiate B cell division and differentiation; IL-2 also acts as an autocrine, stimulating proliferation of the same helper T cells that secreted it.

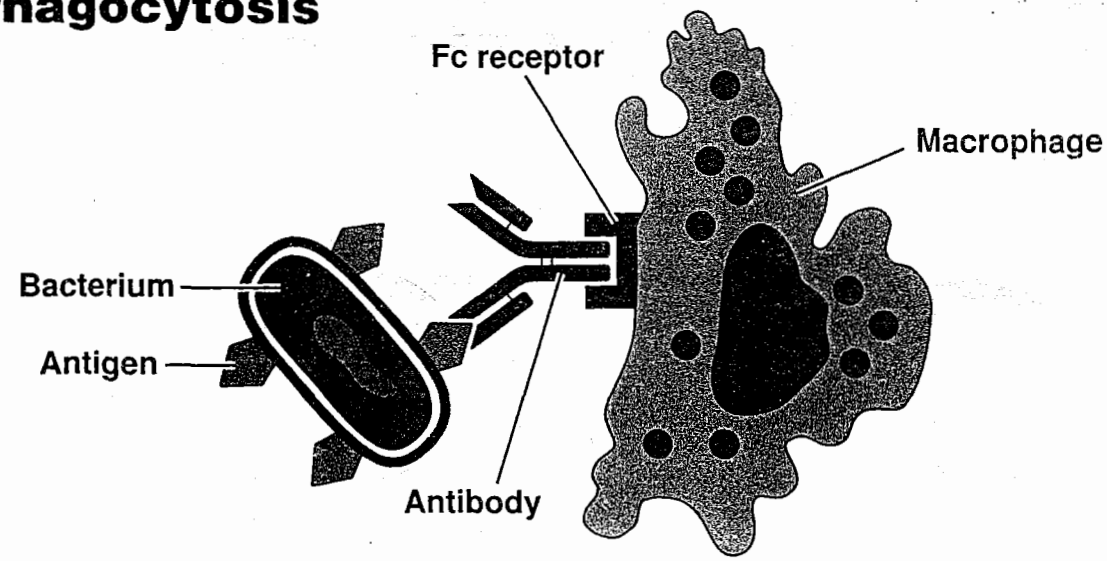
ANTIBODY FUNCTIONS

Bustami

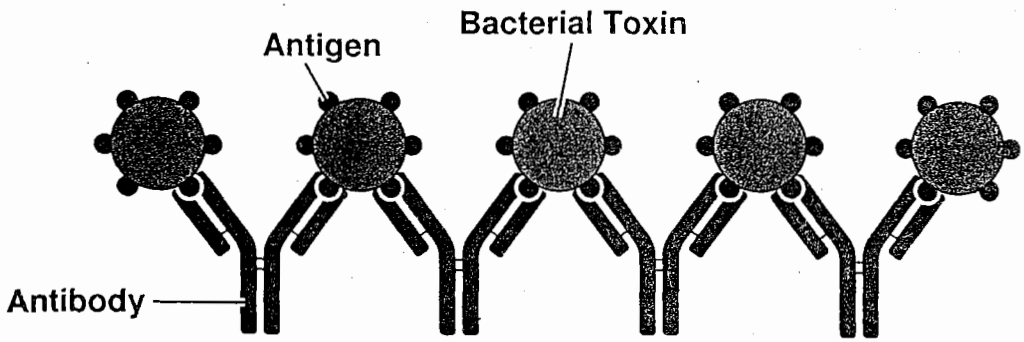
Activation of Complement



Phagocytosis



Neutralization



Antibody Functions

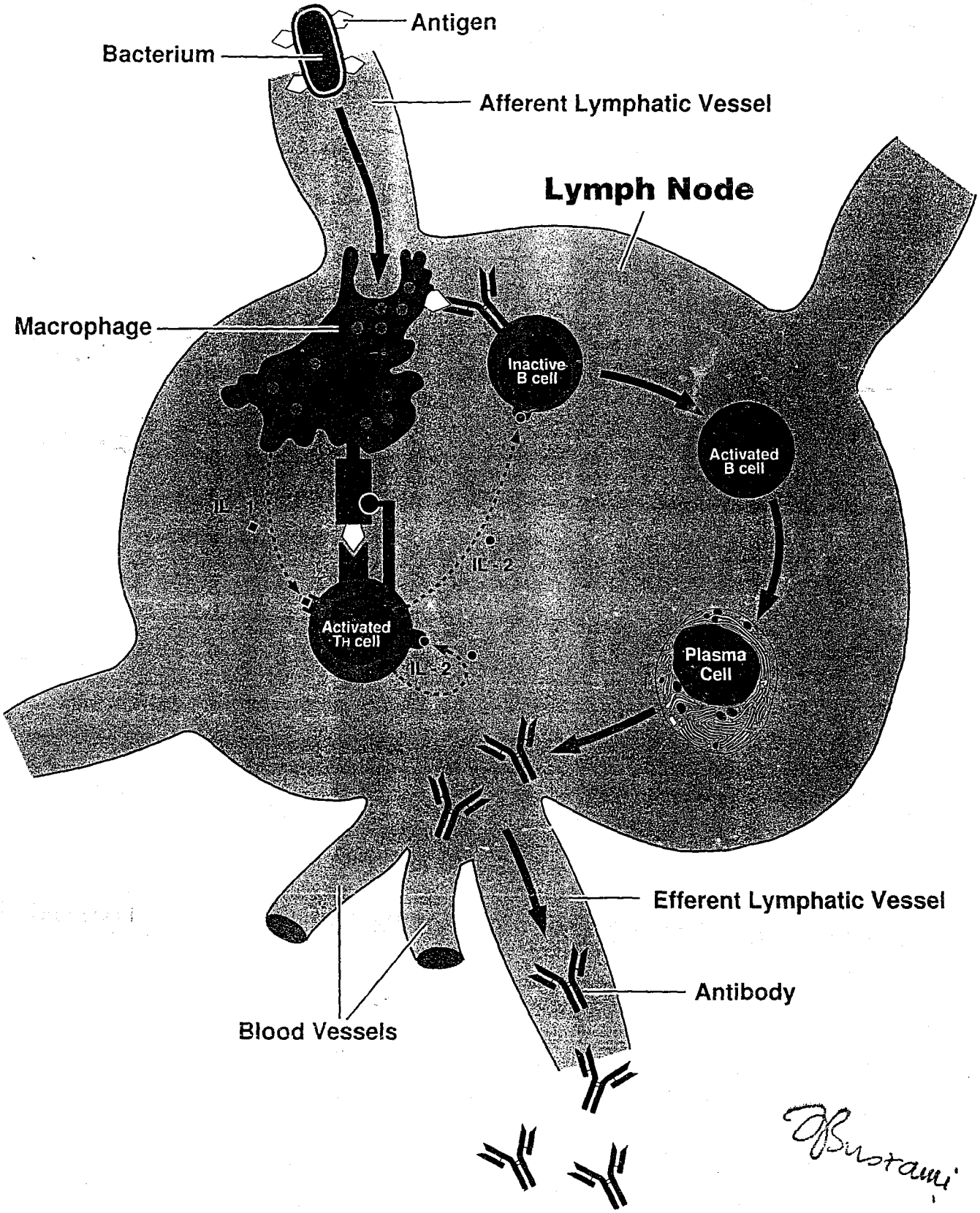
Antibodies destroy antigens by three basic mechanisms:

(1) Activation of Complement Complement kills bacteria by cytolysis and enhances phagocytosis.

(2) Phagocytosis Coating of bacteria with antibody (opsonization) enhances phagocytosis.

(3) Neutralization Antibodies link toxins or viruses, forming nonpathogenic substances.

ANTIBODY PRODUCTION IN LYMPH NODE



Bustami

Cell-Mediated immunity

Directly Kill specific ABNORMAL or FOREIGN cells

effective against

* Intracellular Pathogens — fungi, Protozoa, viruses inside body cells
* Cancer cells
* cells of tissue transplantation

Mechanism

Activation of Cytotoxic T cells

e.g virus

viruses attack body cells by injecting their nucleic acids into the cytoplasm → viral nucleic acids alter the DNA of the host cell causing it to produce viral proteins which are used to produce new viruses

SOME OF THE VIRAL PROTEINS ARE INSERTED IN THE PLASMA MEMBRANE OF THE HOST CELL COMPLEXED WITH MHC-I Proteins

since MHC-I proteins are present on all body cells this type of antigen-MHC-I complex can be formed by any virus-infected cell.

Tumour antigens → cancer cells result from genetic changes induced by viruses, chemicals or radiation

genetically altered cancer cells produce UNUSUAL PROTEINS NOT FOUND IN NORMAL BODY CELLS

SOME OF THESE CANCER-INDUCED PROTEINS CALLED TUMOR ANTIGENS ARE INSERTED IN THE PLASMA MEMBRANES OF TUMOR CELLS ASSOCIATED WITH MHC-I PROTEINS

* THE ANTIGEN-MHC-I complexes serve as BINDING SITES for cytotoxic T cells

Antigen Recognition

Refers to BINDING of an antigen to a T cell Receptor (TCR)

There are millions of different cytotoxic T cells
→ EACH WITH UNIQUE TCRs THAT CAN RECOGNIZE SPECIFIC ANTIGEN–MCH–I Complexe

(*) When a resting (inactive) cytotoxic T cell encounters its antigen complexed with MHC-I Proteins on the surface of a virus-infected or Cancer cells it BINDS TO (Recognizes) the Complex

Activated cytotoxic T cells → Enlarge & divide forming a clone of cytotoxic T cells
→ At the same time memory cytotoxic T cells are produced

The activated cytotoxic T cells are carried by the BLOOD from the lymph nodes or spleen to all tissues of the Body → When they encounter cells that display their antigens complexed with MHC-I Proteins → they bind & RELEASE DAMAGING CYTOKINES

Attack by Cytotoxic T Cells

Cytotoxic T cells have three killing mechanisms :

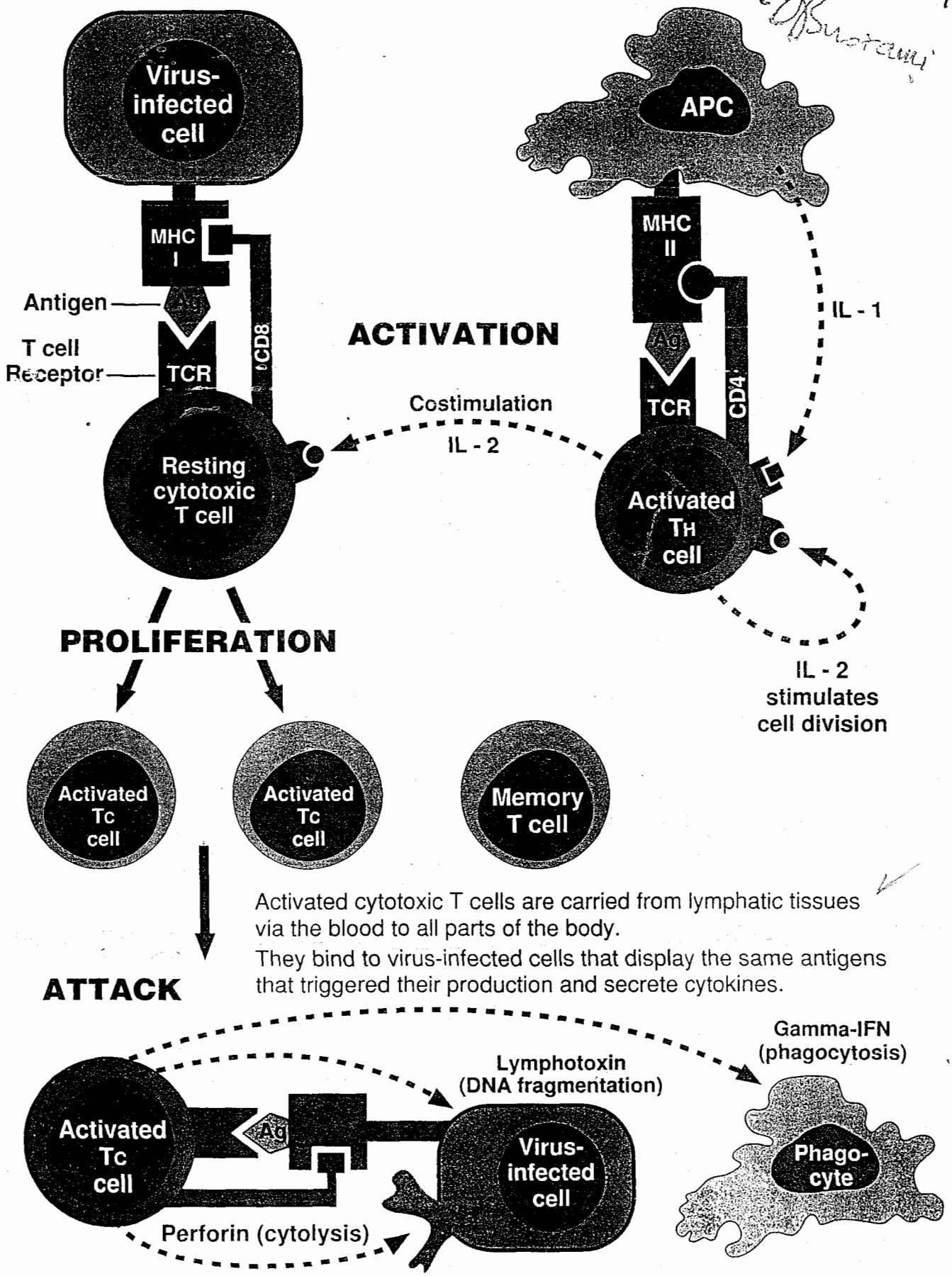
(1) Cytolysis (Lysis) A cytokine called *perforin* forms pores in the plasma membranes of target cells, causing them to burst and die.

(2) DNA Fragmentation A cytokine called *lymphotoxin* kills target cells by DNA fragmentation.

(3) Phagocytosis A cytokine called *gamma-interferon* enhances the phagocytic activity of macrophages, which ingest and kill the target cells.

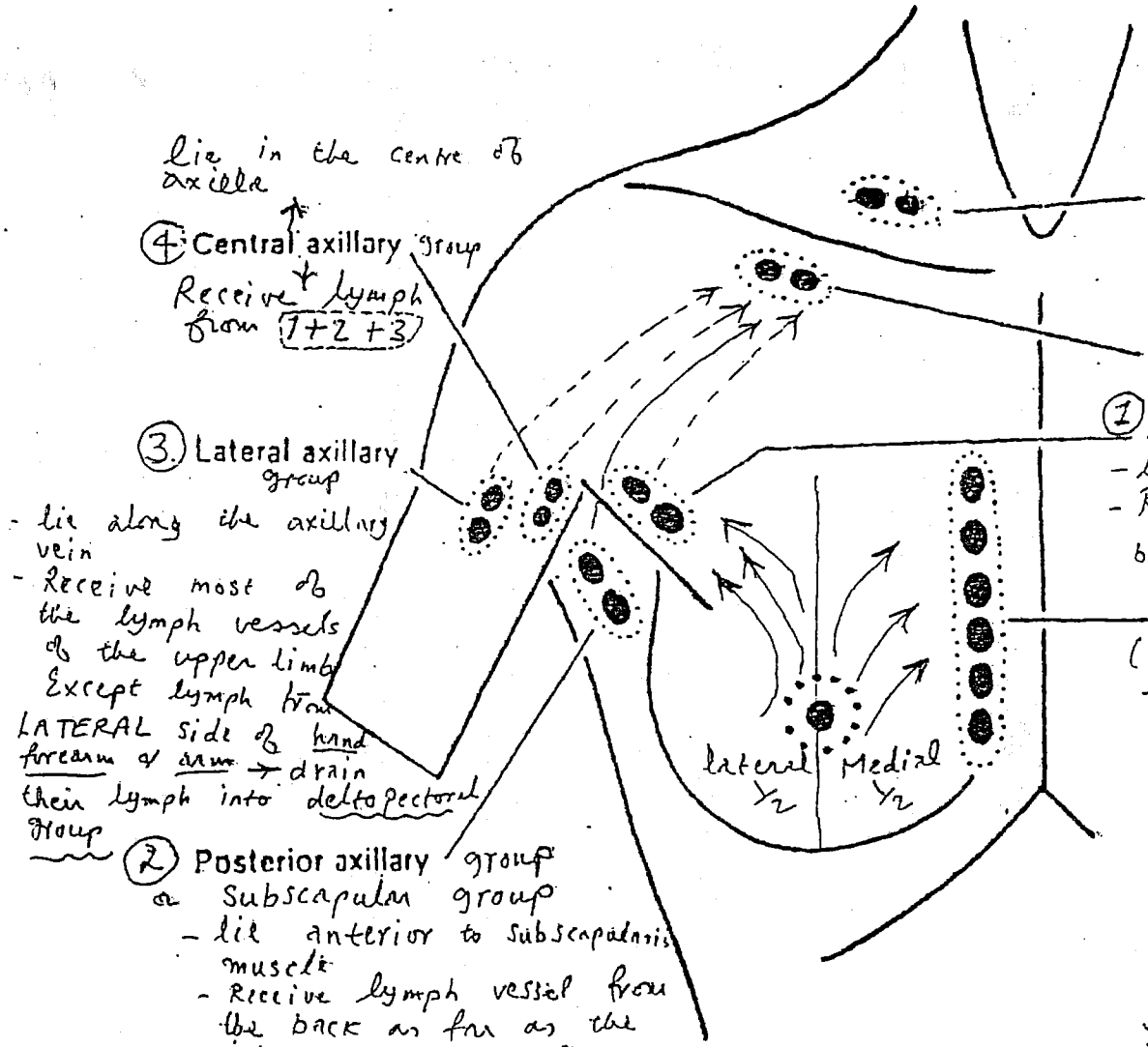
Costimulation Macrophages phagocytize virus-infected cells and cancer cells. They process and insert fragments of the antigens into their plasma membranes associated with MHC II. The macrophages present these antigens to resting helper T cells located in lymphatic tissues. The helper T cells are costimulated by IL-1, which is secreted by the macrophages. The activated helper T cells proliferate and secrete a variety of cytokines, especially IL-2. The IL-2 acts as a costimulator for antigen-bound cytotoxic T cells. IL-2 also acts as an autocrine, increasing the proliferation of helper T cells (a positive feedback mechanism).

CELL-MEDIATED IMMUNITY



Activated cytotoxic T cells are carried from lymphatic tissues via the blood to all parts of the body.
They bind to virus-infected cells that display the same antigens that triggered their production and secrete cytokines.

{Superficial lymphatics follow veins
deep " " arteries}



lie in the centre of axilla

④ Central axillary group
Receive lymph from (1+2+3)

③ Lateral axillary group
- lie along the axillary vein
- Receive most of the lymph vessels of the upper limb
Except lymph from LATERAL side of hand forearm or arm → drain their lymph into deltopectoral group

② Posterior axillary group
or Subscapular group
- lie anterior to subscapularis muscle
- Receive lymph vessel from the back as far as the iliac crest

lie at the apex of axilla
receive lymph from 1+2+3+4

① Anterior axillary group (Pectoral group)
- Lies behind Pectoralis major
- Receive lymph from:
a- lateral ½ of breast
b- abdominal wall above umbilicus

Internal mammary (inside thorax)
- Receive lymph from medial ½ of breast

Lymph nodes draining the breast

- The apical lymph nodes drain into the subclavian lymph trunk
- on the left this trunk drains into thoracic duct → venous circulation
- " " right " " " " Rt-lymph trunk → " "

Shnotami

Shnotami

11

SUPERFICIAL INGUINAL LYMPH NODES

The superficial inguinal lymph nodes are variable in their number and size. Their arrangement is 'T'-shaped, having a lower vertical group and an upper horizontal group. The upper nodes can be subdivided into the upper lateral and upper medial groups.

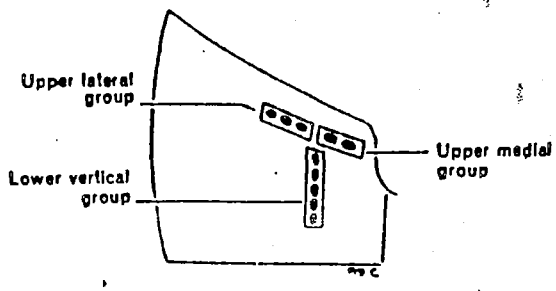


Fig. 5 Superficial inguinal lymph nodes.

1. The *lower vertical group* is placed along both sides of the upper part of great saphenous vein. It drains the skin and fasciae of the lower limb, except the buttock (to upper lateral group) and the short saphenous territory (to popliteal nodes).

2. The *upper lateral group* is placed below the lateral part of inguinal ligament. It drains the buttock, flank and the back below the waist.

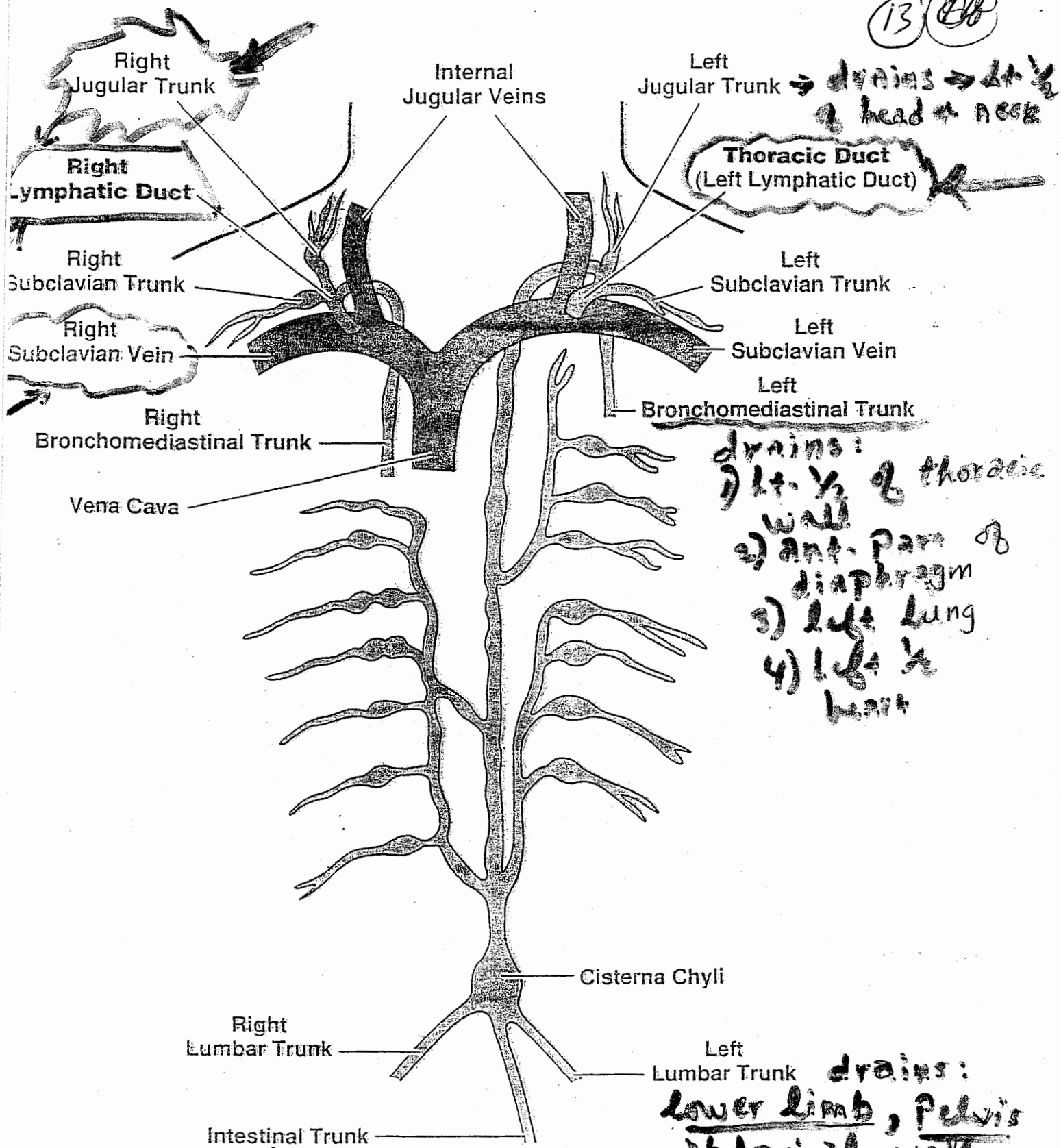
3. The *upper medial group* is placed below the medial end of the inguinal ligament; one or two nodes may lie above the inguinal ligament on the course of the superficial epigastric vessels. They drain anterior abdominal wall below the umbilicus, and the perineum.

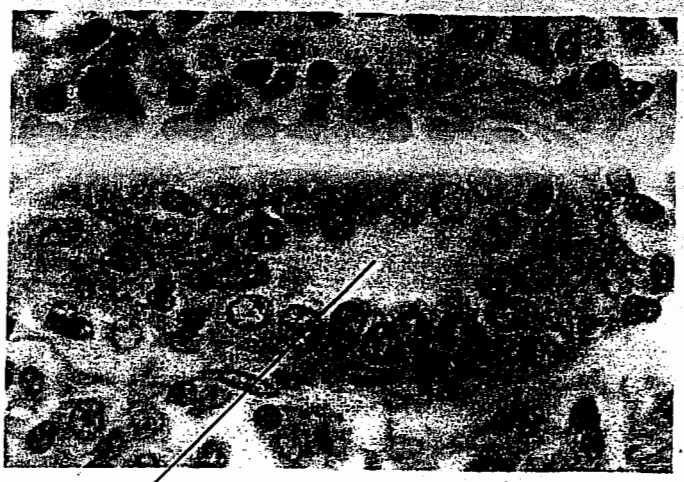
* The *efferents* from all superficial nodes pierce the cribriform fascia, and terminate into the deep inguinal lymph nodes which lie along the upper part of the femoral vessels.

Painful enlargement of the superficial inguinal lymph nodes may therefore indicate a disease of the superficial parts of the lower limb including the buttock, infraumbilical part of anterior abdomial wall, perineum, external genitalia, anus, vagina and round ligament of uterus.

LYMPH TRUNKS AND LYMPHATIC DUCTS

13





Postcapillary venules lined with simple cuboidal endothelium

Feature	*Thymus*	*Lymph Node*	*Spleen*
Role	Primary	Secondary	Secondary
Connective tissue capsule with septa or trabeculae	Present	Present	Present
Cortex and medulla	Present	Present	Absent
Lymphatics	Efferent only	Afferent and efferent	Efferent only
Major epithelial component*	Epithelial reticular cells and thymic corpuscles	Absent	Absent
Main derivatives	T cells; thymic hormones	Immunoglobulins; T & B cells	Immunoglobulins
Exposure to foreign antigens	Cortex is partly shielded	In lymph	In blood
Lymphoid nodules	Absent from cortex	Present in cortex	Present in white pulp (associated with arteries)
Plasma cells	Absent from cortex; uncommon in medulla	Present in medulla	Present in red pulp
Recirculating lymphocytes	Present in medulla only	Present	Present

* Excluding vascular endothelium or covering mesothelium.

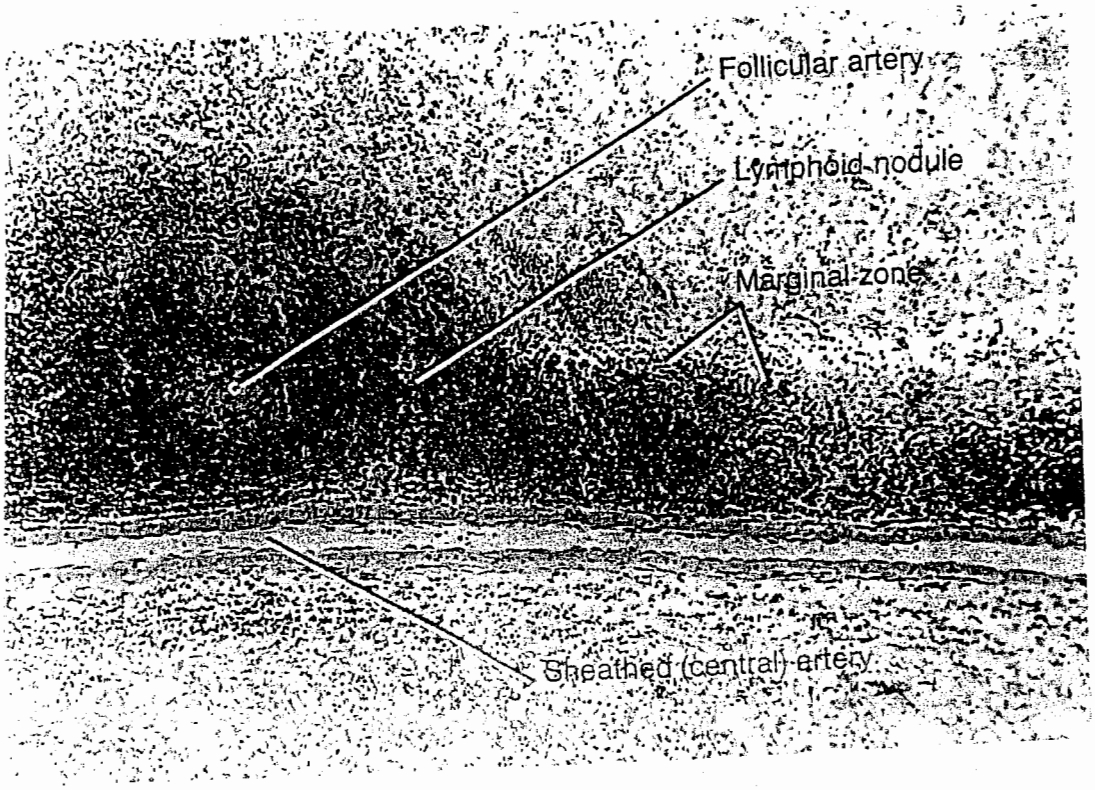


Figure 7-8
Sheathed (central) artery of the spleen, showing the lymphoid sheath, a lymphoid nodule and its follicular artery, and the border between the white pulp and red pulp (marginal zone).