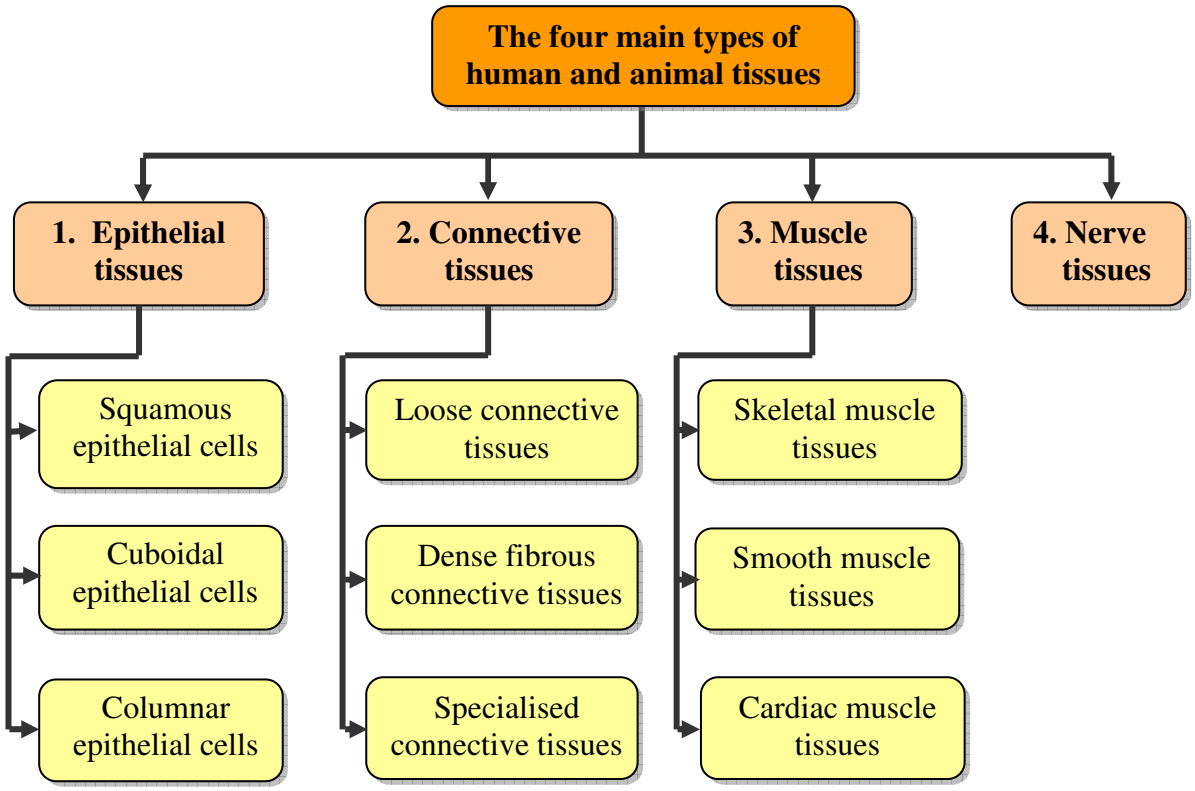
CHAPTER 2: CELL STRUCTURE AND CELL ORGANISATION

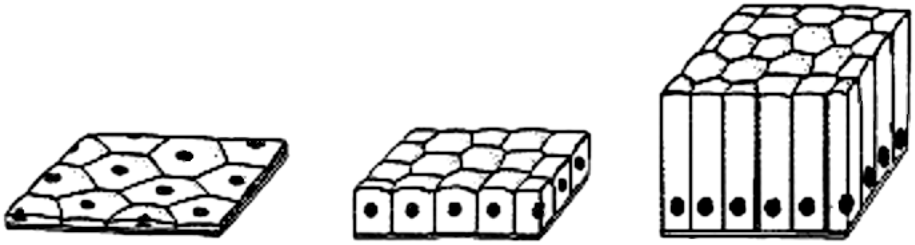
Human and Animal Tissues



The four main types of human and animal tissues

1. **Epithelial tissues**
   (a) **Epithelial tissues**:
   - are made up of closely-packed cells arranged in flat sheets
   - form the linings of external and internal body surfaces
   - perform a variety of functions such as protection, absorption, excretion, secretion and lubrication

   (b) **Epithelial cells** exist in **three** basic shapes:
   - **squamous** – thin flat, scale-like cells that look like fried eggs
   - **cuboidal** – each cell has a square shape and its nucleus is in the central position
   - **columnar** – each cell is rectangular, and its nucleus is displaced towards the base of the cell

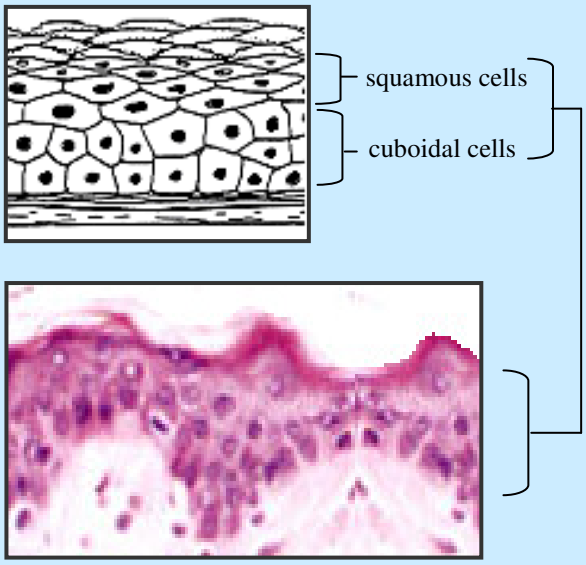


Squamous epithelium | Cuboidal epithelium | Columnar epithelium

The three basic shapes of epithelial cells

Human epithelial tissues

(a) Epithelial tissues lining the outer skin, mouth, pharynx, oesophagus, vagina and anus

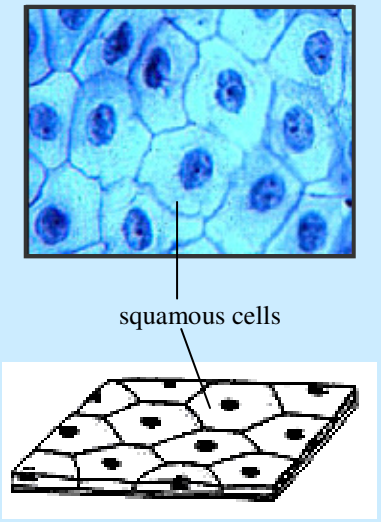


Stratified squamous epithelium of the human skin

Structure:
- also known as **stratified** (formed into layers) **squamous epithelium**
- newly produced cuboidal cells, which are pushed towards the surface of the tissue, are gradually transformed into flat, squamous cells

Functions:
- protects against abrasion
- forms the first line of defence against microorganisms (*see Figure 10.3, page 348, Nexus SPM Biology*)

(b) Epithelial tissues lining the **alveoli** of the lungs and the renal **glomeruli**

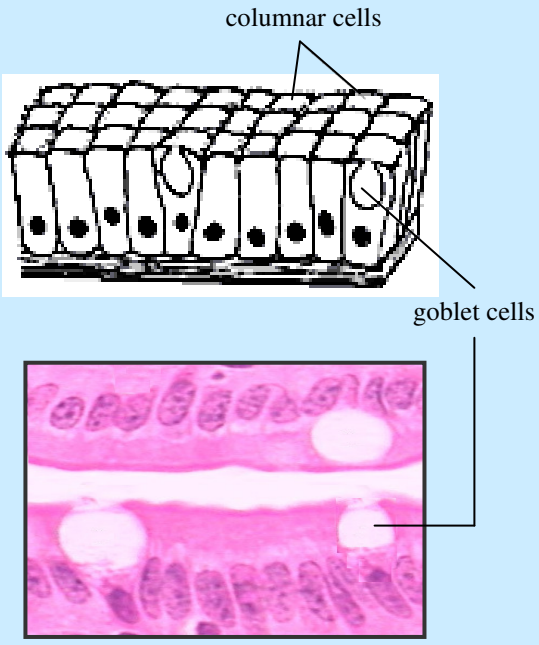


Simple squamous epithelium

Structure:
- also known as **simple squamous epithelium** (simple refers to only **one** layer of squamous epithelial cells)

Functions:
- diffusion (*see Figure 7.24, page 228, Nexus SPM Biology*)
- filtration (*see Figure 12.31, page 440, Nexus SPM Biology*)
- forms the first line of defence against microorganisms

(c) Epithelial tissues lining the **small intestine** and the **stomach**

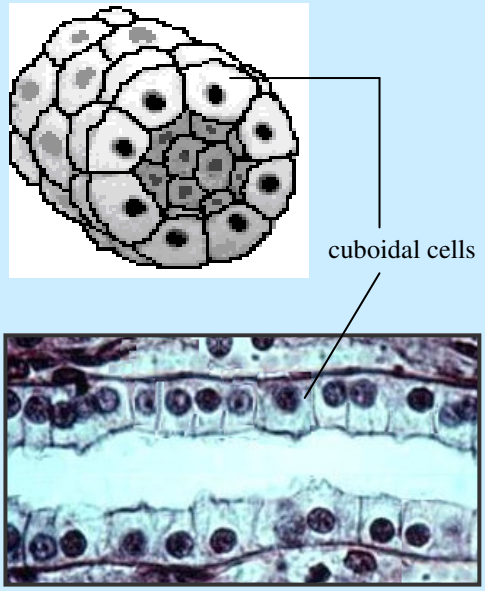


Simple columnar epithelium of the small intestine (LS)

Structure:
- also known as **simple columnar epithelial tissue**

Functions:
- secretes digestive enzymes into the intestine
- goblet cells secrete mucus (*see Figure 6.32, page 173, Nexus SPM Biology*
- absorbs digested food

(d) Epithelial tissues lining the **kidney tubules, salivary ducts** and **pancreatic ducts**

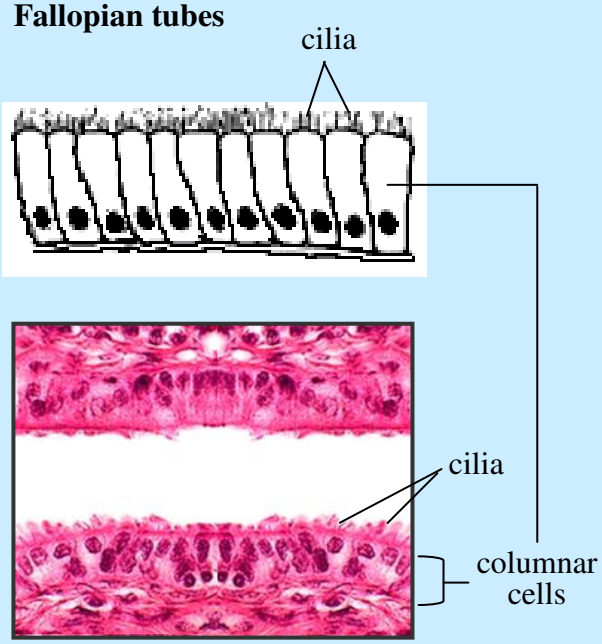


Kidney tubule (see Figure 12.30, page 439, Nexus SPM Biology)

Structure:
- also known as **simple cuboidal epithelium**

Functions:
- secretion of mucus or enzymes
- *absorption (microvilli increase the surface area)*
- excretion

(e) Epithelial tissues lining the **trachea** (and other air passages)**, nose, uterus** and **Fallopian tubes**

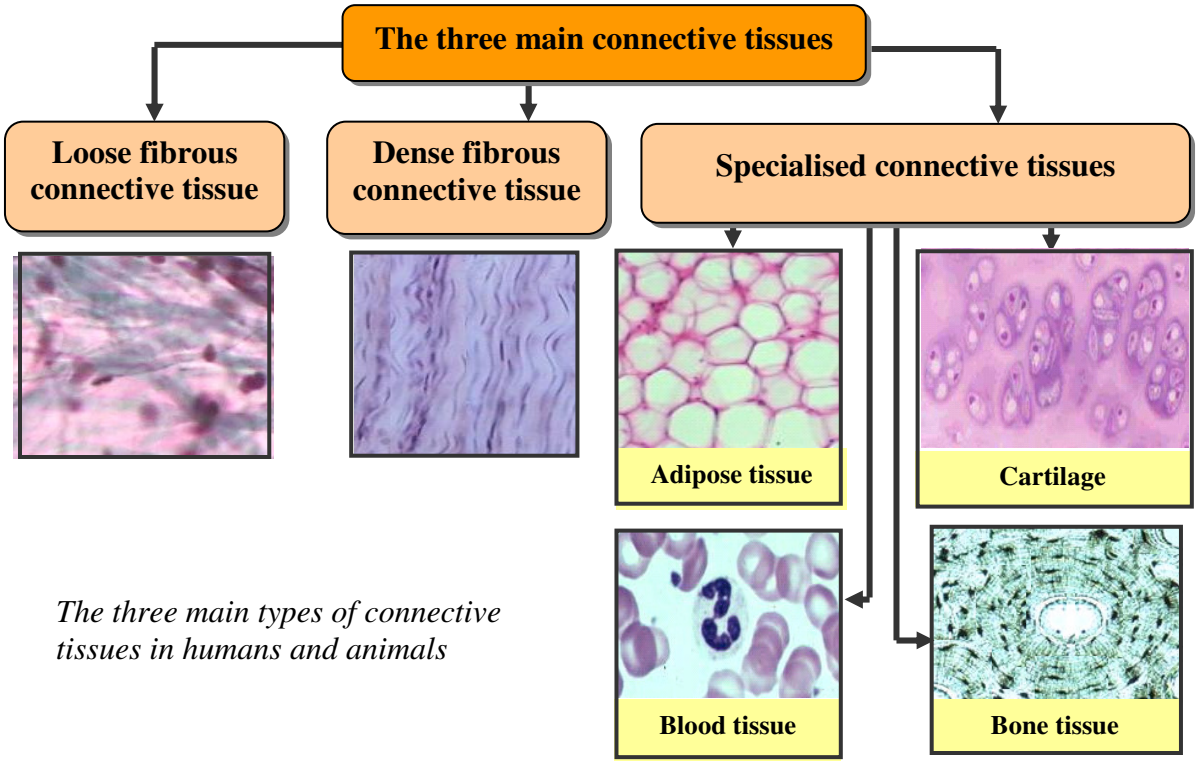


Ciliated columnar epithelium of the Bronchiole (LS) – (see Table 7.4, page 223, Nexus SPM Biology)

Structure:
- also known as **ciliated columnar epithelium**

Functions:
- The movement of the cilia (in the trachea and the nose) in a certain direction causes the mucus to move in that direction
- The movement of the cilia in the Fallopian tubes propels the ovum to the uterus *(see Figure 13.11, page 471, Nexus SPM Biology)*

2. **Connective tissues**
   - serve to 'connect' (support and bind) other tissues
   - consist of various types of **cells** scattered throughout an **extracellular matrix**, which is made of a complex mixture of **carbohydrates** and **proteins** (plus **minerals** in the case of a bone)
   - are widely distributed in the body



The three main types of connective tissues in humans and animals

The **three** main types of connective tissues (see diagram above) are as follows:

(a) **Loose fibrous connective tissue:**
- It is the most widespread connective tissue in the body.
- It holds the organs in place and attaches the epithelial tissue to other underlying tissues.

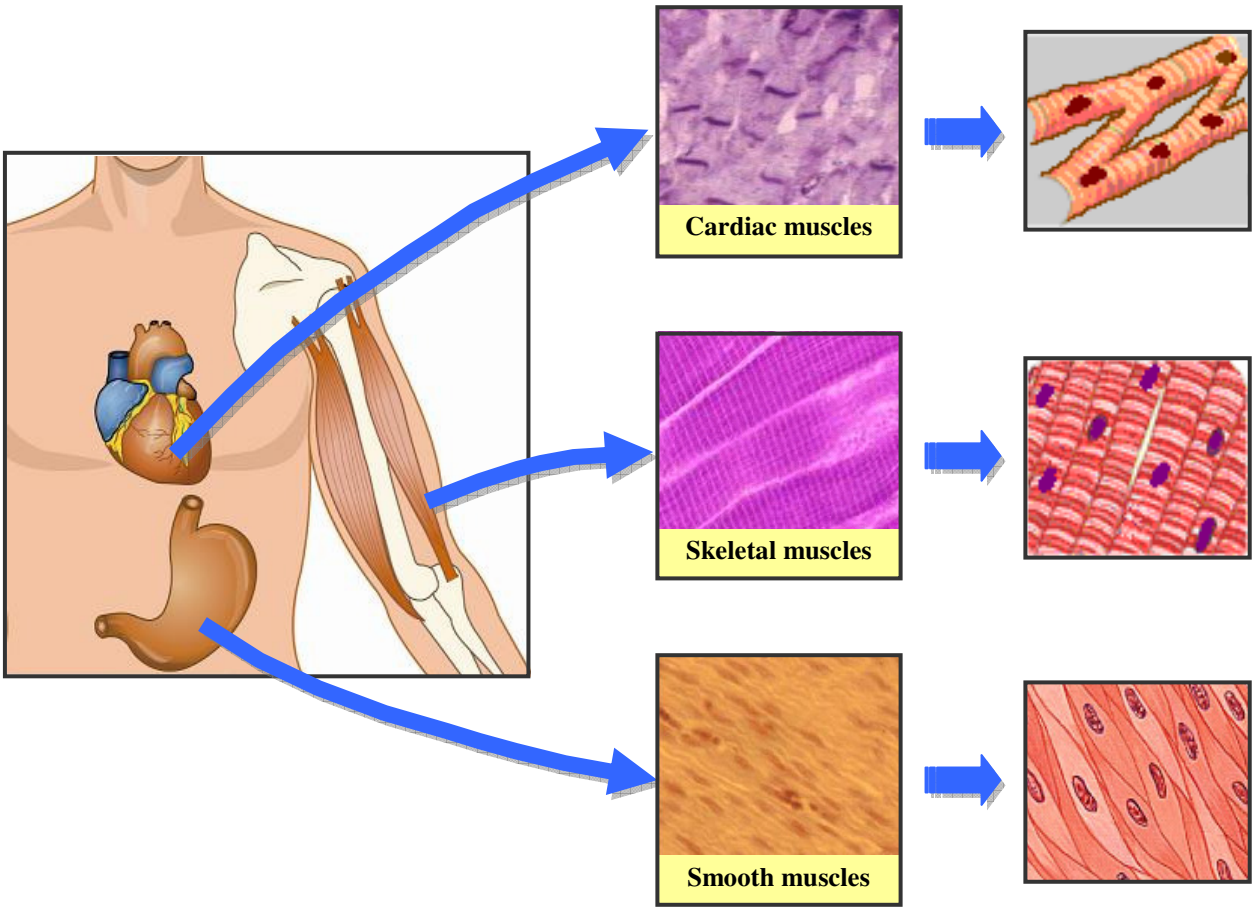
(b) **Dense fibrous connective tissue:**
- It is found in **tendons** and **ligaments.**
- It consists of large amounts of closely packed **collagenous fibres.**

(c) **Specialised connective tissues which consist of:**
- **adipose tissue** – is a type of loose connective tissue that stores fat
- **blood tissue –** consists of blood cells (erythrocytes, leucocytes and platelets) suspended in the plasma (the extracellular matrix)
- **bone –** is a type of mineralized connective tissue that contains collagen and calcium phosphate (which makes the bone hard)
- **cartilage –** is a strong and flexible connective tissue which supports the nose, ears and covers the ends of the bones at the joints

3. **Muscle tissues**
The **three** types of muscle tissues are as follows:
(a) **Skeletal muscle tissue**
- It is found attached to the skeleton.
- It contracts and relaxes to move the bones at the joints.
- It is found in the arms, legs and body parts where there is movement.

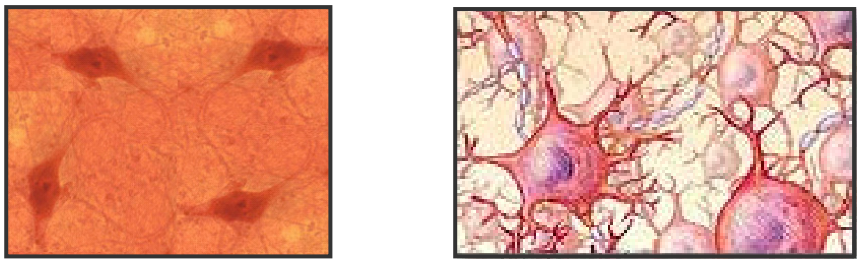
(b) **Smooth muscle tissue**
- It contracts and relaxes to enable all involuntary body movements, e.g. peristalsis.
- It is found in the walls of the digestive, urinary and reproductive tracts, and the blood vessels.

(c) **Cardiac muscle tissue**
- It is only found in the wall of the heart.
- It contracts to pump blood to all parts of the body.
(*see Figures 11.20, 11.21 and 11.22, page 389, Nexus SPM Biology*)



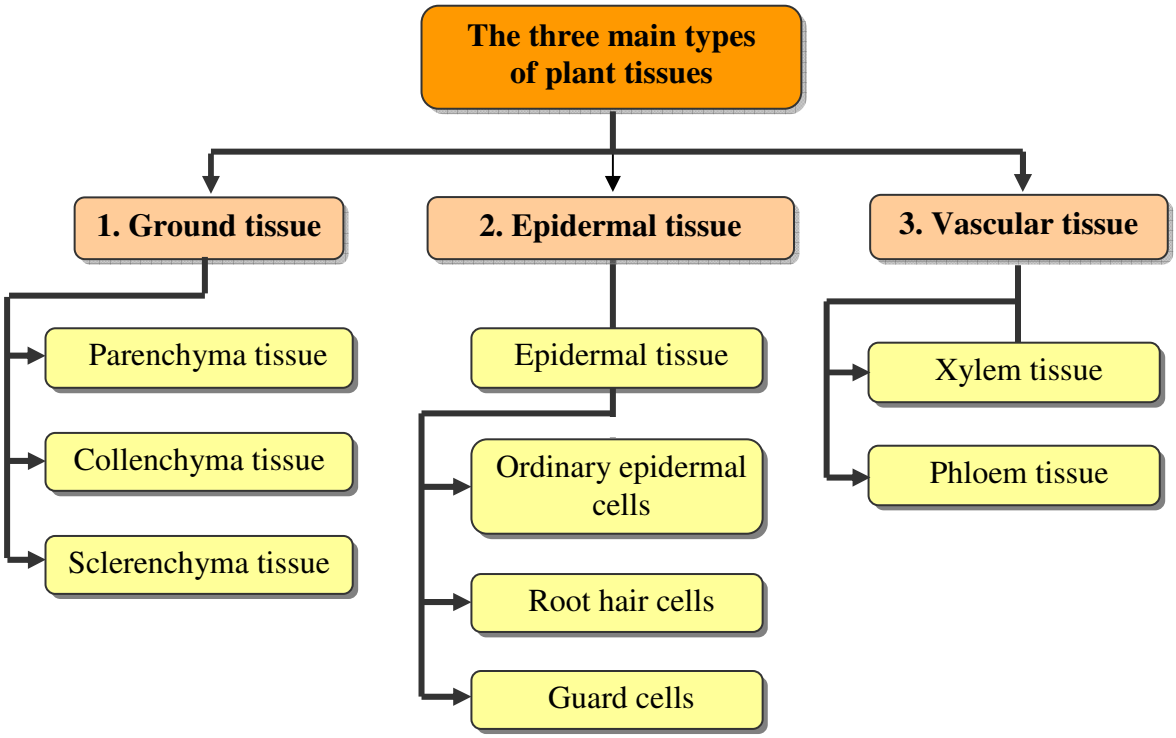
The three main types of muscle tissues

4. **Nerve tissue**
   - It consists of **neurones** or nerve cells.
   - A neurone is a very long cell that transmits **impulses** (electrical signals).
   - It controls and coordinates body activities (*see unit 12.2, page 419, Nexus SPM Biology*).



Nerve tissue

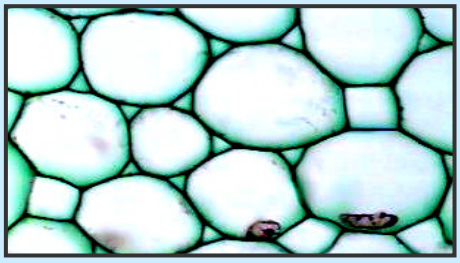
Plant Tissues



The three main types of plant tissues
(see Figure 11.48, page 403, Nexus SPM Biology)

1. **Ground tissue**
   General functions: Various functions including photosynthesis, support and storage

Parenchyma tissue

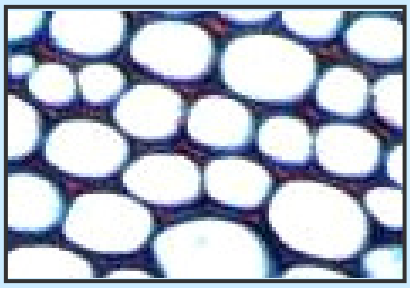


Parenchyma tissue (XS)

Structure:
- cells have thin flexible primary cell walls and large central vacuoles
- consists of unspecialised cells found in all plant organs

Functions:
- e.g. **palisade mesophyll** cells and **spongy mesophyll** cells contain chloroplasts to carry out photosynthesis *(see Table 6.28, pages 187 - 188, Nexus SPM Biology)*
- e.g. forms packing tissue and provides **support** and **shape** to herbaceous plants; also to store food *(see no. 7, unit 11.3.3, page 404, Nexus SPM Biology)*

Collenchyma tissue

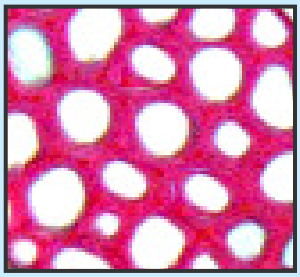


Collenchyma tissue (XS)

Structure:
- cells have unevenly thickened walls, especially at the corners
- found just under the epidermis of the stem and along leaf veins

Function:
- supports herbaceous plants, young stems and petioles (*see no. 7(b), page 404 Nexus SPM Biology*)

Sclerenchyma tissue



Sclerenchyma tissue (XS)

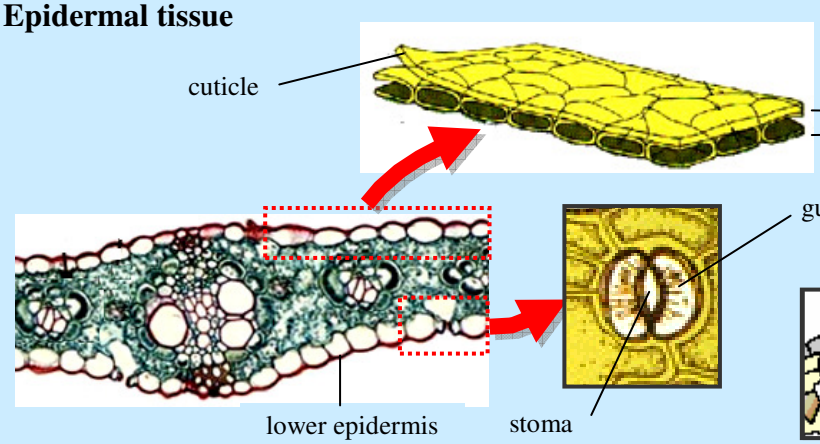
Structure:
- cells have uniformly thickened secondary walls and large vacuoles
- cells may be dead at maturity

Function:
- provides support to the plant
  (see no. 7(c), page 404 Nexus SPM Biology)

2. Epidermal tissue

General functions: Covers and protects the young plant parts

Epidermal tissue



The cuticle, epidermis and guard cells of the leaf

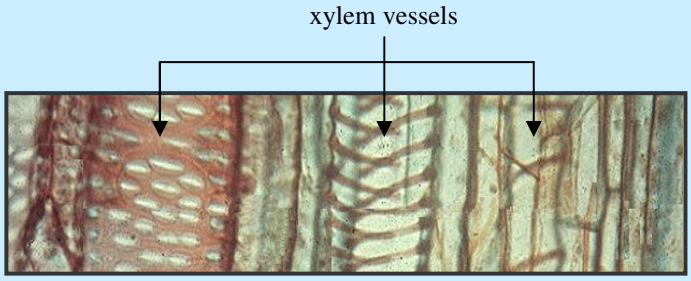
Root hairs (XS, tip of the root)

Structure:
- forms the outermost layer covering stems, leaves, and roots
- most epidermal cells are flat and have large vacuoles
- cells are closely packed; some are covered with a waxy **cuticle** layer

Functions:
- e.g. **ordinary epidermal cells** covering stems, leaf petioles and leaves help to reduce water loss (by the cuticle) and protect against mechanical injury and invasion of microorganisms
- e.g. **root hairs** for the absorption of water and minerals *(see Figure 10.46, page 360, Nexus SPM Biology)*
- e.g. **guard cells** control the opening and closing of the stomata *(see Figure 10.62 and 10.63, page 367, Nexus SPM Biology)*

3. **Vascular tissues**
General functions: Transport materials throughout the plant

Xylem tissue

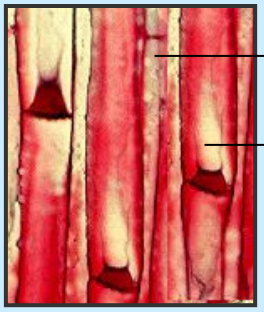


Xylem tissue (LS)

Structure:
- consists **mainly** of dead xylem vessels joined end to end from the roots right up to the leaves

Function:
- transports water and dissolved mineral salts from the roots to other parts of the plants (*see Figure 10.44, page 357 and unit 10.7.4 page 360, Nexus SPM Biology*)

Phloem tissue

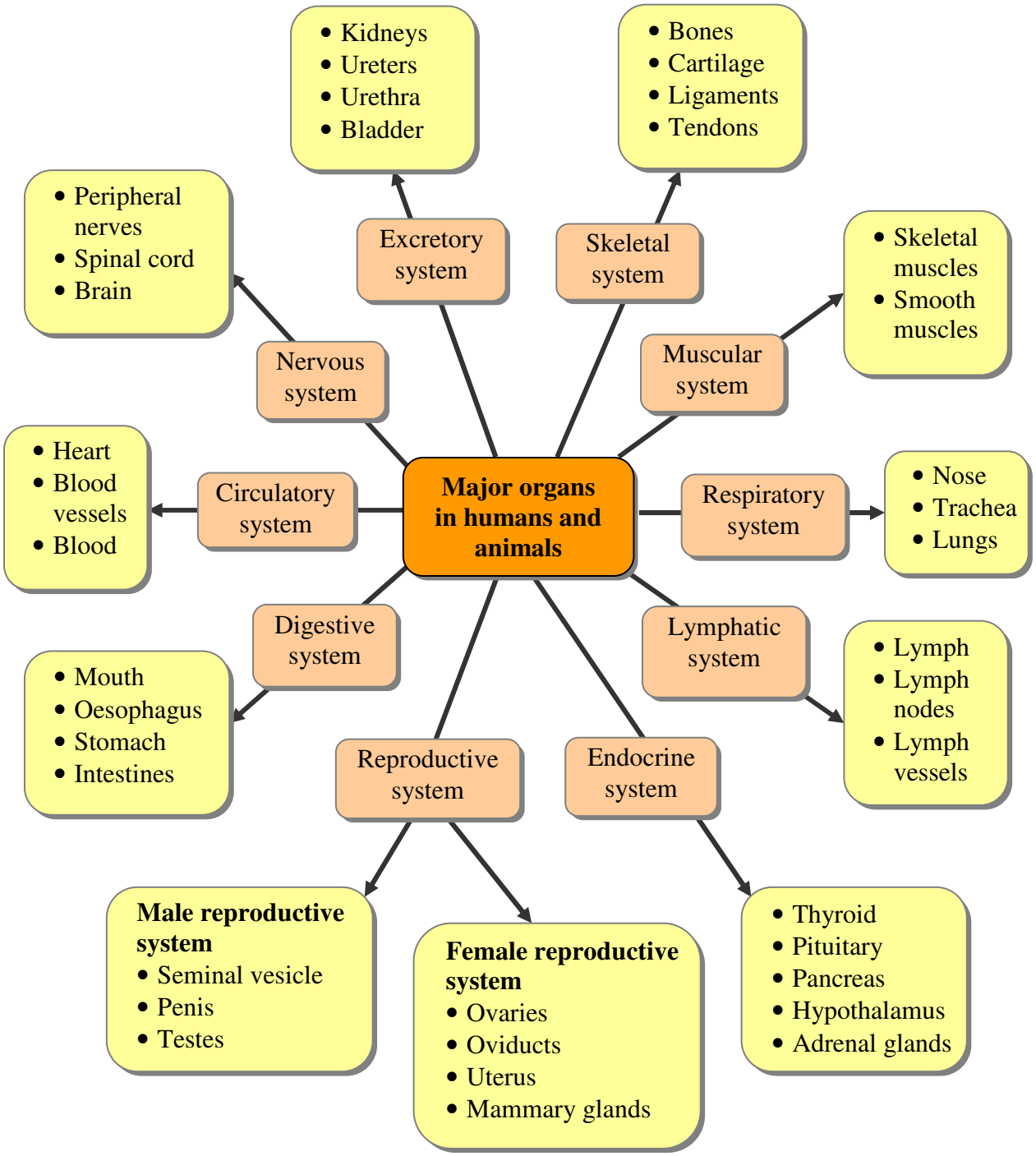


Phloem tissue (LS)

Structure:
- consists **mainly** of large cylindrical cells that join end to end to form sieve tubes

Function:
- transports dissolved nutrients made during photosynthesis (*see unit 10.7.5 page 362, Nexus SPM Biology*)

Human and Animal Organs



Some major human and animal organs (in yellow boxes)

Plant Organs

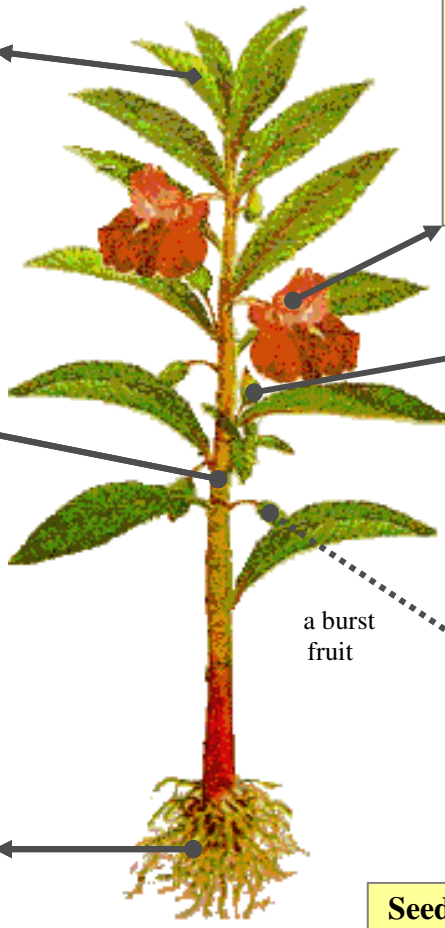
1. Plant organs are divided into **vegetative** and **reproductive** organs.
2. Vegetative organs produce **growth** in plants and reproductive organs are involved in **sexual reproduction**.
3. The vegetative organs are…
   (a) the roots (b) the stems (c) the leaves
4. The reproductive organs are…
   (a) the flowers (b) the fruits (c) the seeds

Leaf:
- To photosynthesise
- For gaseous exchange and excretion
- To regulate transpiration

Flower:
- Contains the organs of plant sexual reproduction
- To attract insects for pollination

Stem:
- To transport water, nutrients and organic materials
- To lift the leaves above the ground to trap sunlight

Fruit:
- To protect and disperse seeds for reproduction



Roots:
- To anchor the plant
- To absorb water and nutrients
- To store excess sugar as starch

Seeds:
- To protect and nourish the embryo or baby plant
- Aids in dispersal

The organs of a plant (Impatiens balsamina)