

Introduction to Exercise Physiology – Overview



What is the module about?





Format

1 hour lecture

2 hour practical

Readings - Moodle

Worksheet

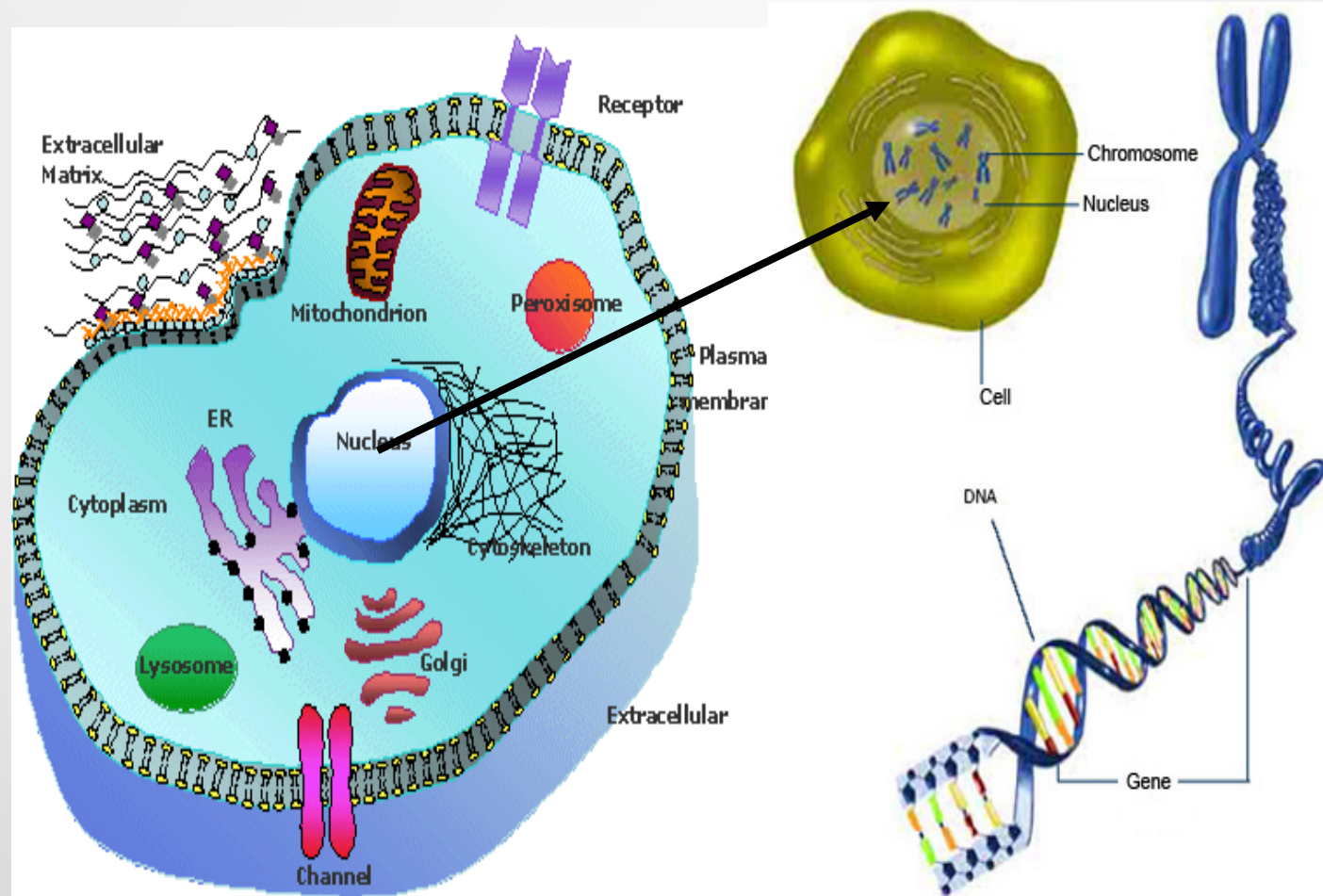
Why is this Important?

- Prescribing exercise
- Teaching / coaching
- Rehabilitation
- Health, exercise, lifestyle promotion
- Lifestyle Coaching
- Nutritional Assessment
- Understand the nature of health and illness / disease

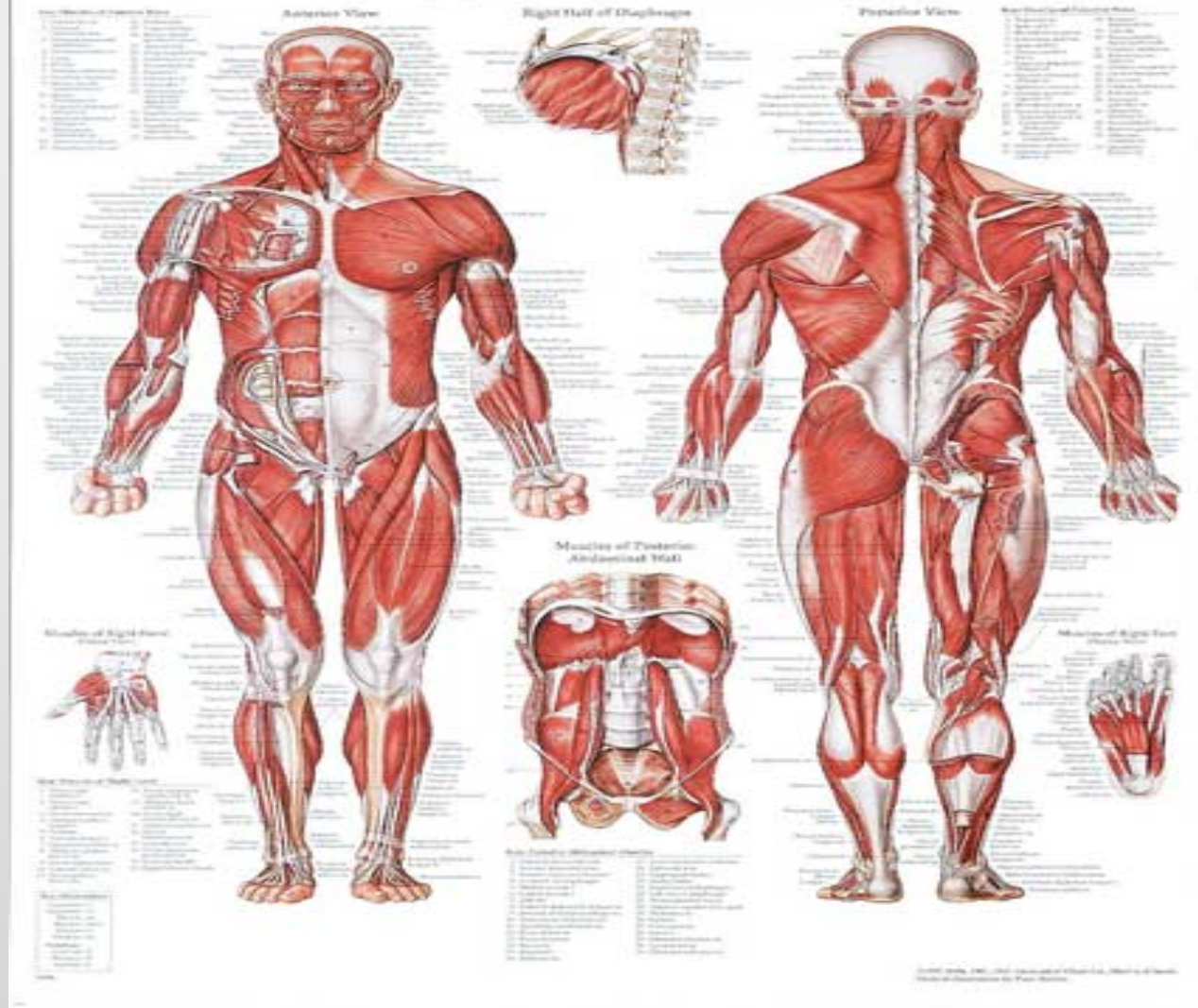
Homeostatis/ The Cell

- Structure of the cell.
- Organelles and their functions.
- DNA
- Maintenance of balance within the system
- Core level for cellular regulation

Eukaryotic Cell



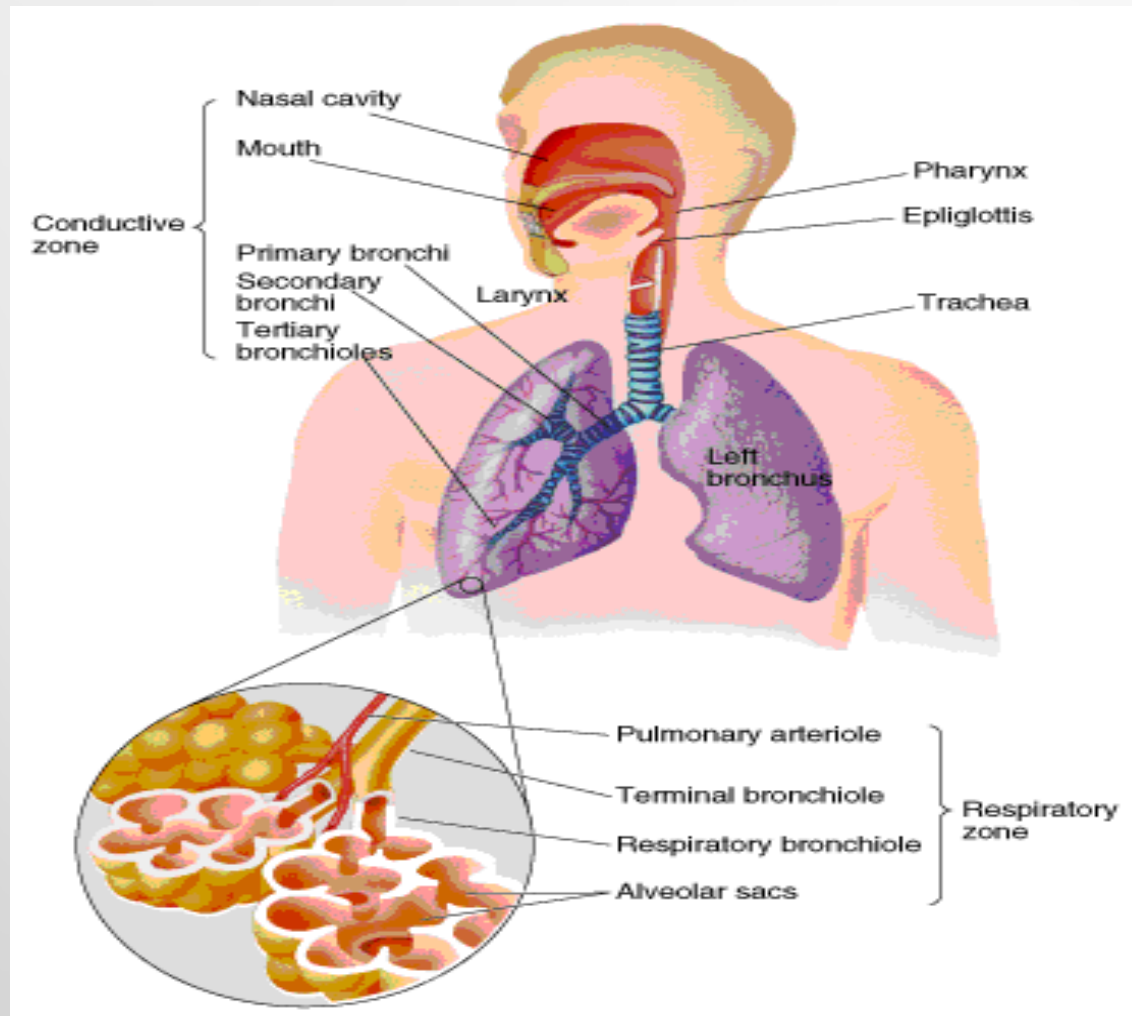
THE MUSCULAR SYSTEM



Musculoskeletal system

- Structure of muscle
- Skeletal, smooth and cardiac muscle
- Fibre types
- Contractile process
- Muscle Fatigue
- Innervation and control
- Effects of exercise and training
- Origin, Insertions and actions

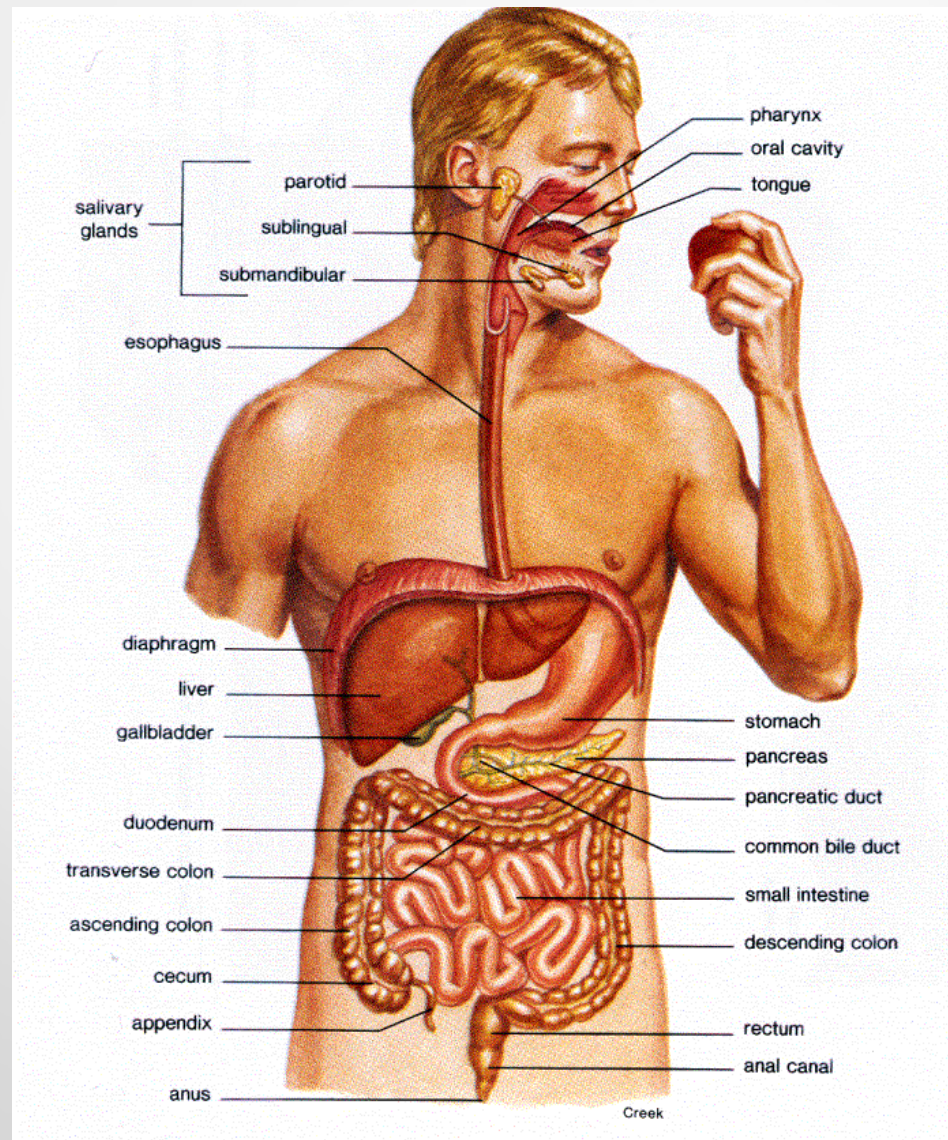
Respiratory System



Respiratory system

- Lungs
- Mechanics of breathing
- Diffusion and partial pressure
- Transport of oxygen
- Transport of carbon dioxide
- Lung capacities and volumes
- Effects of exercise and training

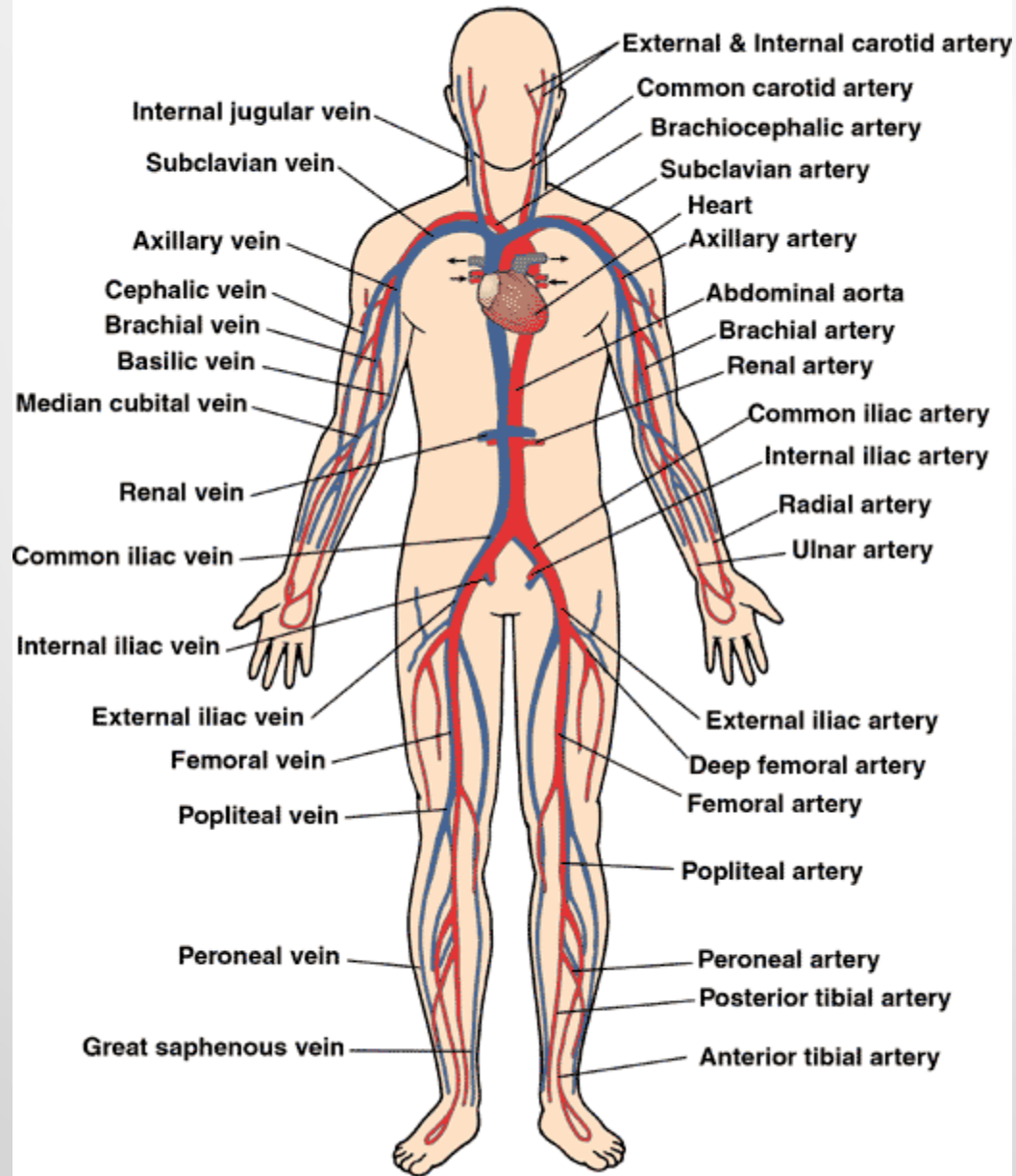
Digestive System



Digestive System

- Structure of the system
- Processes of digestion
- Enzyme activity
- Processes of absorption

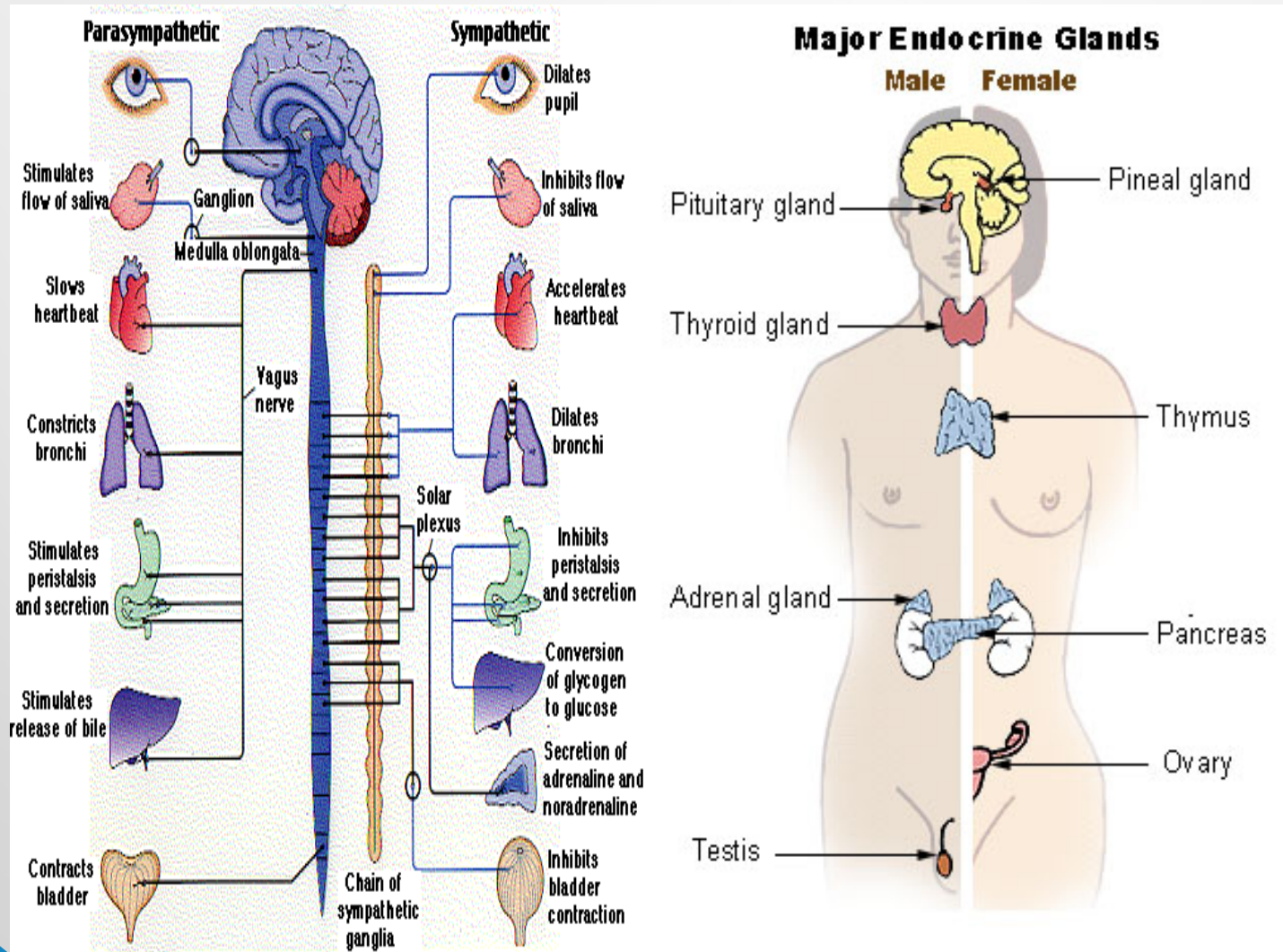
Circulatory System



Cardiovascular system

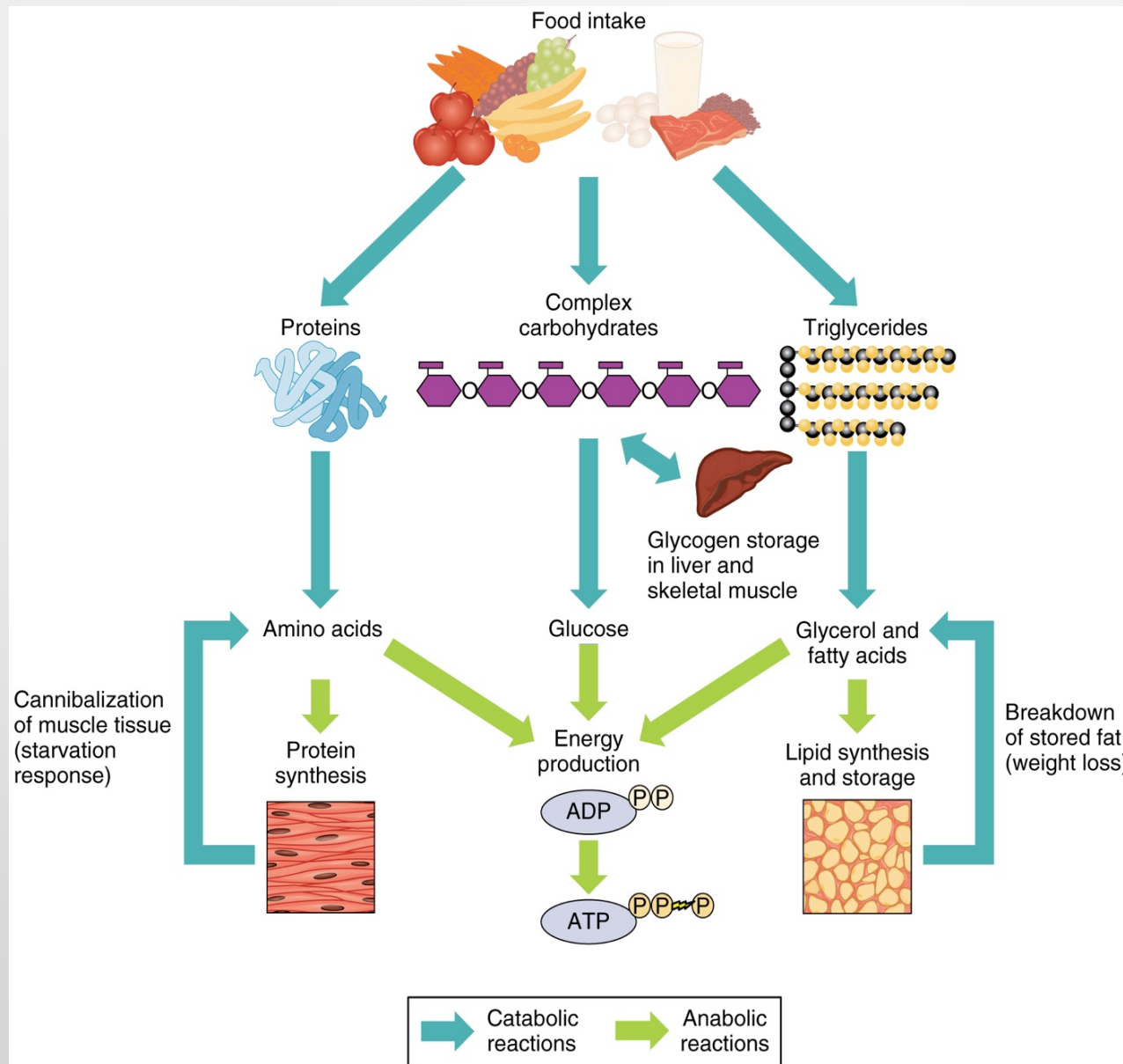
- Heart
- Blood
- Circulation, including blood vessels
- Blood pressures
- Cardiac output
- ECG
- Nerve / hormonal regulation
- Effects of exercise and training

Nervous and endocrine system

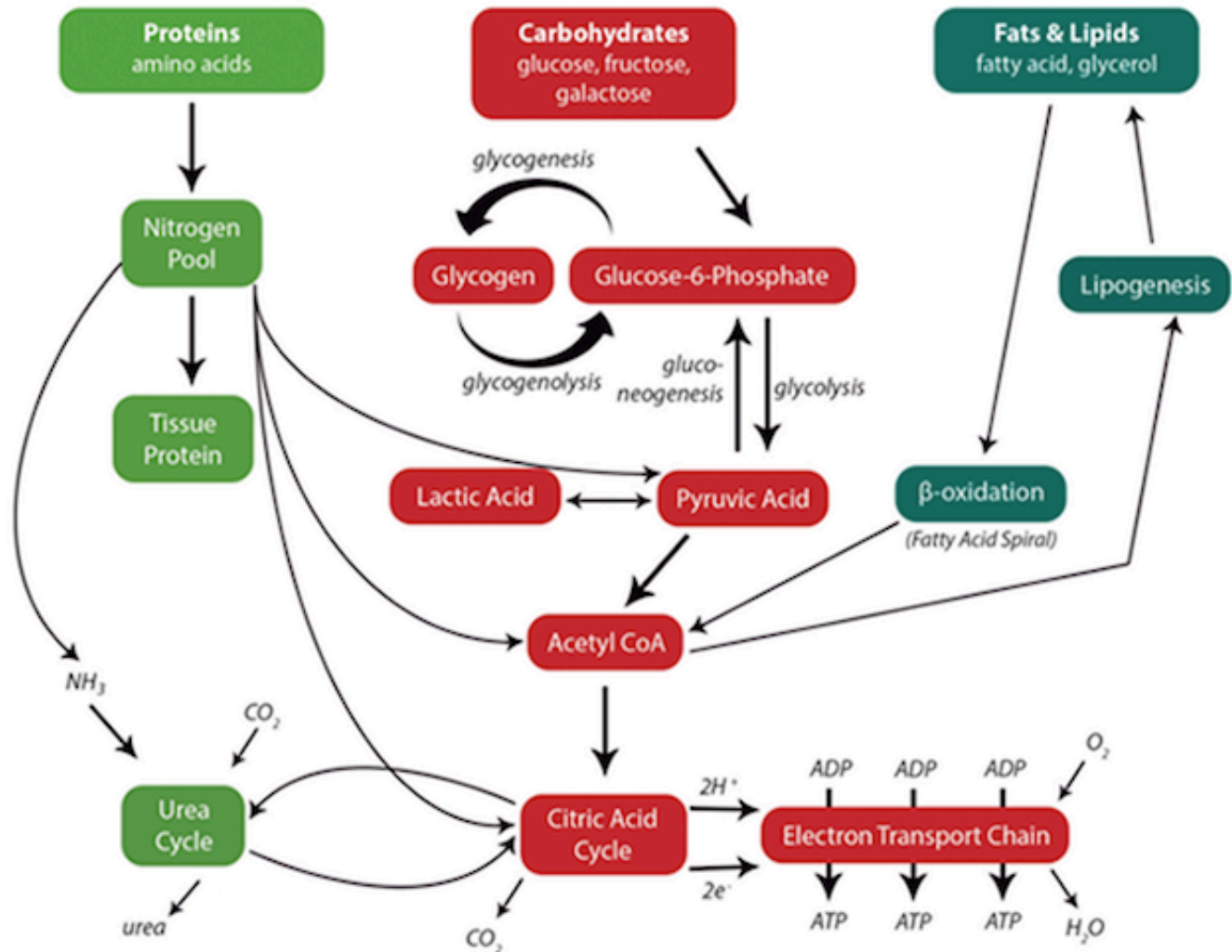


Nervous / Endocrine systems

- Structure of nerves
- Nerve impulse transmission
- Sympathetic and Parasympathetic systems
- Glands and secretion of hormones
- Nature of hormones
- Function of hormones
- Control of the body



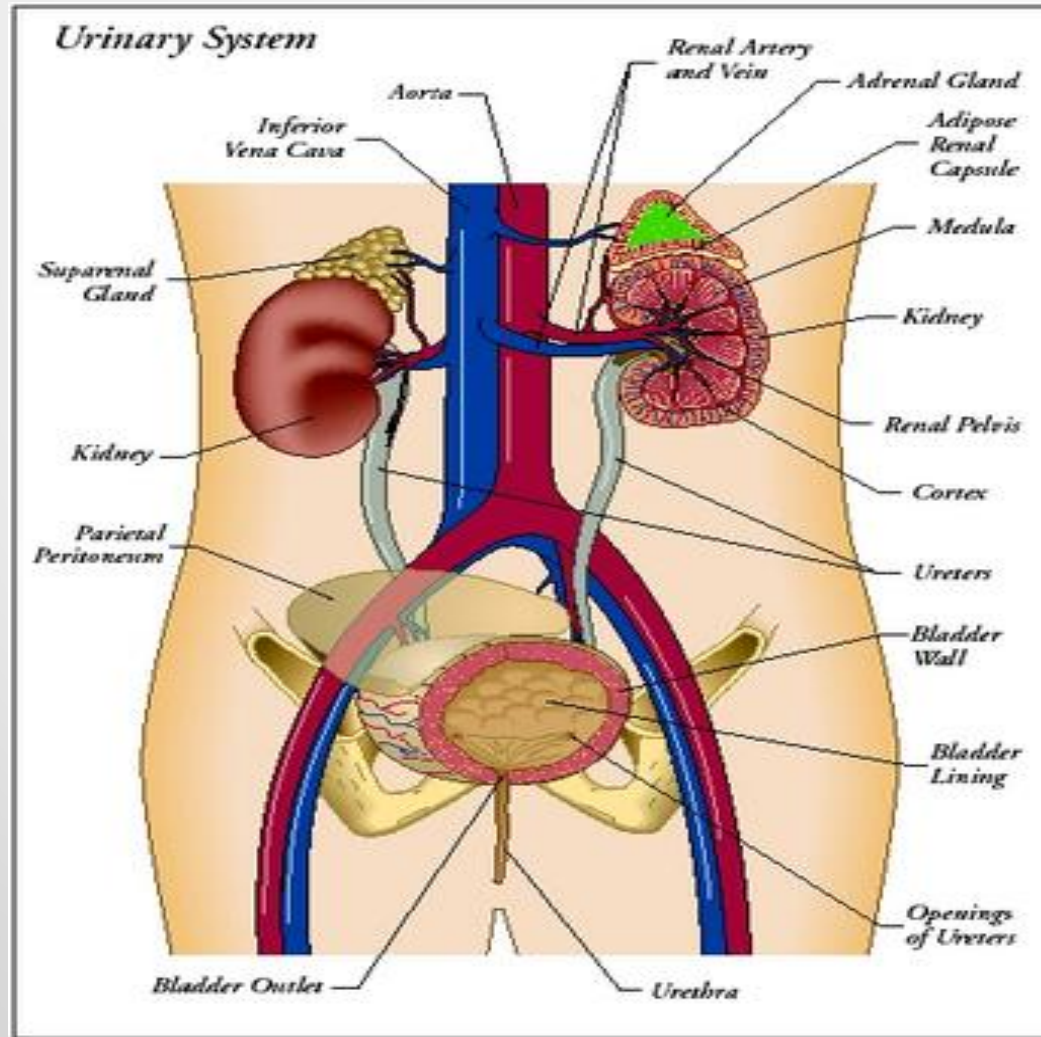
Metabolism Summary



Energy systems

- Adenosine triphosphate
- Aerobic v Anaerobic
- Glycolysis
- Krebs cycle
- Electron transport
- Beta oxidation
- Protein metabolism
- Requirement during and after exercise

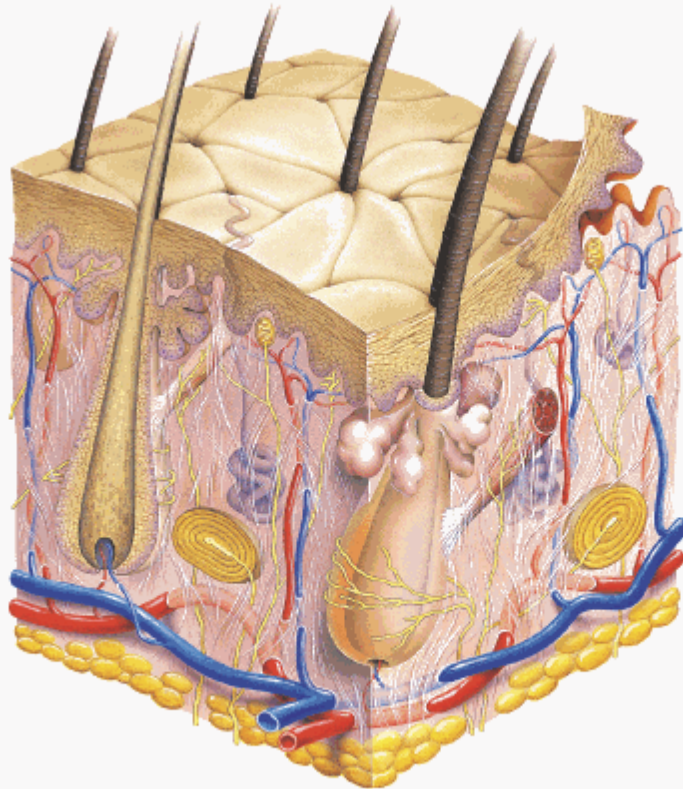
Excretory



Excretory System

- The kidneys
- Constituents of Urine
- Defecation
- Sweating

Integumentary

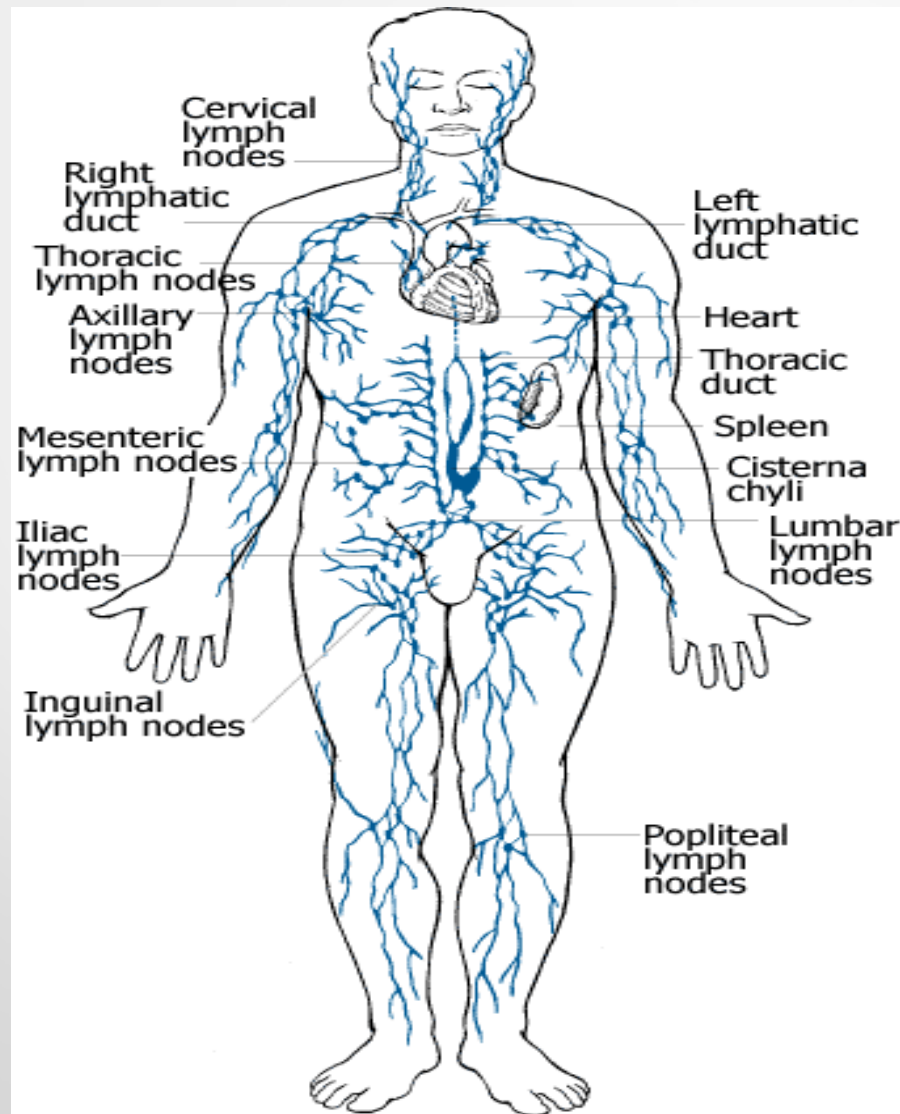


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Integumentary System

- Skin and structure of the system
- Functions of the system

Lymphatic



Lymphatic system

- Structure of the system
- Function
- Infections

Assessment

- Coursework
 - 50% Final Mark (16th December 2016)
- Coursework (audio-visual presentation)
 - 50% Final Mark (13th January 2017)

Homeostasis

- Process that occurs in all living things
- All organ systems work together to achieve homeostasis
- Ability of an organism to maintain its internal environment, despite changes to its internal or external environment

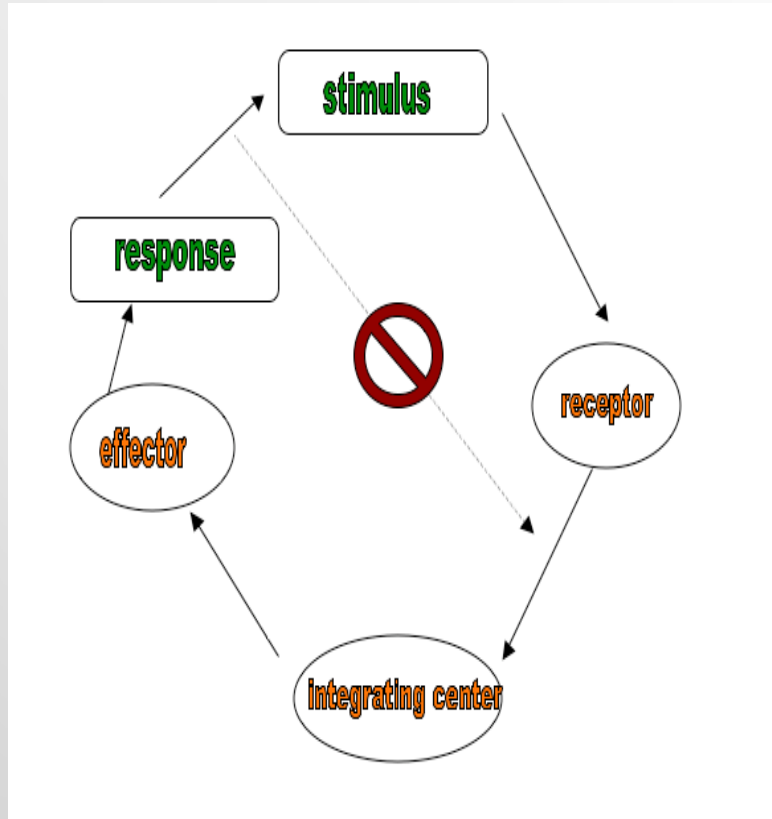
How does Homeostasis work?

- Feedback pathways
 - A cellular relay race!
 - Specific organs and structures must communicate with each other in response to changes in the body
- Keeps levels of certain processes within a normal range

What needs regulation?

- Body Temperature
- Blood pressure
- Blood pH
- O₂ and CO₂ concentration
- Osmoregulation-Water balance
- Blood glucose

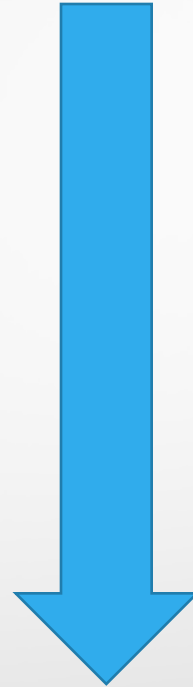
Why do we need feedback



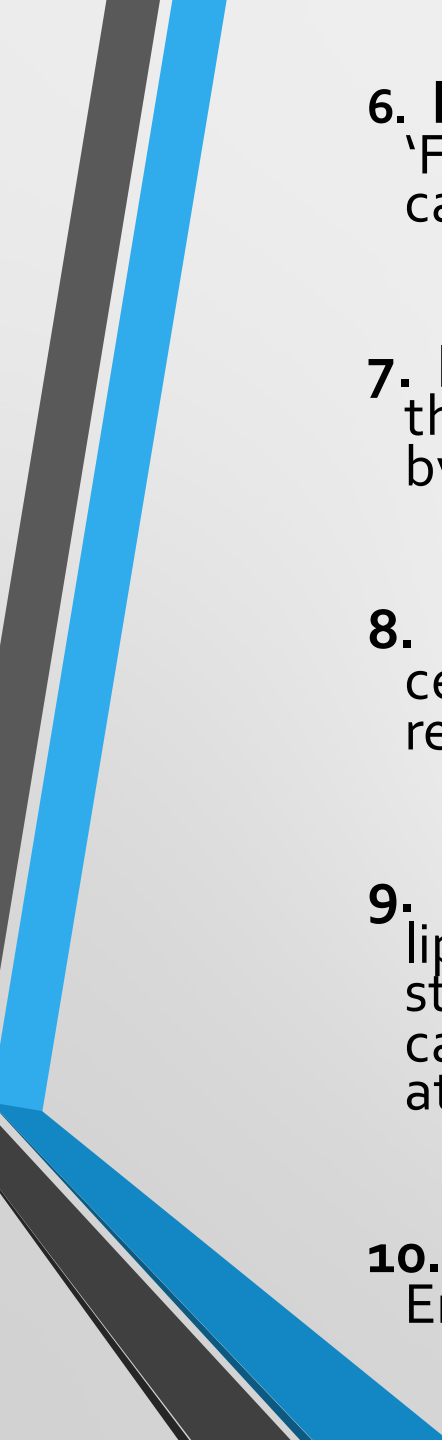
- Allows baseline to be regained
- Conserves resources
 - Cellular Materials
 - Energy (ATP)

Nature of the Body

- Subatomic structure
- Molecules and atoms
- DNA
- Cells
- Systems of the Body
- Physical Characteristics



1. **Plasma Membrane** – 'Cell Membrane'. Forms the boundary of a cell, protecting its contents and also separating it from the adjacent cells other environments.
2. **Cilia** – the structures for the locomotion, such as the lining of the trachea. Non-motile Cilia have a sensory function.
3. **Microfilaments** – very thin proteins, which help in maintaining the shape of the cells.
4. **Microtubules** - provide support to the cell skeleton and transport some protein molecules within the cell.
5. **Mitochondria** – Convert food energy to chemical energy (ATP) aerobically allowing cell function.

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6. **Peroxisome** – contain enzymes which help eliminating 'Free Radicals' (free radicals are the bad substances which cause damage to cell and its contents).
 7. **Lysosome** - These particles also contain many enzymes that help to lyse (i.e. kill or digest) and foreign body ingested by the cell (this is called Phagocytosis).
 8. **Centrioles** – Centrioles line up the chromosomes inside the cell and then they pull the chromosomes apart during cell replication.
 9. **Smooth Endoplasmic Reticulum (SER)** – synthesise lipids and steroids, also metabolize carbohydrates and steroids. They are the sole organelles which can regulate the calcium levels in cell and help in 'detoxification' and attachment of receptors to cell membrane.
 10. **Rough Endoplasmic Reticulum (RER)** - It is the Smooth Endoplasmic Reticulum attached with 'Ribosomes'.

11. Ribosomes – synthesise proteins in the cell from amino acids and send them to Golgi Apparatus for processing.

12. Golgi Apparatus - It serves as the unique 'Sorting and Packing Device'. It receives proteins from RER, sort them out according to signals they carry, and process and pack them to release to cell membrane, which releases them outside.

13. Nucleus - It's the main control centre for a cell. It stores the information about the cell and also determines the function of the cell. It synthesizes 'Ribosomes' which in turn synthesize proteins.

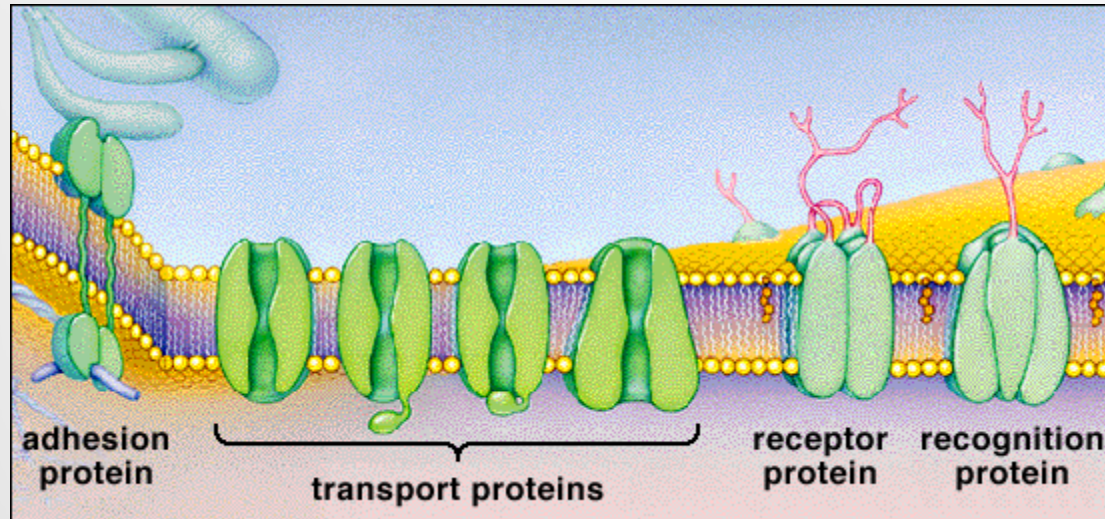
14. Nuclear Pores - These serve as passage for the transport of materials between nucleus and cytoplasm.

15. Chromatin - It is the condensed material inside the nucleus containing lots of chromosomes.

Other cellular processes

- Active transport and Passive transport - Movement of molecules into and out of cells.
- Autophagy - The process whereby cells "eat" their own internal components or microbial invaders.
- Adhesion - Holding together cells and tissues.
- Cell division - a eukaryotic cell process resulting in the formation of daughter cells; there are two major types, that of mitosis and meiosis, asexual reproduction and sexual reproduction, respectively.
- Cell movement: Chemotaxis, Contraction, cilia and flagella.
- Cell signaling - Regulation of cell behavior by signals from outside.
- DNA repair and Cell death.
- Metabolism: Glycolysis, respiration.
- Transcription and mRNA splicing - gene expression.

Plasma Membrane



- Controls the flow of substances into and out of the cell.
- Controls the stimulation or inhibition of cell function.
- Controls the internal environment of the cell allowing or inhibiting the specialised function/s of the cell.

Cytoplasm

Contains;

1. Cytosol - fluid containing water, salts and organic molecules
2. Organelles - membrane bound compartments
3. Inclusions - insoluble substances such as; glycogen, starch and fat.

Mitochondria

- Aerobic synthesis of ATP (Krebs cycle, electron transport).
- Transient store of calcium
- Heat production
- Cell death – apoptosis
- Other metabolic tasks

Lysosomes

- Vesicles that contain acid hydrolase enzymes to break up waste materials and cellular debris.
- Therefore they digest excess or worn-out organelles, food particles, and engulf viruses and bacteria.

Ribosome

- Make proteins by assembling amino acids transcribed from mRNA.

Rough Endoplasmic reticulum

- Endoplasmic reticulum containing ribosomes.

The ribosomes bind to the ER when it begins to synthesize a protein for the secretory pathway.

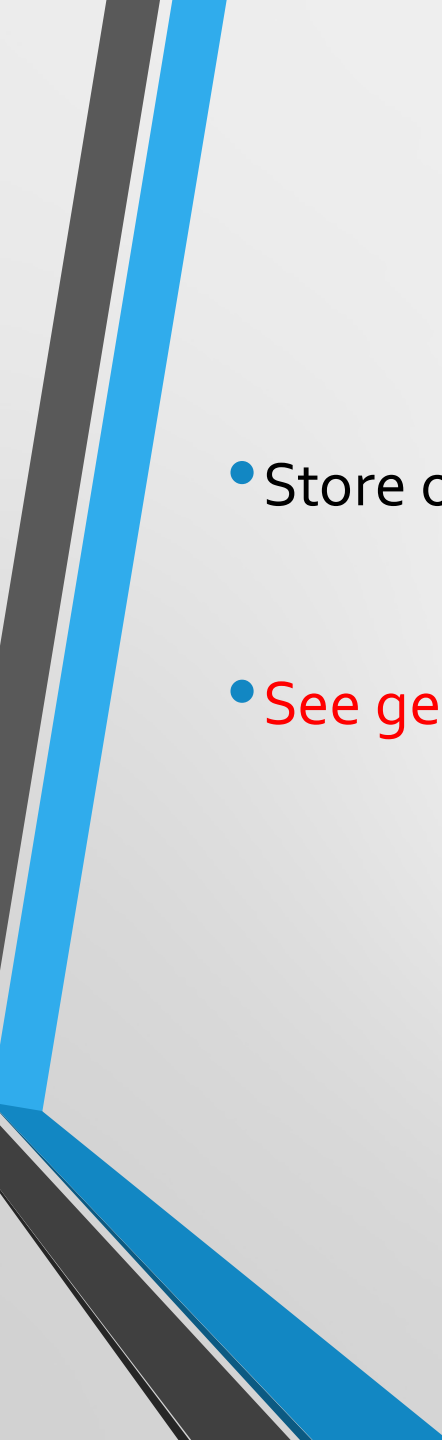
The RER is continuous with the cell membrane

Smooth Endoplasmic Reticulum

- It is connected to the nuclear envelope and provides a network which increased surface area for the products, action or storage of key enzymes.
- Synthesis of lipids and steroids,
- Metabolism of carbohydrates,
- Regulation of calcium concentration,
- Drug detoxification,
- Attachment of receptors on cell membrane
- Steroid metabolism

Golgi Apparatus

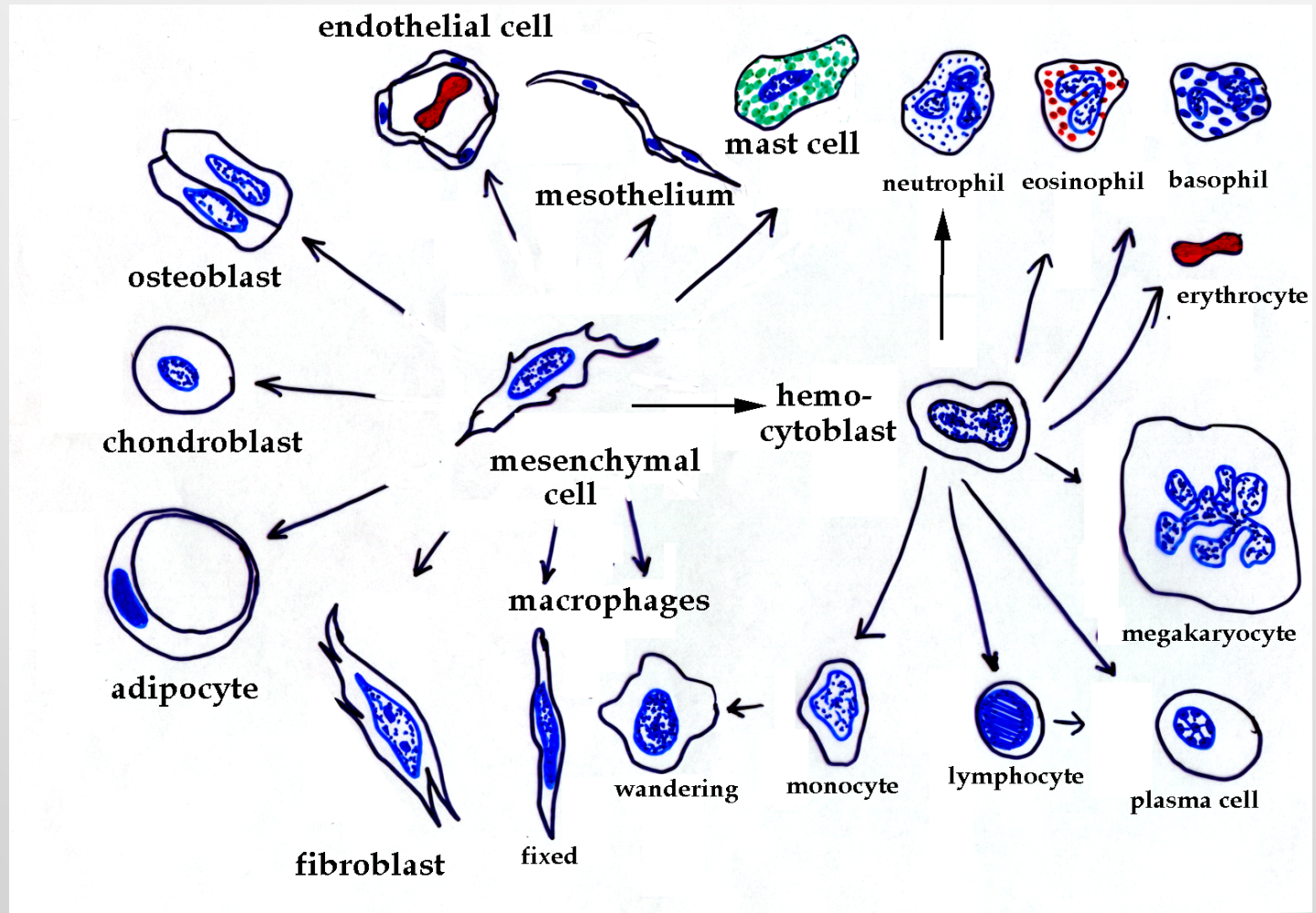
- To process and package macromolecules, such as proteins and lipids, after their synthesis and before they make their way to their destination within or outside the cell.
- Particularly important in the processing of proteins for secretion.



Nucleus

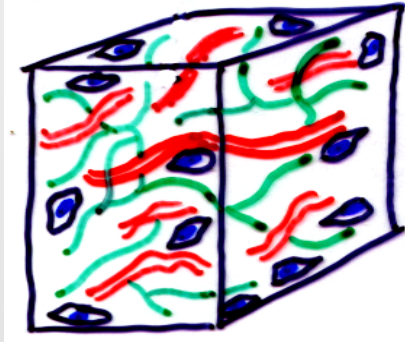
- Store of genetic code
- See gene expression.

Development of connective tissue

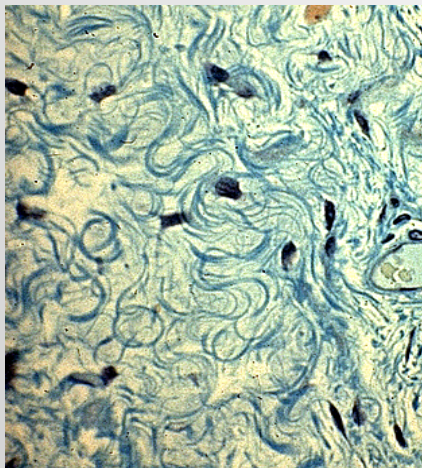


TYPES OF CONNECTIVE TISSUE

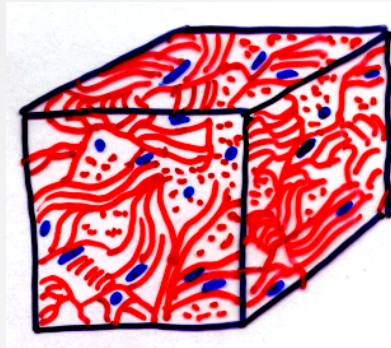
Loose Connective Tissue



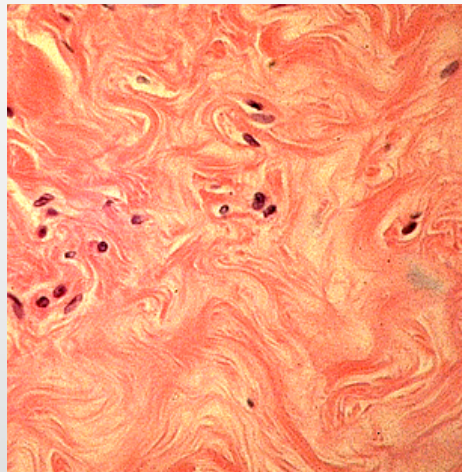
(i.e. mesentery, omentum)



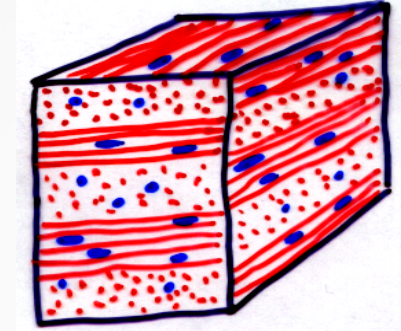
Dense Irregular Connective Tissue



(i.e. dermis of skin)



Dense Regular Connective Tissue



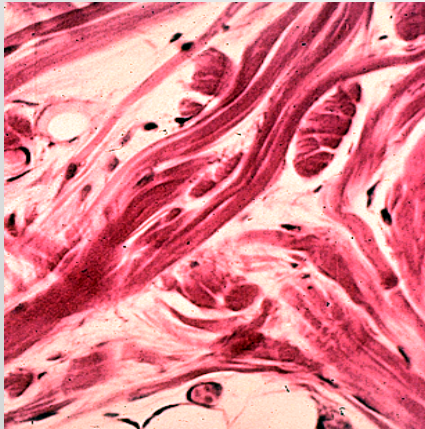
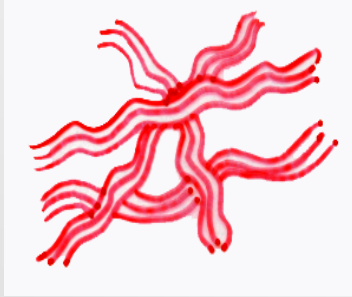
(i.e. tendons, ligaments, cornea)



CONNECTIVE TISSUE FIBERS

Collagenous Fibers

(bundles)



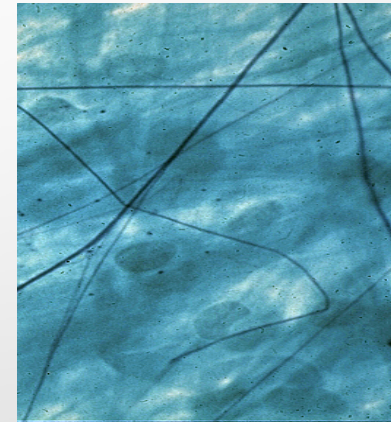
Reticular Fibers

(networks)



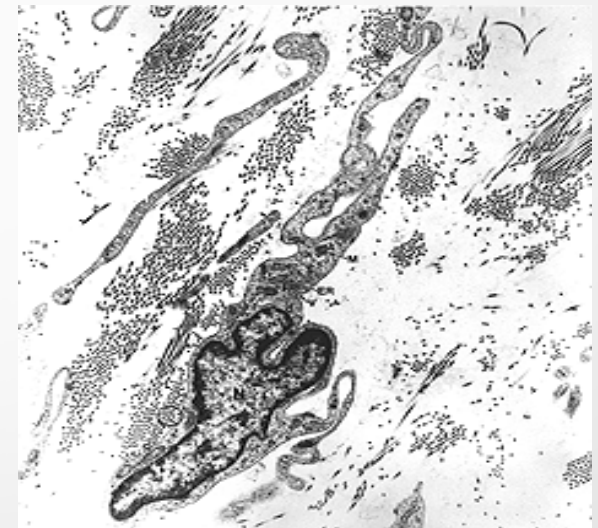
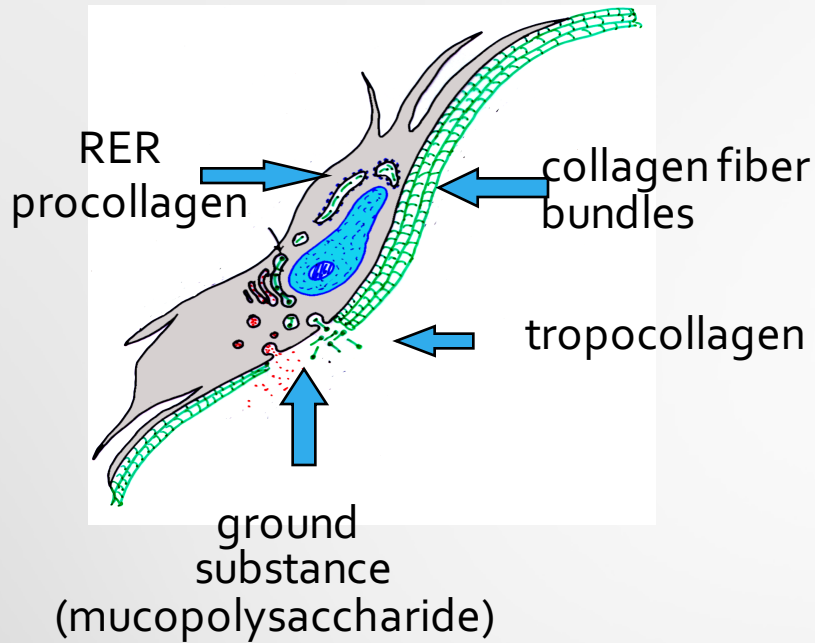
Elastic Fibers

(anastomosing bundles)



FIBROBLAST

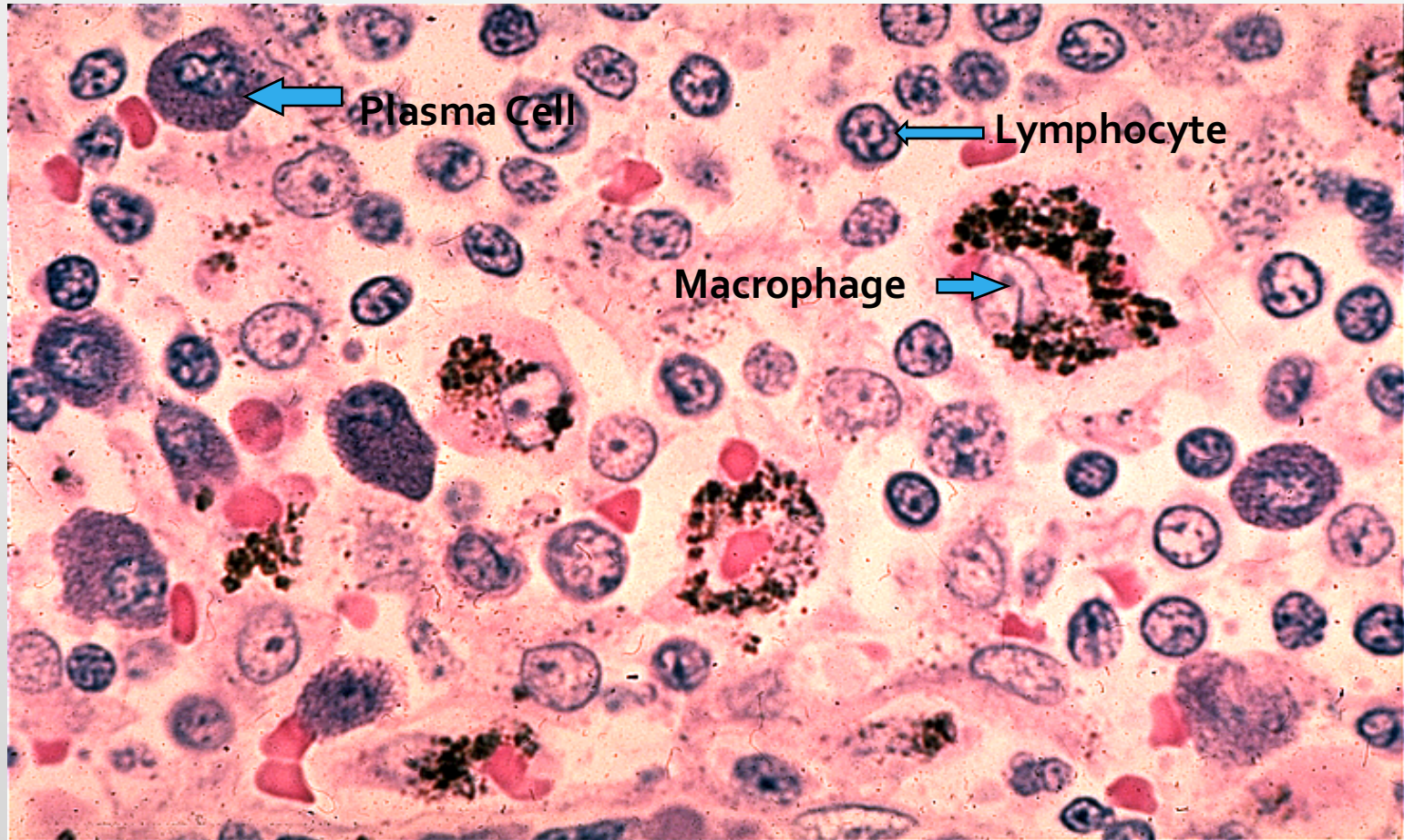
TEM of Fibroblast and Collagen Bundles



Collagen Types

- I - skin, bone, tendon cornea (most common type)
- II- cartilage, embryonic cornea
- III- reticular fibers, loose c.t., bv walls, dermis
- IV- basal lamina of epithelium
(no fibers, mat of randomly-oriented molecules)

Connective Tissue Cells



Recap Tissue Types

- Cartilage
- Areolar
- Adipose
- Fibrous
- Elastic
- Blood
- Lymphoid
- Muscle
- Glandular
- Nerve
- Membranous
- Regenerative