



Histology & Embryology

<http://fdjpkc.fudan.edu.cn/d201404/main.htm>

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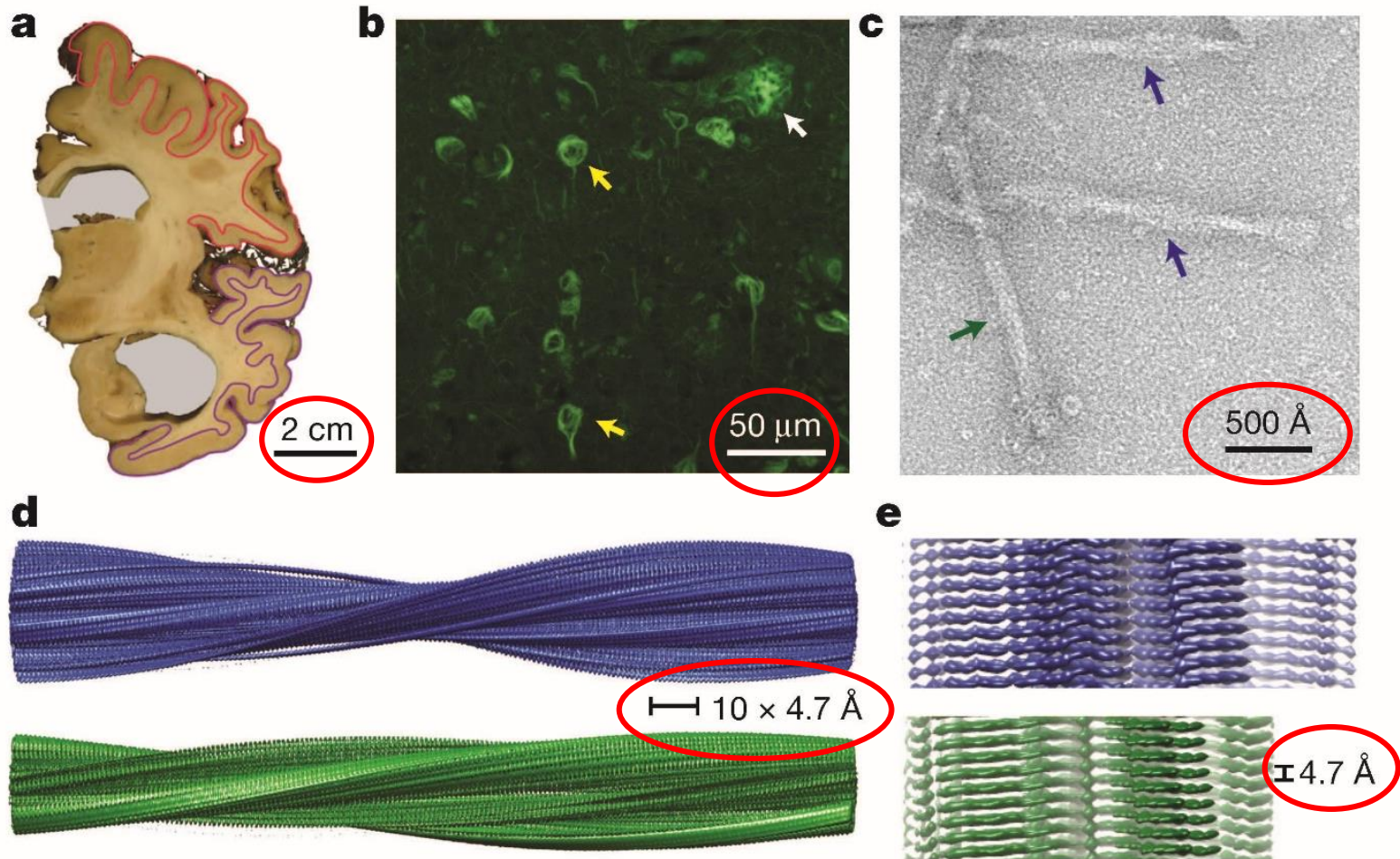
Introduction

- **Histology**
- **Approach of Study**

WHAT?

HOW?

Structure of tau filaments from Alzheimer's brain



Fitzpatrick et al. Nature. 2017

Alzheimer's disease, AD

- the **most common** neurodegenerative disease, and there are **no mechanism-based** therapies.
- defined by the presence of **abundant** neurofibrillary **lesions** and neuritic **plaques** in the cerebral cortex.
- Neurofibrillary lesions comprise paired helical and straight tau filaments, **whereas tau filaments with different morphologies** characterize other neurodegenerative diseases.
- **No high-resolution structures** of tau filaments are available.

I. Histology



- **Definition:**

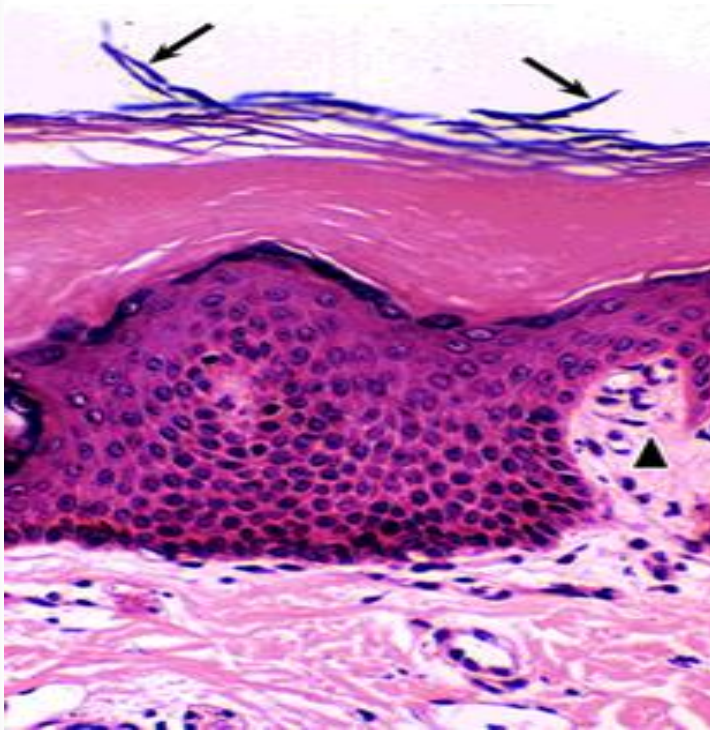
- **Tissue biology:** The study of the tissues of the body.
- also called **Micro-anatomy:** How these tissues are **arranged to constitute organs.**
- **The focus on** how cells' structure and arrangement **optimize functions specific to each organ.**

- **Contents:**

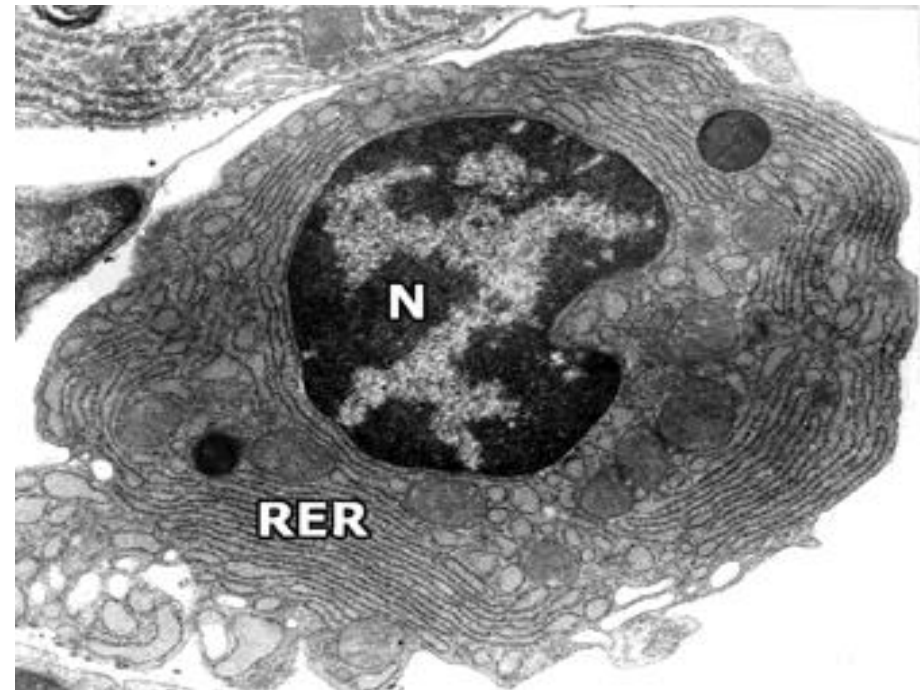
- **Tissues**
 - **Cells**
 - **Extracellular Matrix (ECM)**
 - **Organs**
 - **Systems**
- } **CONTINUUM**
- ☞ **Functions together**
 - ☞ **Reacts to stimuli and inhibitors together.**

A. Cells

- **Basic structural & functional units of the body.**



LM

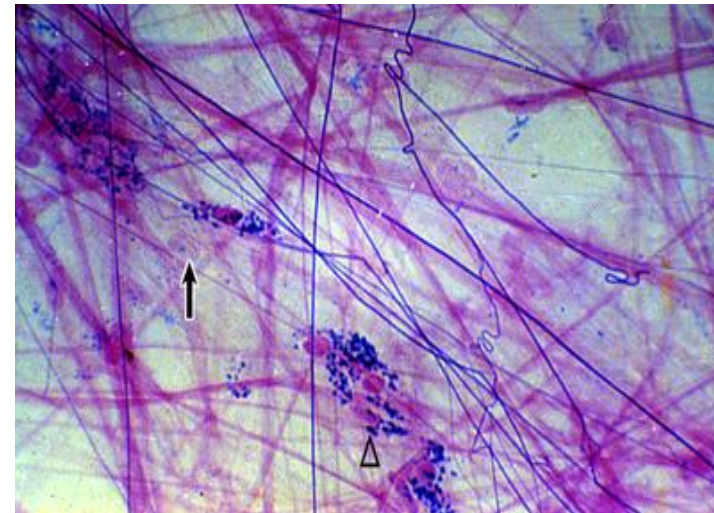
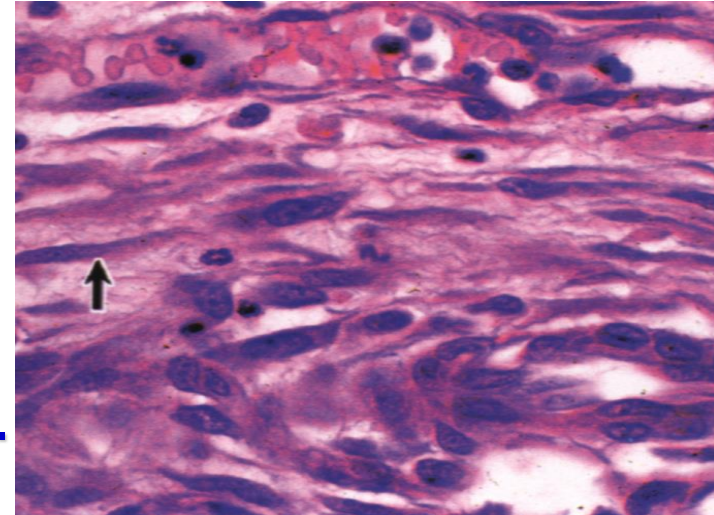


EM

B. Extracellular Matrix (ECM)



- **Definition:**
 - Produced by **cells themselves**.
 - **Surrounding** the cells.
 - As **micro-environment** of the cells to influence or control them.
- **Composition:**
 - **Macromolecules** that form complex structures
 - **Fibers: collagen fibrils**
 - **Ground substances**
 - **Body fluids: as a vector** for transport of nutrients, catabolites, and secretory products.



C. Tissues



- Made of two interacting components:

- Cells
- Extracellular matrix (ECM)

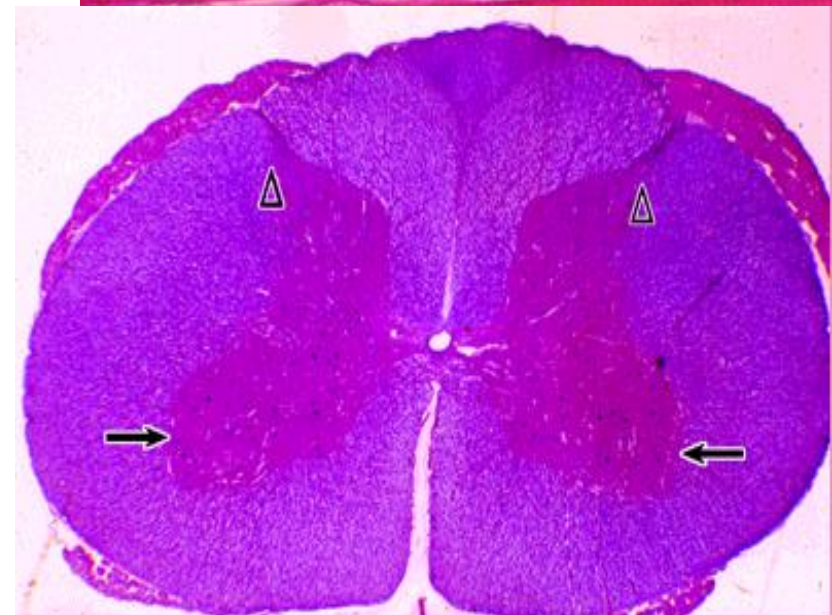
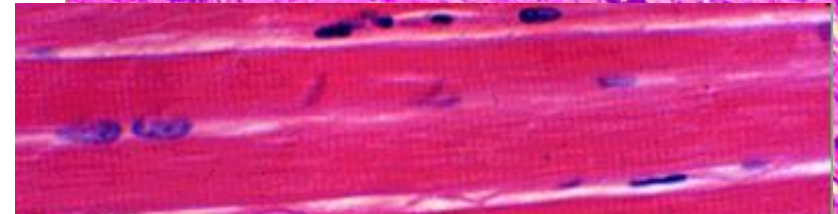
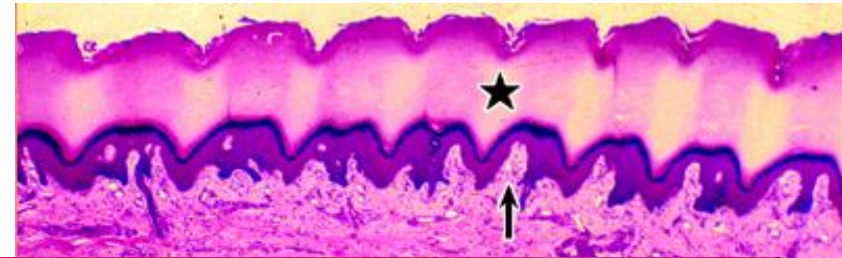
★ Continuum:

functions & reacts to stimuli and inhibitors together

- Four basic types of tissue:

★ cell-specific associations

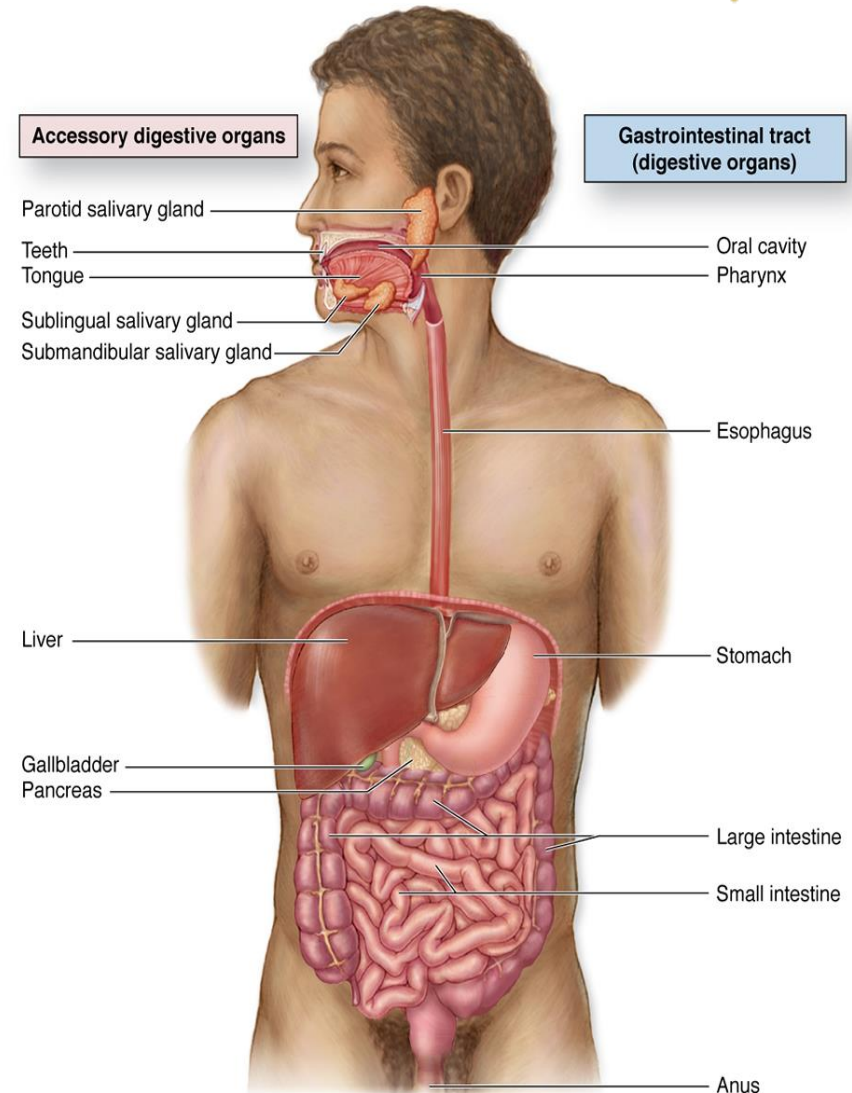
- Epithelial Tissue
- Connective Tissue
- Muscle Tissue
- Nerve Tissue



D. Organs

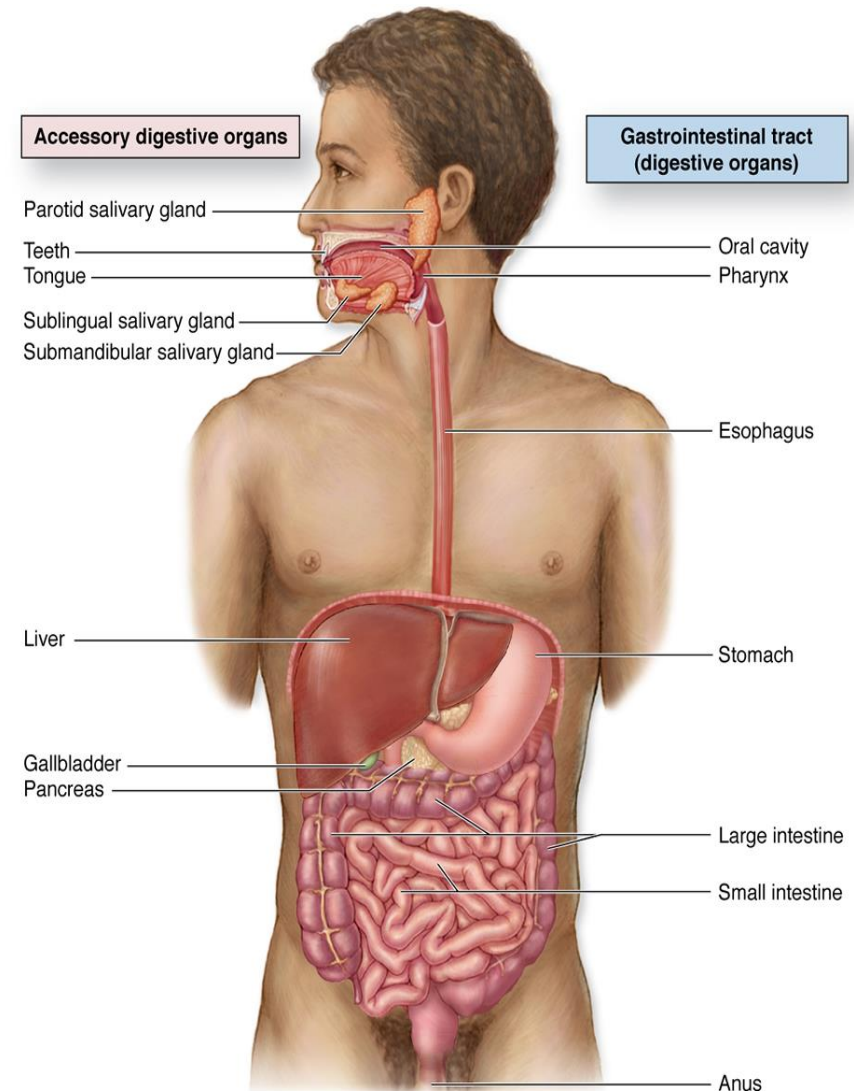


- Formed by an **orderly combination of several tissues.**
- Allows the function of each organ **AS A WHOLE.**
- **i.e., stomach, liver, lung, etc.**

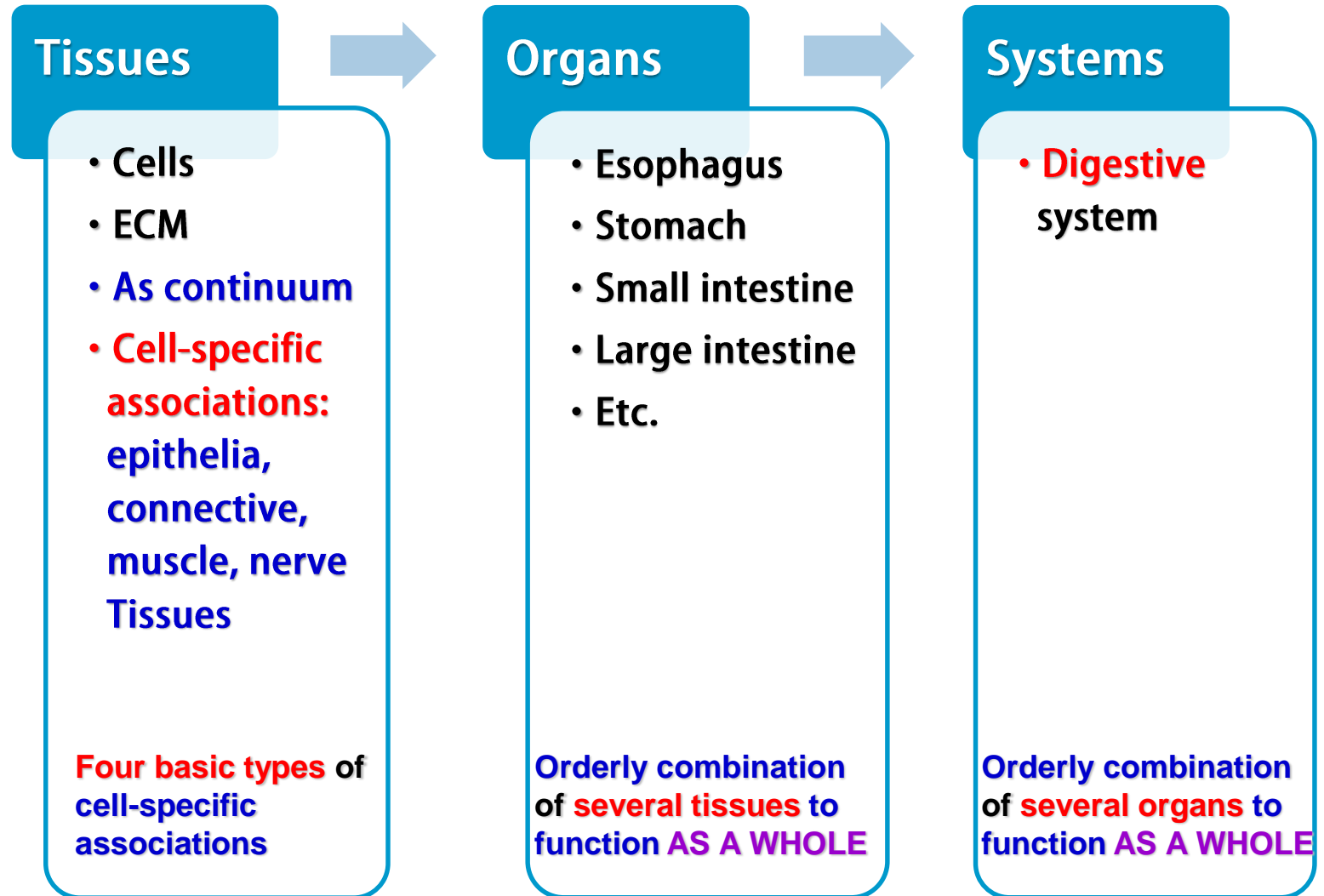


E. Systems

- Formed by an **orderly combination of several organs.**
- Allows the function of the organism **AS A WHOLE.**
- **i.e., digestive system, respiratory system, etc.**



Summary I - Histology



I. Histology



- **Definition:**

- **Tissue biology:** The study of the tissues of the body and how these tissues are arranged to constitute organs.
- **The focus on how cells' structure and arrangement optimize functions specific to each organ.**

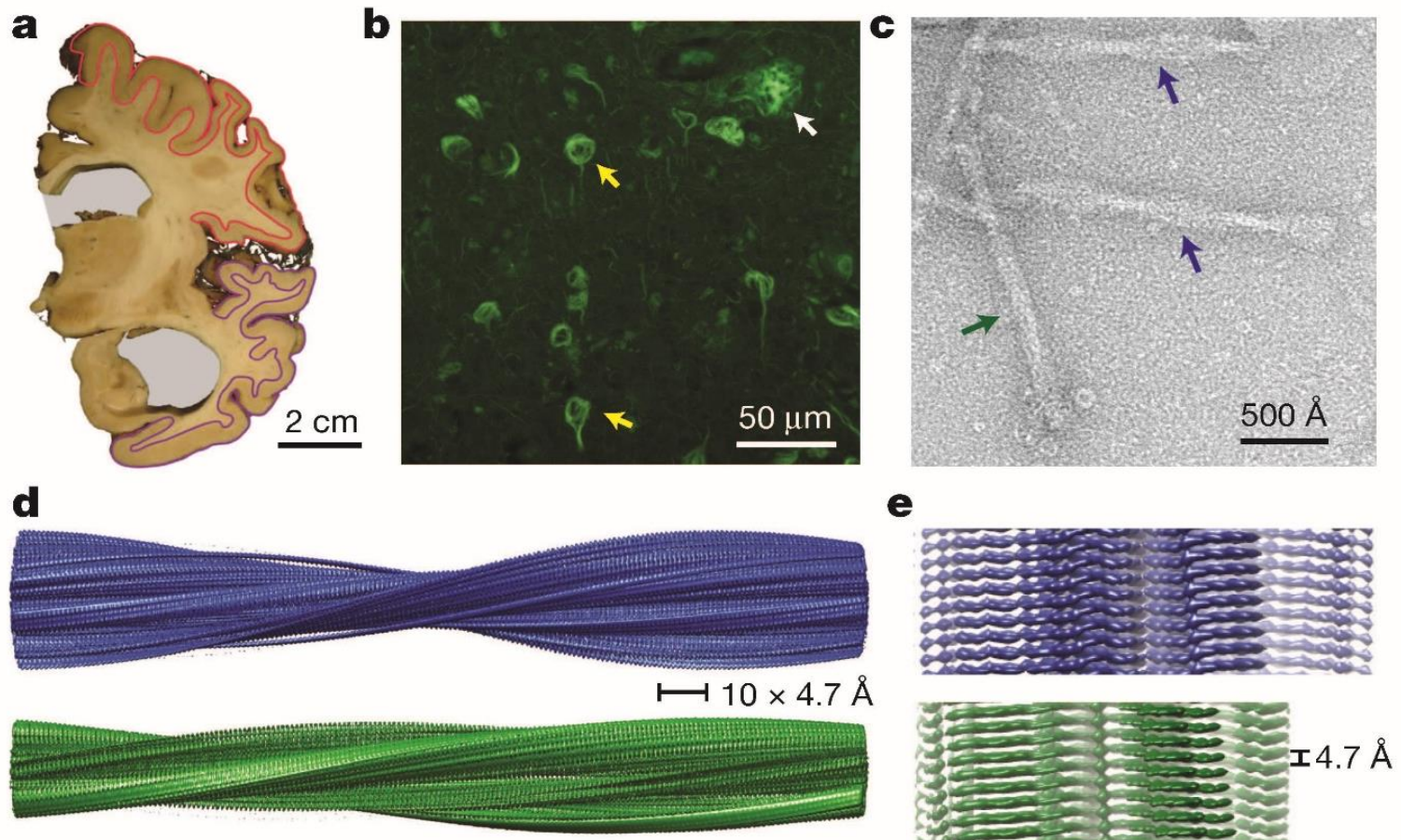
- **Contents:**

- **Tissues:** four basic types of **cell-specific associations**
 - **Cells**
 - **Extracellular Matrix (ECM)**

CONTINUUM

 - ☞ Functions together
 - ☞ Reacts to stimuli and inhibitors together.
- **Organs:** orderly combination of **several tissues** to function **AS A WHOLE**
- **Systems:** orderly combination of **several organs** to function **AS A WHOLE**

II. Approach of Study



Fitzpatrick et al. Nature. 2017 Jul 13

Figure 1 | Structure of tau filaments from Alzheimer's brain.

II. Approach of Study



1. Light microscopy: a beam of transmitted light

- **Bright-field Microscopy: resolution 0.2 μm**
 - HE staining
 - acidophilic, basophilic, neutrophilic
- **Special microscopy**
 - Fluorescence Microscopy
 - Phase-contrast Microscopy
 - Confocal Laser Scanning Microscopy

} Self-study

2. Electron Microscopy: beams of electrons; resolution 3 nm

- Transmission electron microscopy, TEM
- Scanning electron microscopy, SEM

3. Histochemistry (Cytochemistry)

4. Autoradiography

5. Tissue Culture

6. Immuno-cytochemistry

7. In situ Hybridization

} Self-study

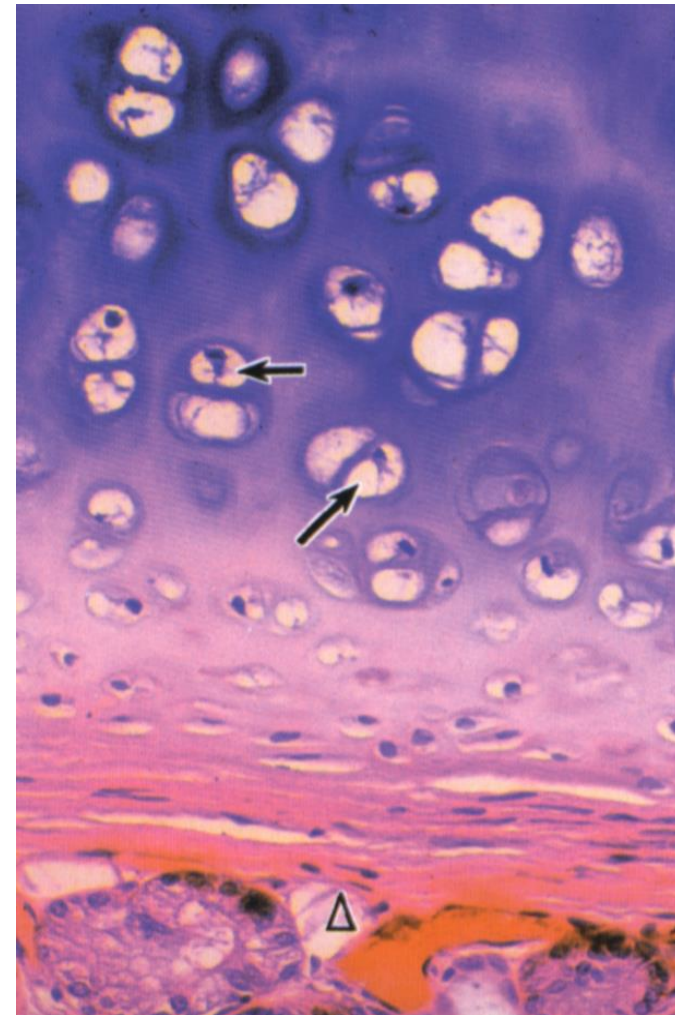
II. Approach of Study (1a)



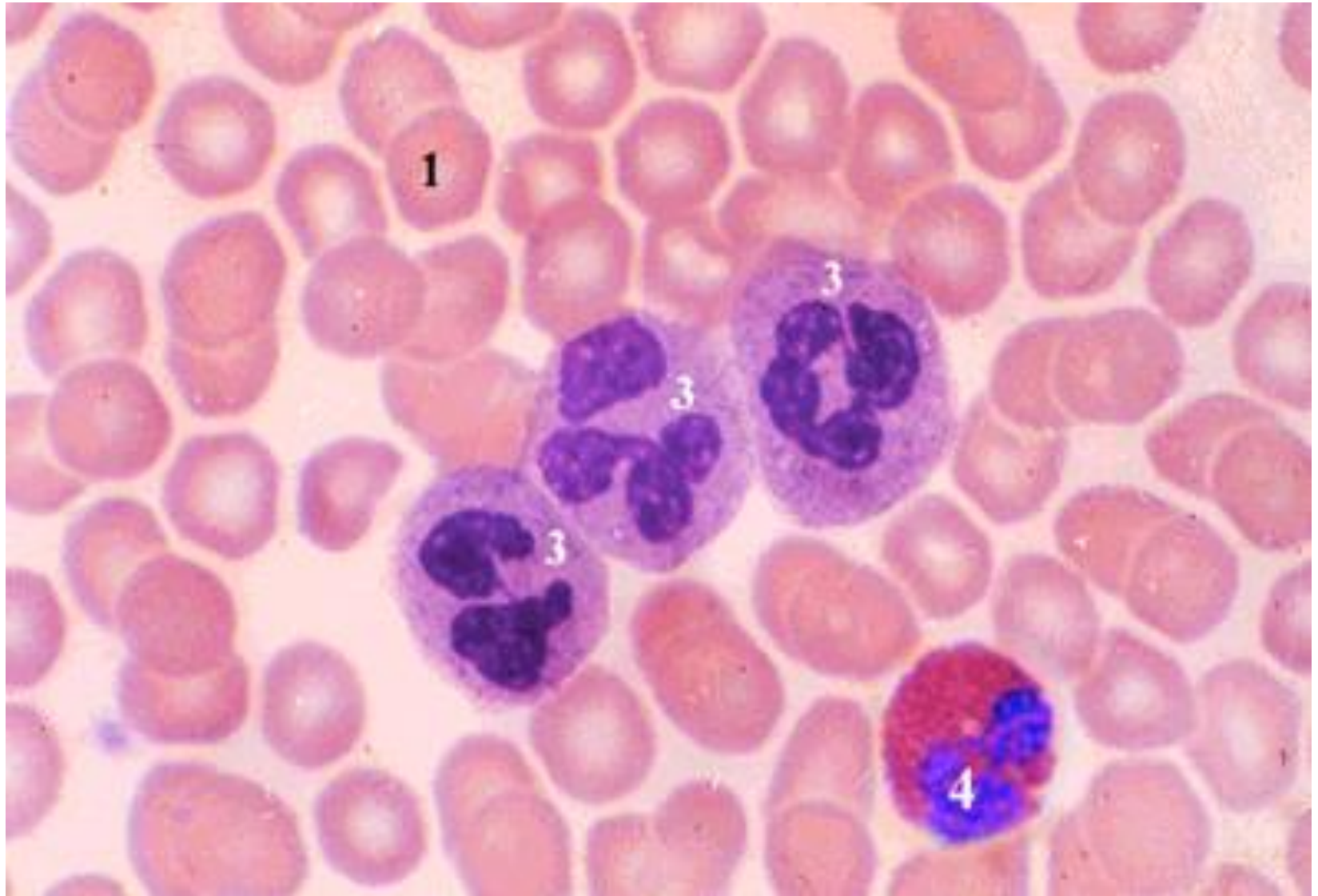
1. Bright-field Microscopy

Paraffin Section, H&E staining

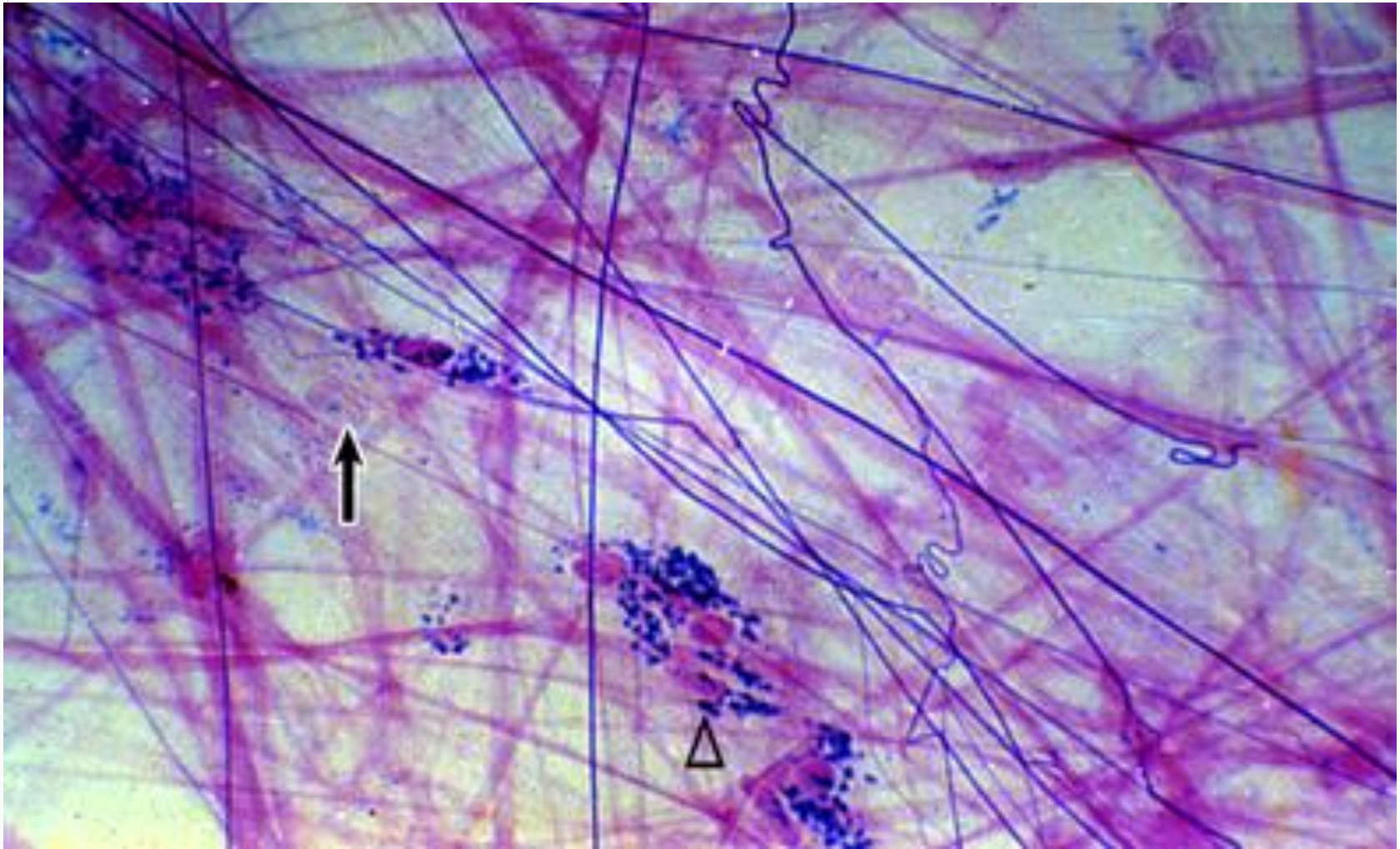
- Fixation
- Embedding & Sectioning
- Staining: H&E
 - Hematoxylin: basic dyes
 - Eosin: acid dyes
- acidophilic & basophilic
- **Frozen Section: enzymes, lipids**
- **Smear: blood, semen**
- **Stretched: mesentery**
- **Ground Section: bone**



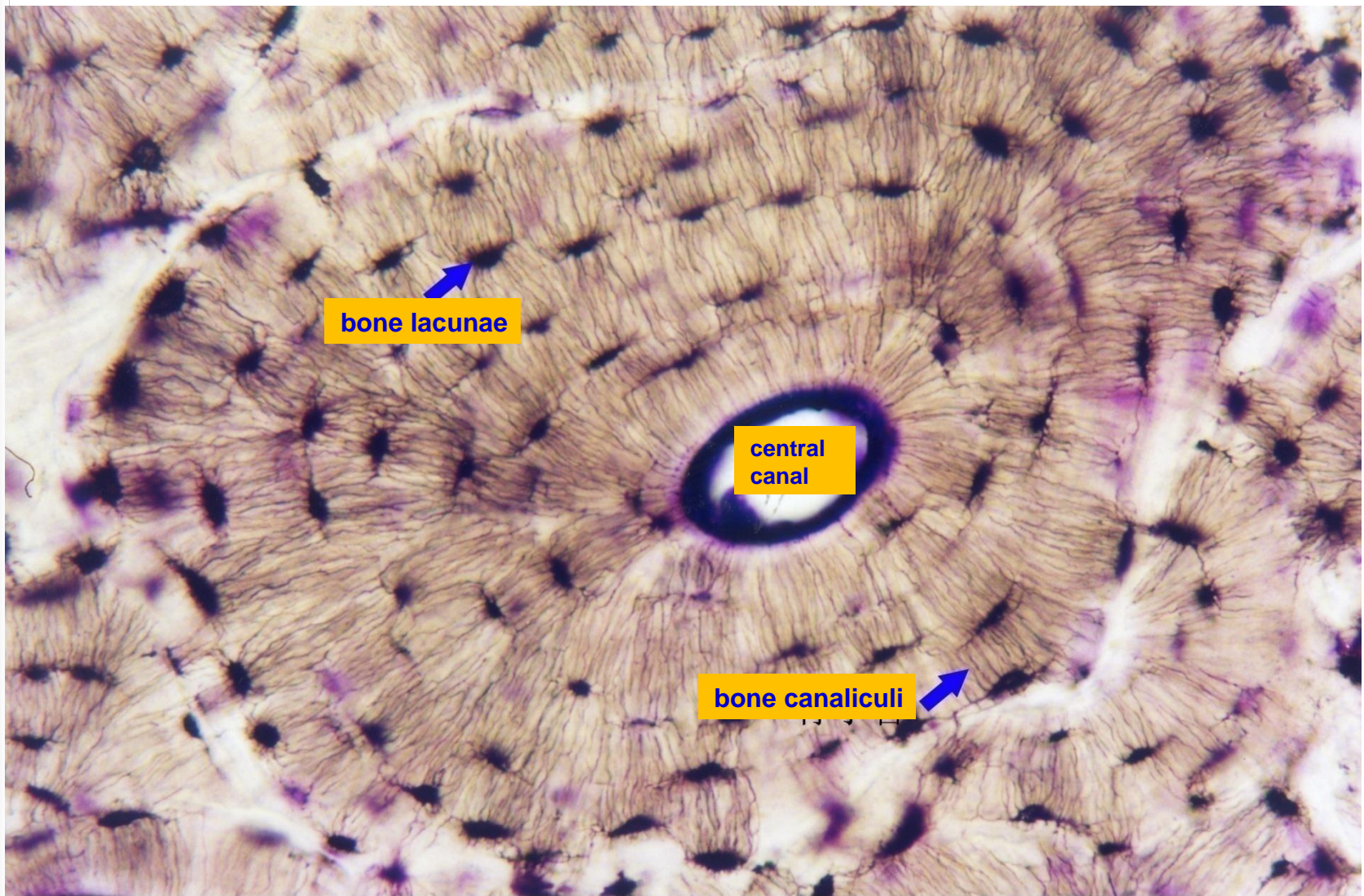
H&E staining: acidophilic, basophilic



Blood smear , Human blood cells, Wright staining, 3.3×100
1 Erythrocyte; 3 Neutrophil; 4 Eosinophil



Loose connective tissue (**stretched** preparation, X 100)



Ground section, Human long bone, 3.3×40

Osteon: central canal; bone canaliculi; bone lacunae

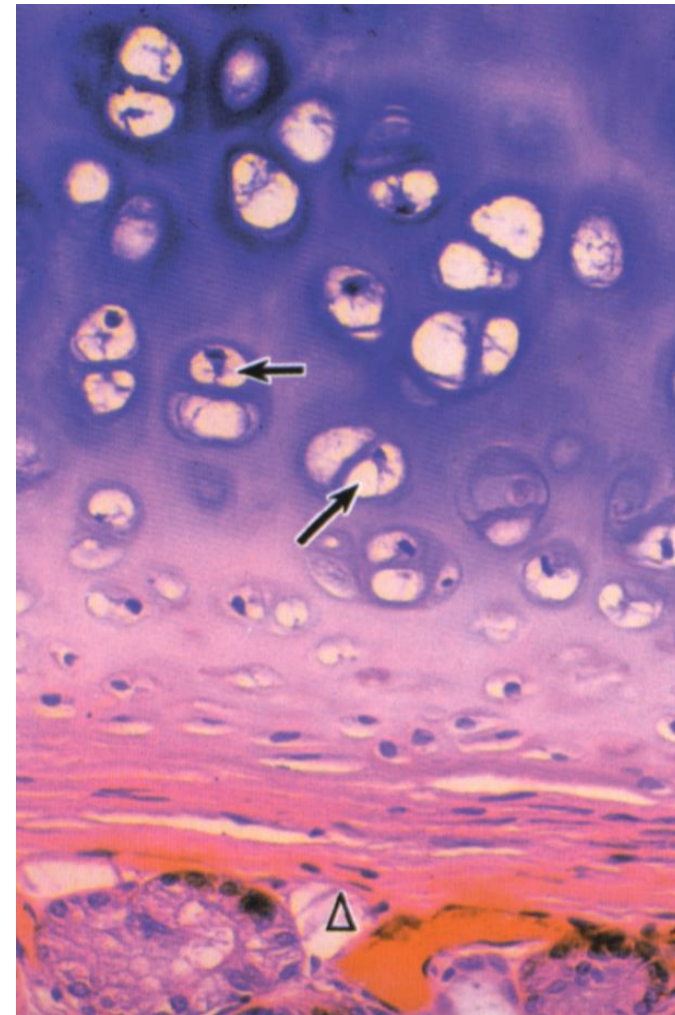
II. Approach of Study (1a)



1. Bright-field Microscopy

Paraffin Section, H&E staining

- Fixation
- Embedding & Sectioning
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 - Hematoxylin: basic dyes
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- **Ground Section: bone**



H&E staining: acidophilic, basophilic

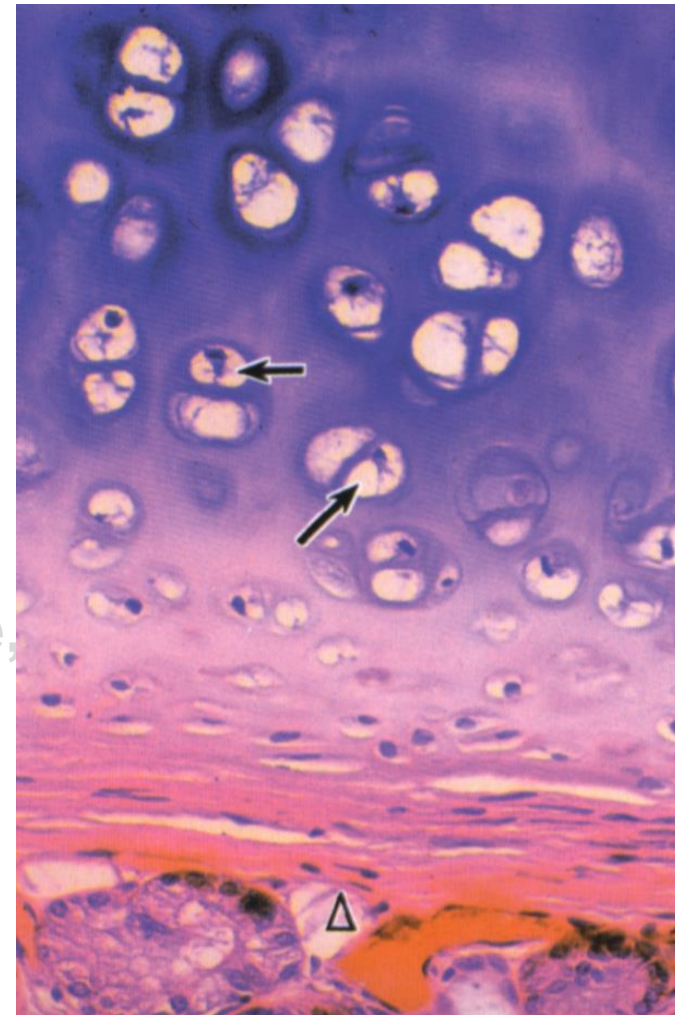
II. Approach of Study (1b)



1. Bright-field Microscopy

Paraffin Section, H&E staining

- Fixation
- Embedding & Sectioning
- Staining: H&E
 - Hematoxylin: basic dyes
 - Eosin: acid dyes
- acidophilic & basophilic
- Frozen Section: for enzyme, lipid
- Smear: blood, semen
- Stretched: mesentery
- Ground Section: bone

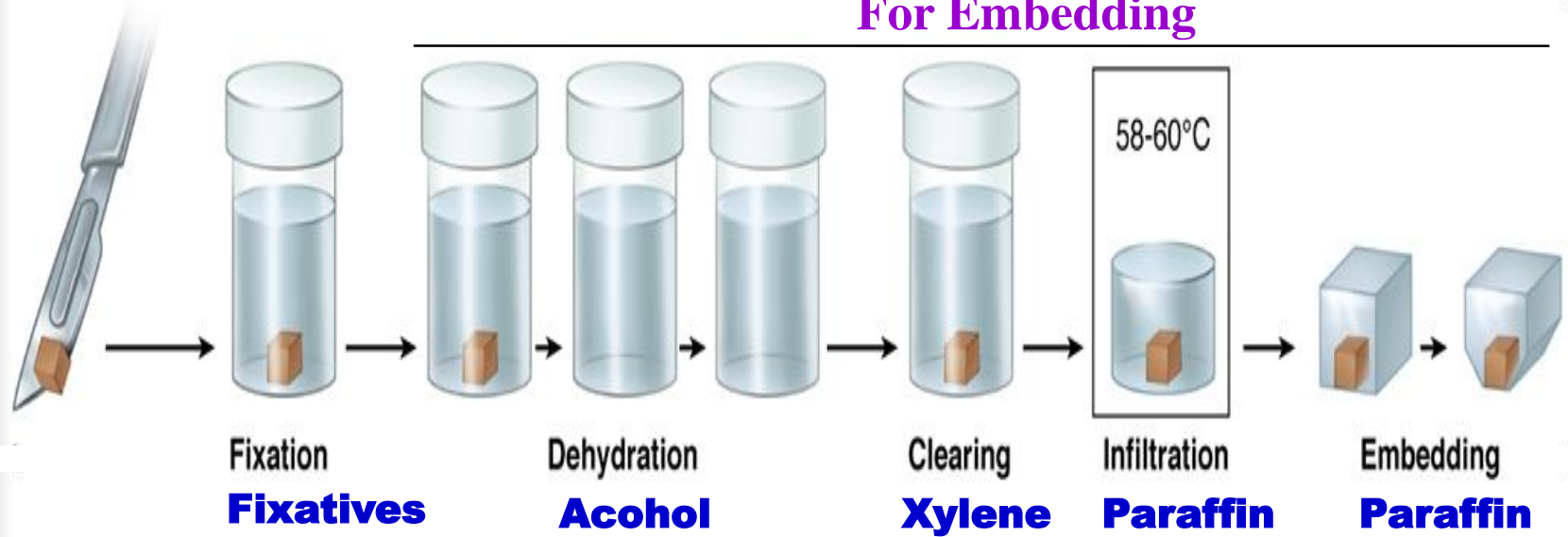


H&E staining: acidophilic, basophilic

Preparation for Paraffin Section



For Embedding



A **microtome** for sectioning **paraffin-embedded tissues** for **light microscopy**.

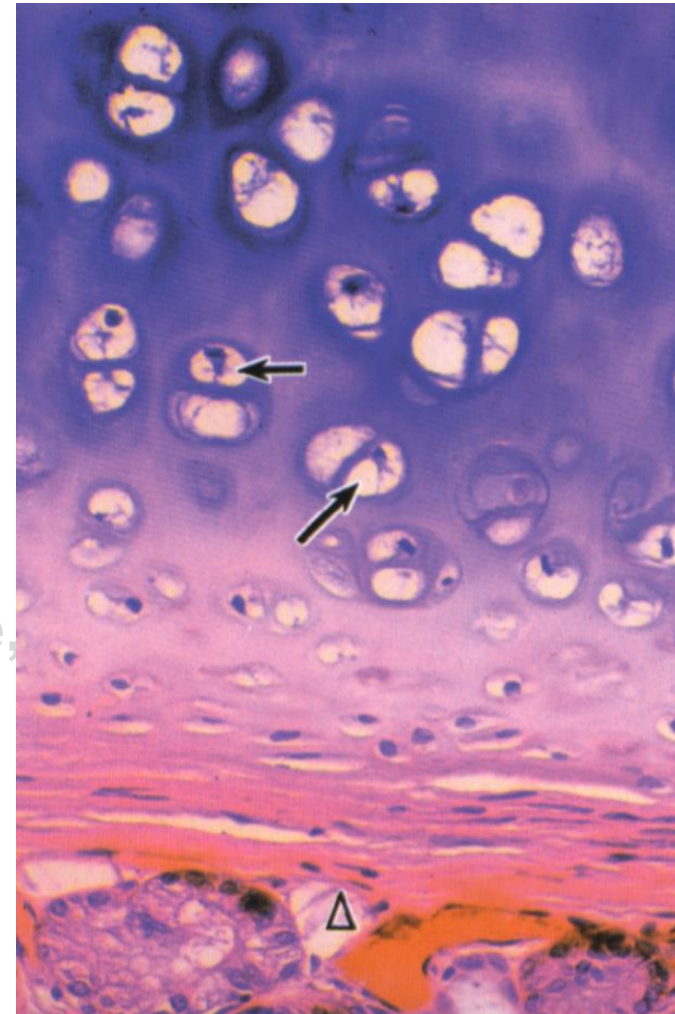
II. Approach of Study (1b)



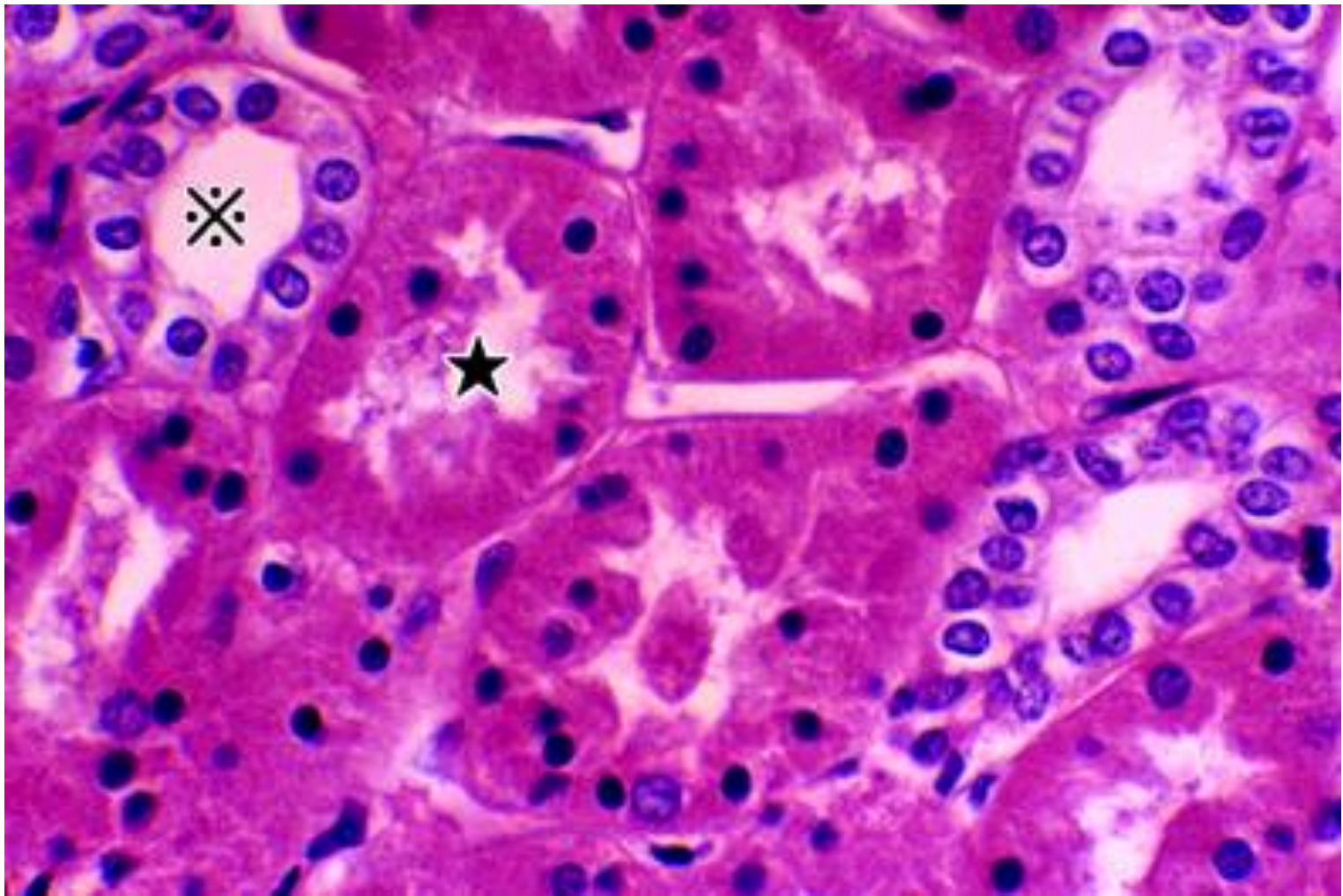
1. Bright-field Microscopy

Paraffin Section, H&E staining

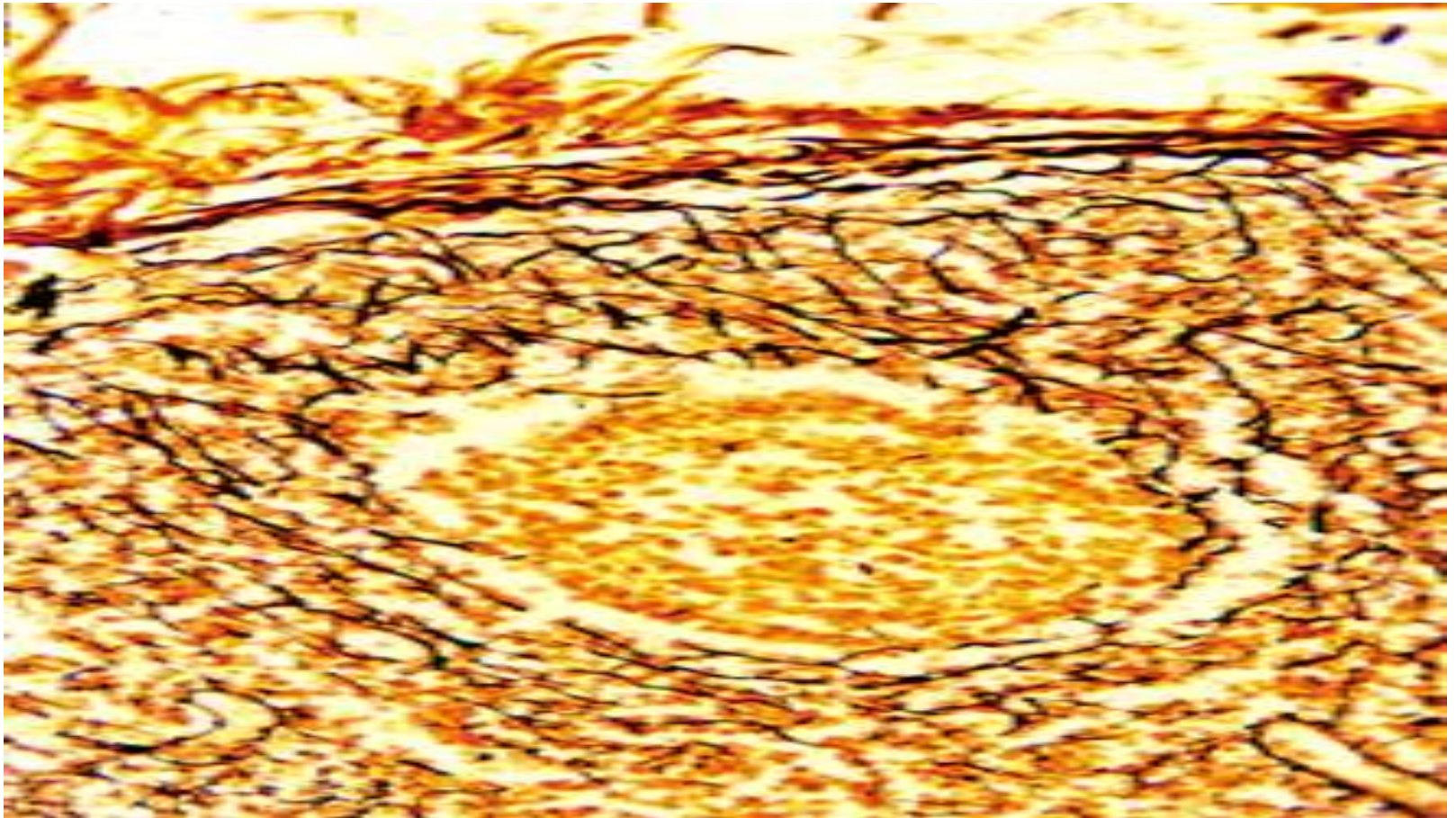
- Fixation
- Embedding & Sectioning
- **Staining: H&E**
 - Hematoxylin: basic dyes
 - Eosin: acid dyes
- **acidophilic & basophilic**
- Frozen Section: for enzyme, lipid
- Smear: blood, semen
- Stretched: mesentery
- Ground Section: bone



H&E staining: acidophilic, basophilic



**Paraffin section, H&E staining
human kidney, 3.3×40**



**Paraffin section, silver staining,
rat lymph node, 5×40
reticular fibers, argyrophilia or argentaffin**

II. Approach of Study (2a)



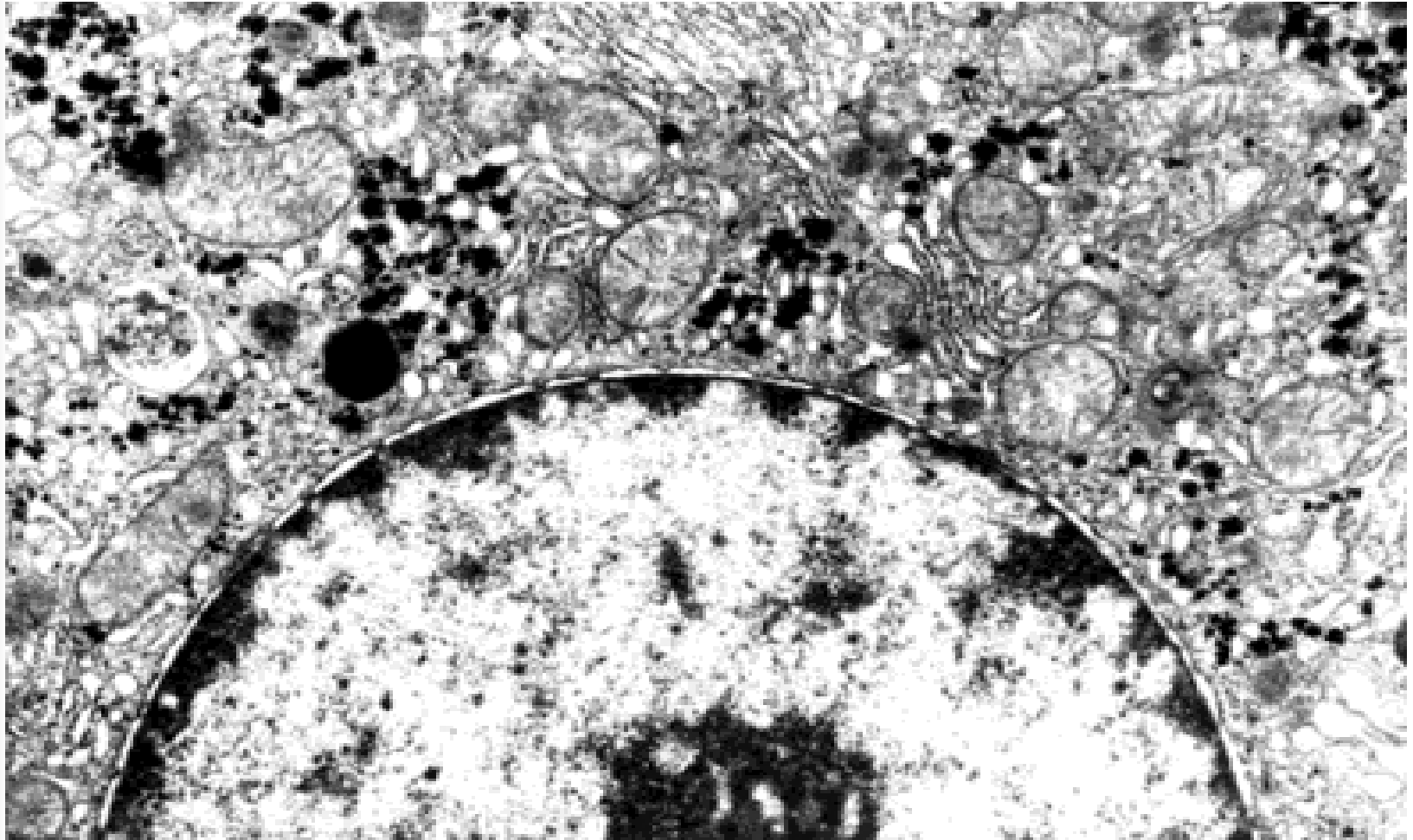
1. Light microscopy: LM

- Bright-field Microscopy
- Specific microscopy

2. Electron Microscopy: EM

- **Transmission Electron Microscopy, TEM**
 - To observe the insides details of cells, tissues and organs.
 - i.e., **organelles.**

Transmission Electron Microscopy, TEM



Rat Hepatocyte, $\times 17200$

Darker/Brighter Electron Dense

II. Approach of Study (2b)

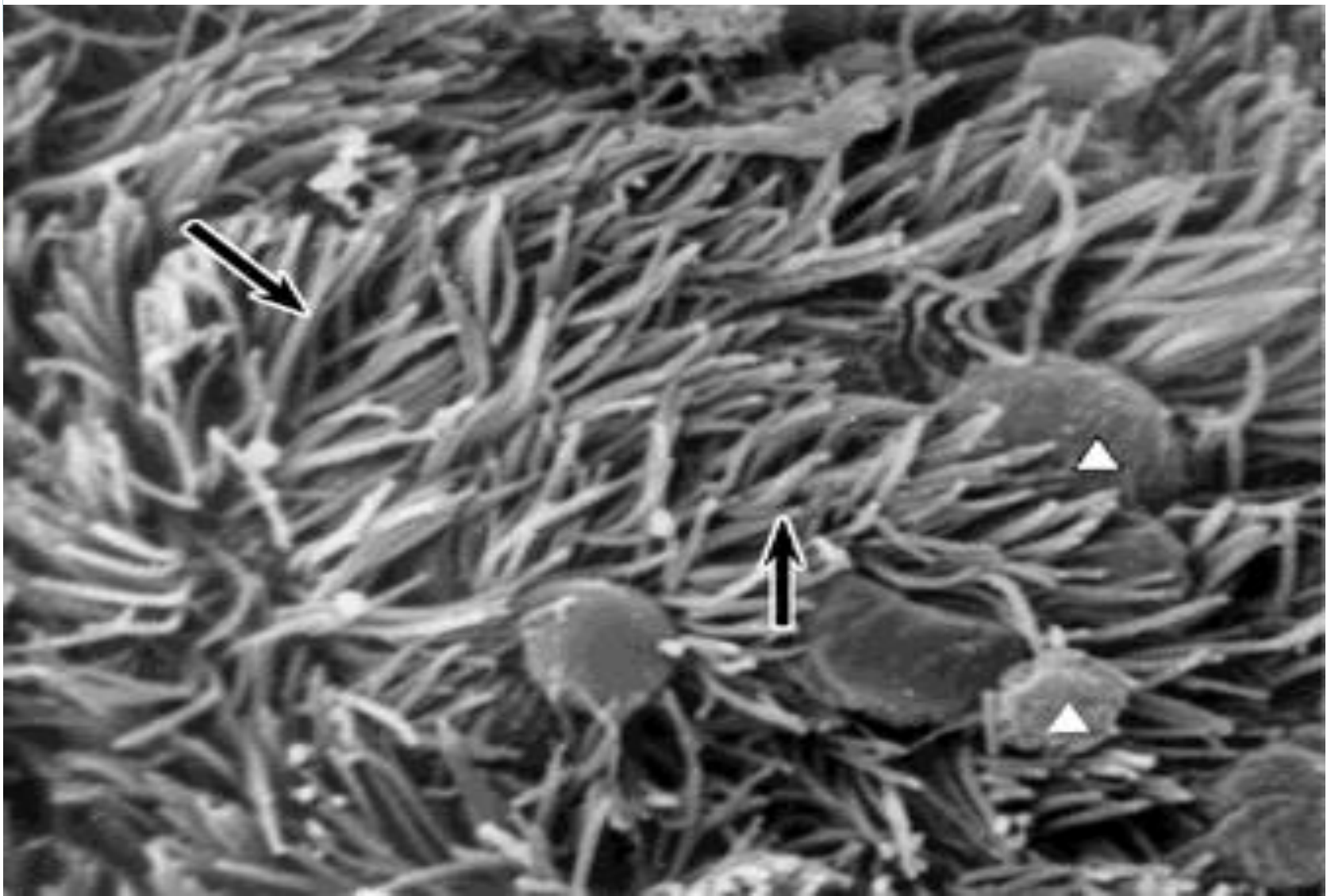


1. Light microscopy: LM

- Bright-field Microscopy
- Specific microscopy

2. Electron Microscopy: EM

- Transmission Electron Microscopy, TEM
- **Scanning Electron Microscopy, SEM**
 - To observe **the pseudo-3D views** of the **surfaces** of cells, tissues and organs.
 - i.e., bulges, microvillium、 cilium, secretion and phagocytosis of cells.



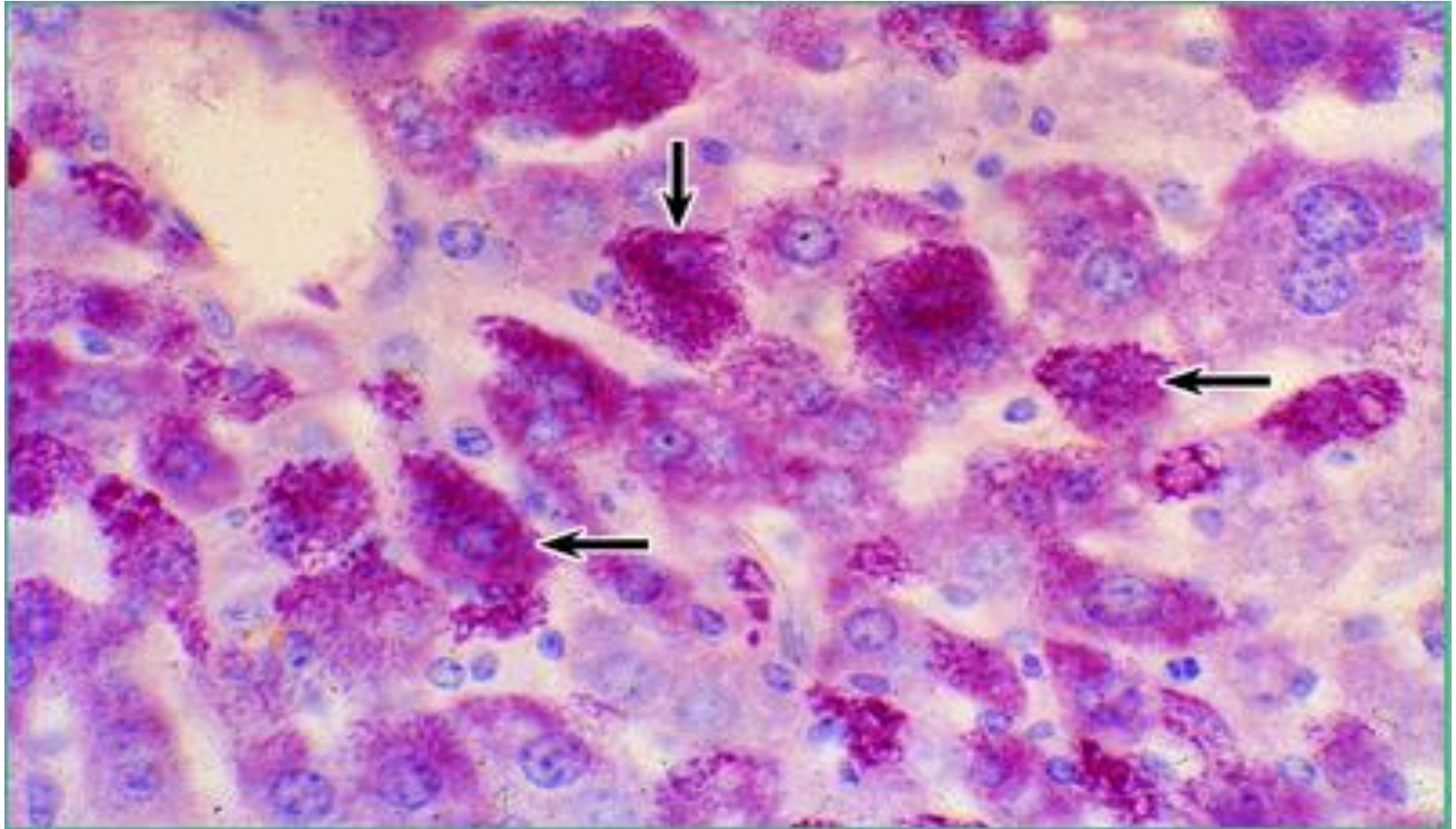
Cilium (SEM photo)

II. Approach of Study (3)

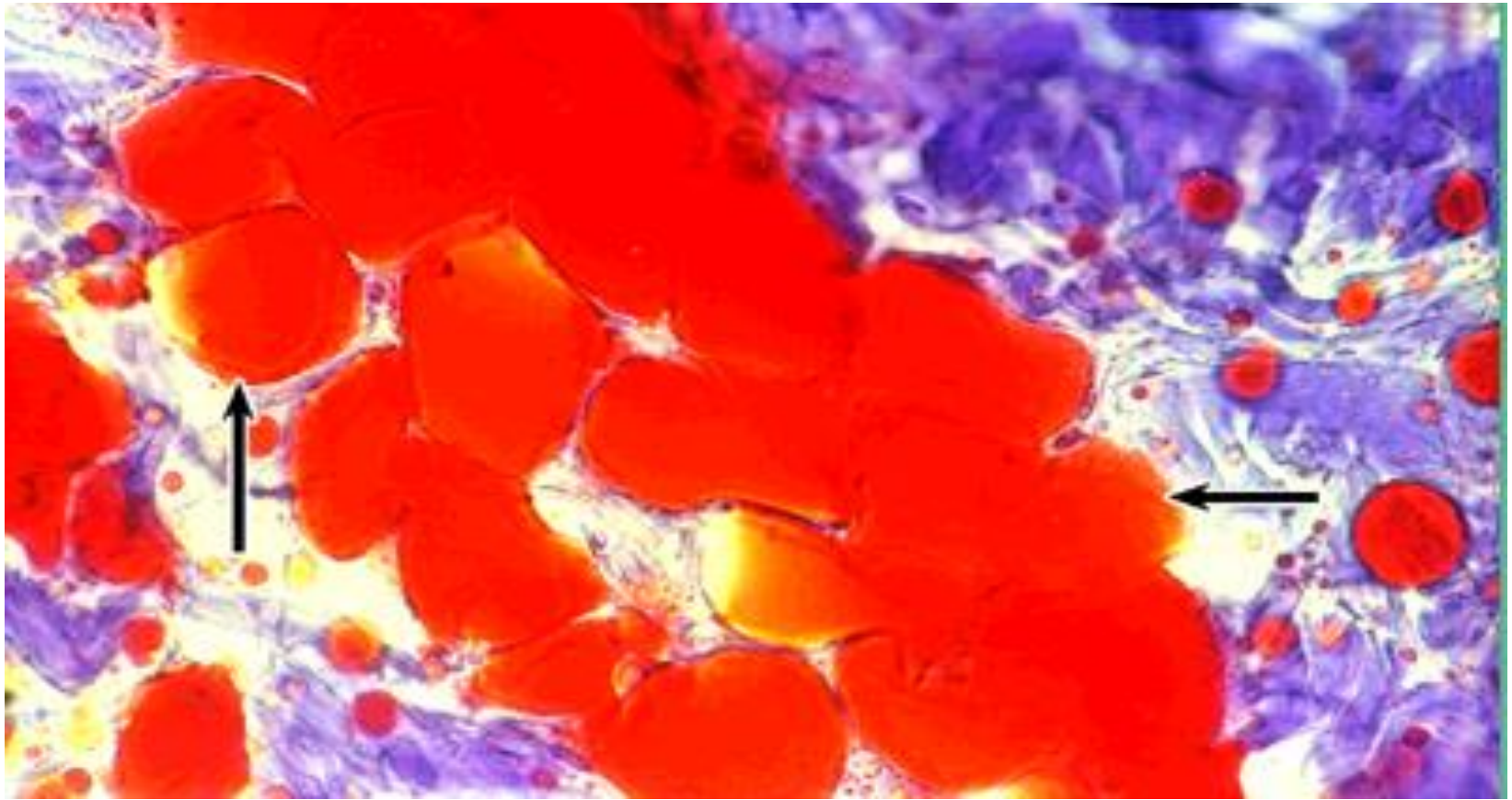


1. Light microscopy: LM
2. Electron Microscopy: EM
3. **Histochemistry (Cytochemistry):**
 - **Glycogen:** periodic acid Schiff reaction, **PAS** reaction.
 - **Lipids:** lipid-soluble dyes, such as **Sudan** dyes, etc.
 - **Enzymes:** **colored** or **electron-dense** products by enzyme reaction on the substrate.
 - **DNA/RNA:** Feulgen reaction

Periodic acid Schiff reaction, PAS reaction: Glycogen

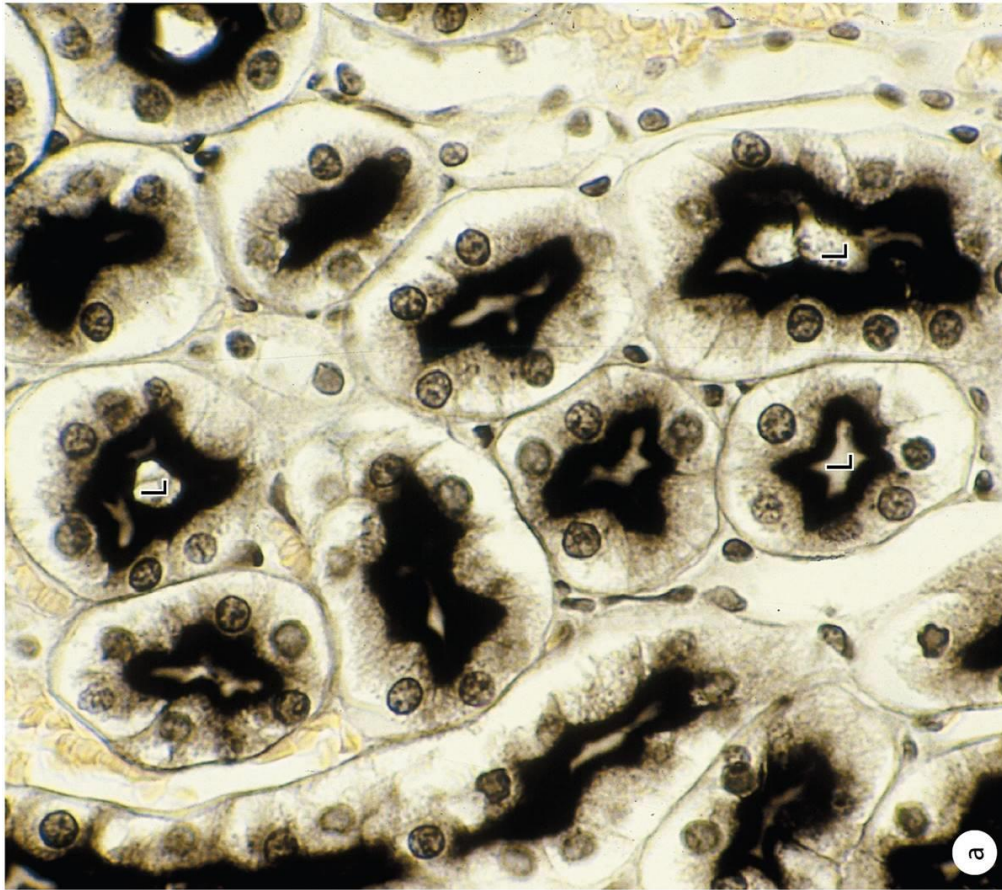


Histochemistry staining: **Lipids**



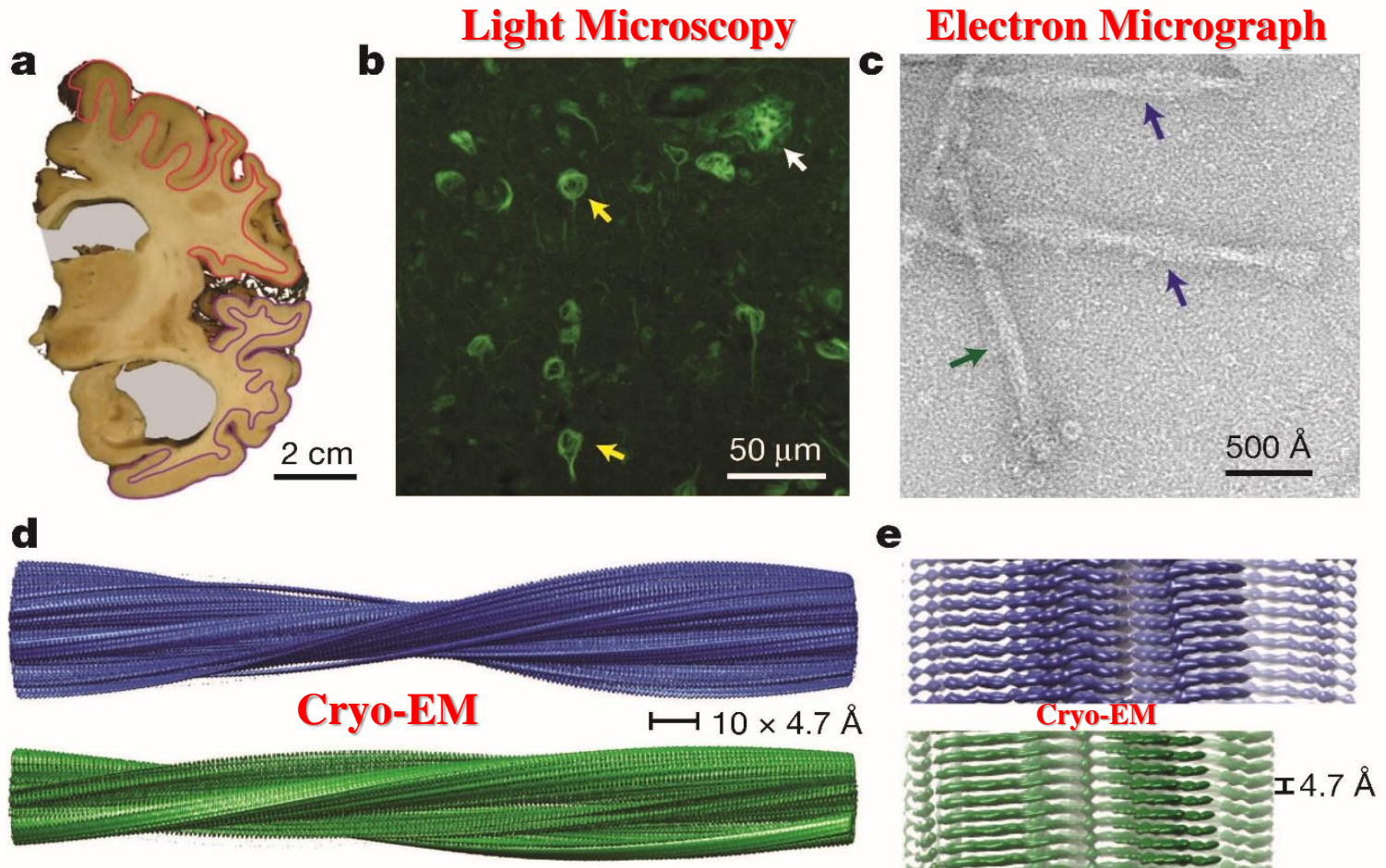
**Rabbit adipose tissue,
Sudan III staining, 5×40**

Histochemistry staining: **Enzymes**



LM image of **a kidney tubules** in which **alkaline phosphatase** shows **strong activity at the apical surfaces** of the cells at the lumens (L) of the tubules. X200.

Summary II - Approach



Fitzpatrick et al. Nature. 2017 Jul 13

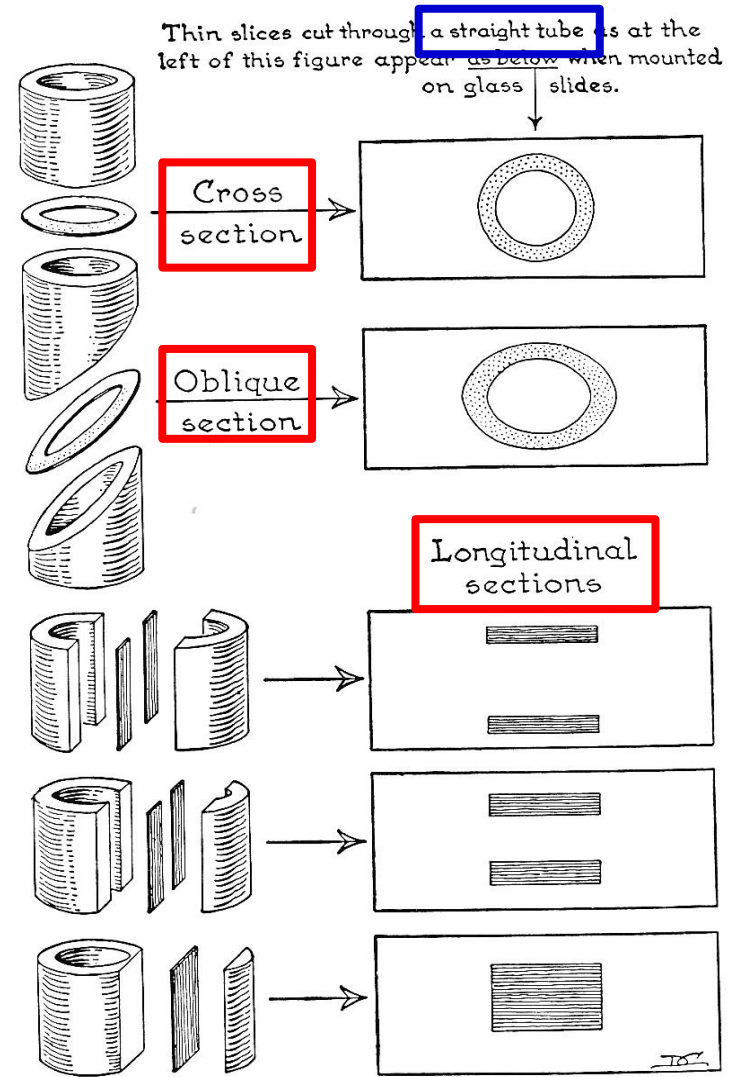
Figure 1 | Structure of tau filaments from Alzheimer's brain.

II. Approach of Study

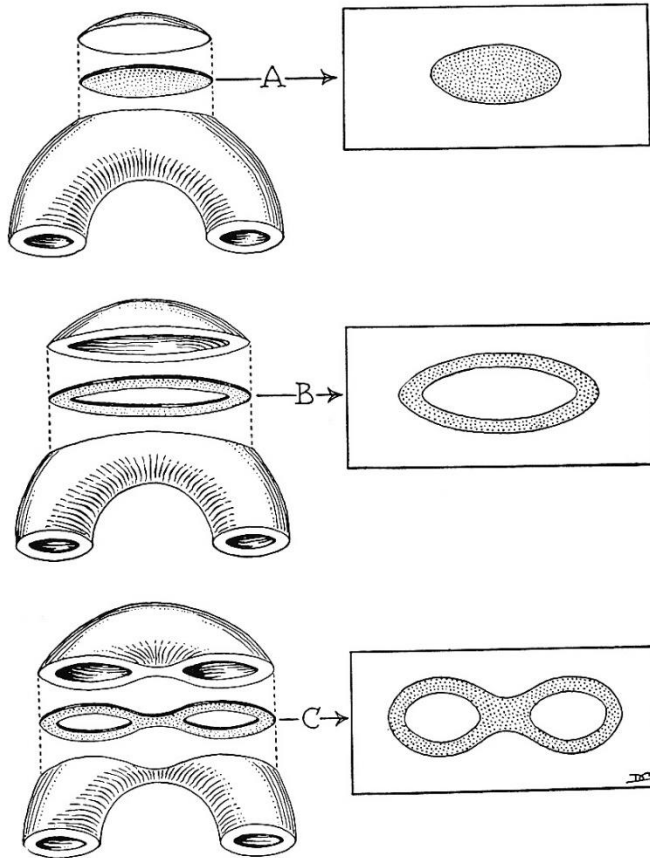
1. **Light** Microscopy: **Bright field, HE Staining**
 2. **Electron** Microscopy: **TEM, SEM**
 3. **Histochemistry (Cytochemistry):**
 - **Glycogen**
 - **Lipids**
 - **Enzymes**
 4. **Autoradiography**
 5. **Tissue Culture**
 6. **Immunocytochemistry**
 7. **In situ Hybridization**
- } **Self-study**

III. Interpretation of images (1)

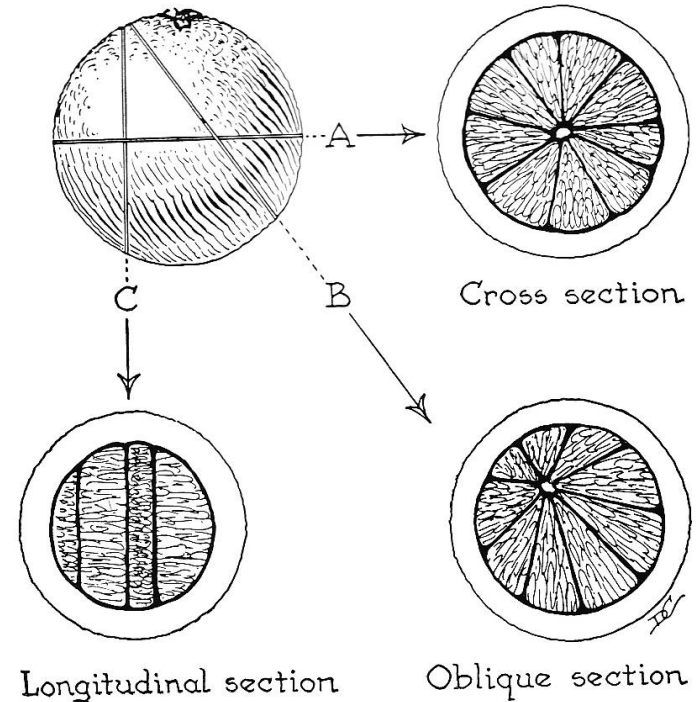
- **Same structure** can appear as **different images** under microscope
- **2D images** under microscope reflecting **3D structures** in fact
- **Important to bear this** in your mind



III. Interpretation of images (2)



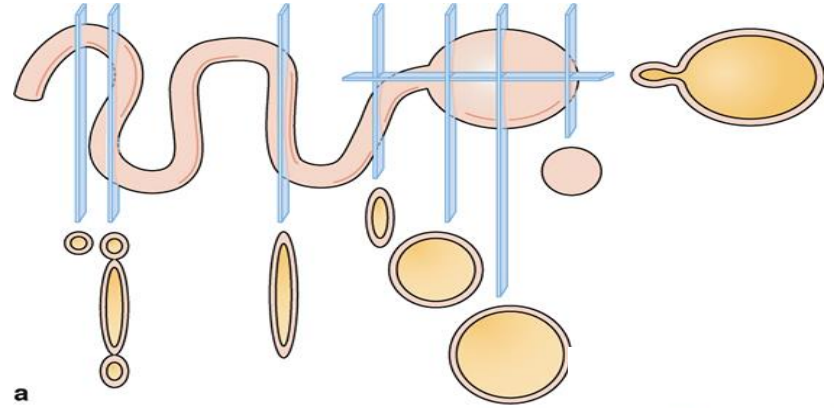
Curved tube



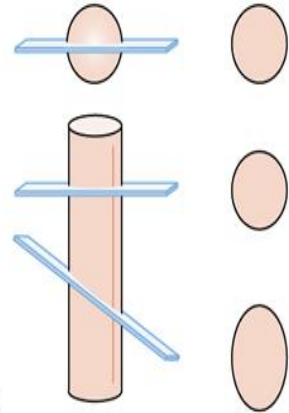
Globular acinus

TIPS

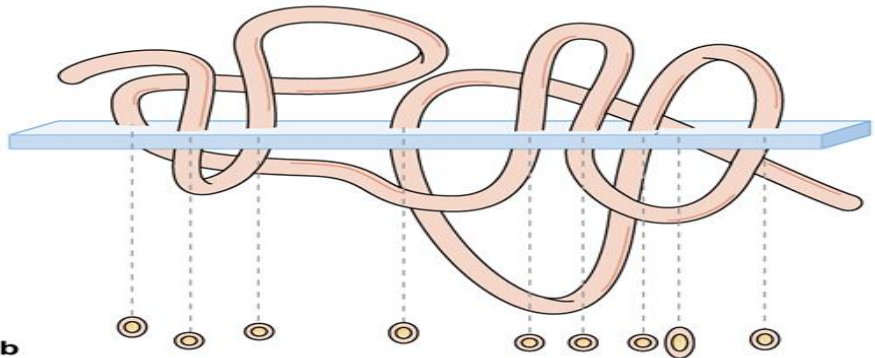
- Theory ↔ Slides
- Morphology ↔ Function
- Microstructure ↔ Gross anatomy
- 2D images ↔ 3D structures
- Static ↔ dynamic



a



c



b

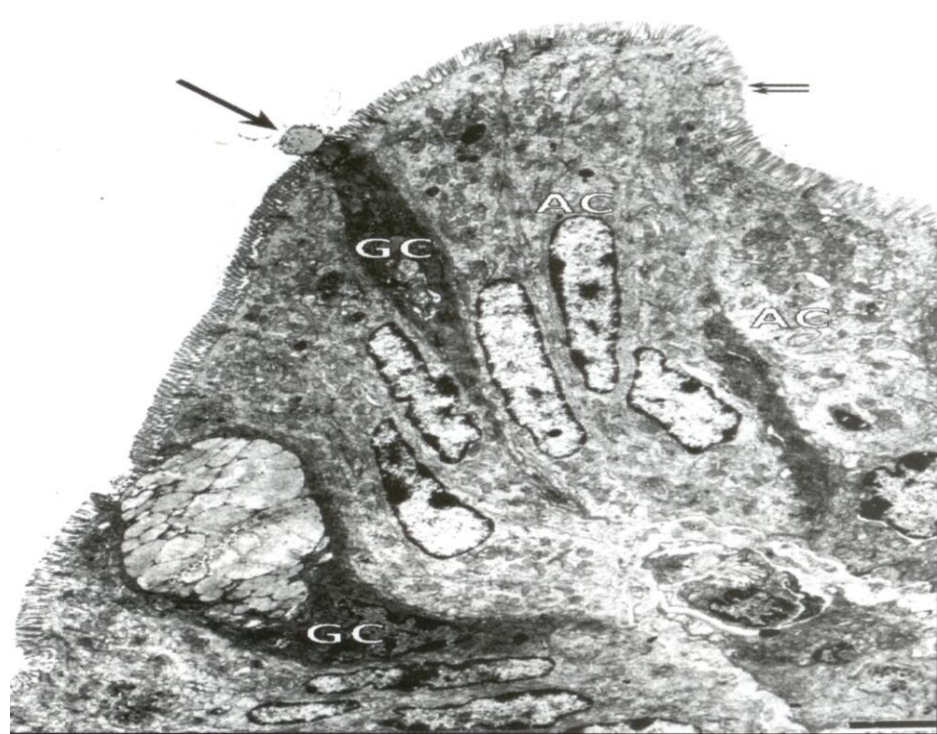
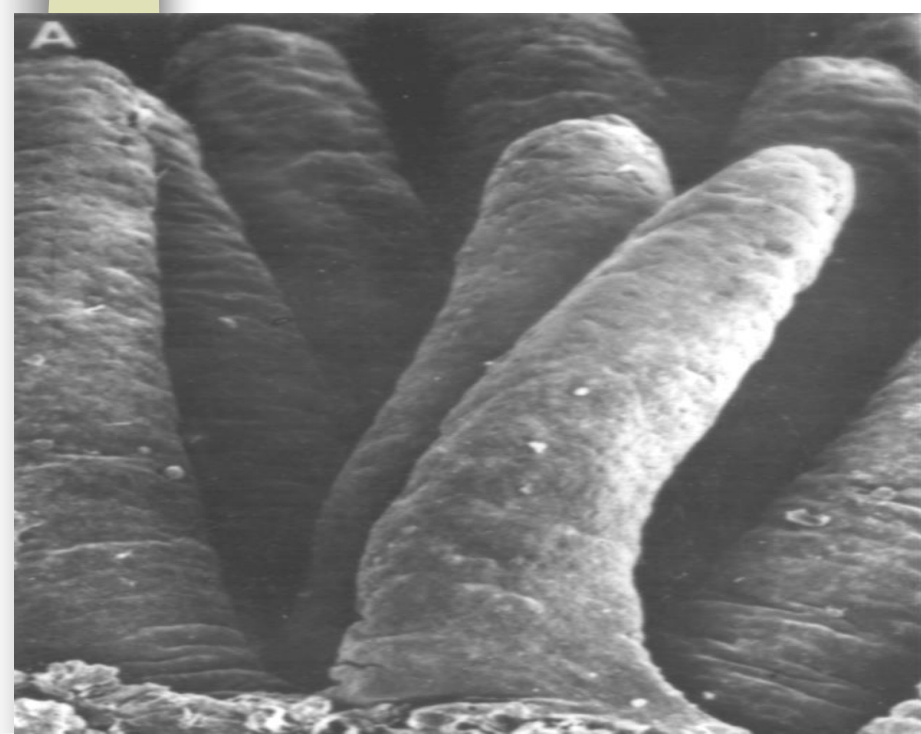
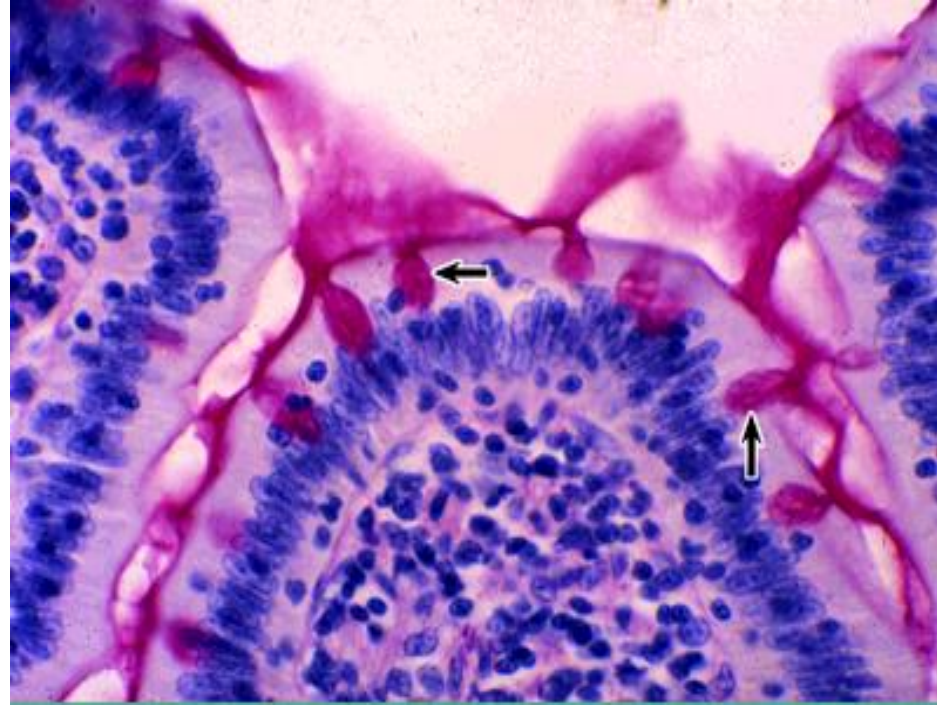
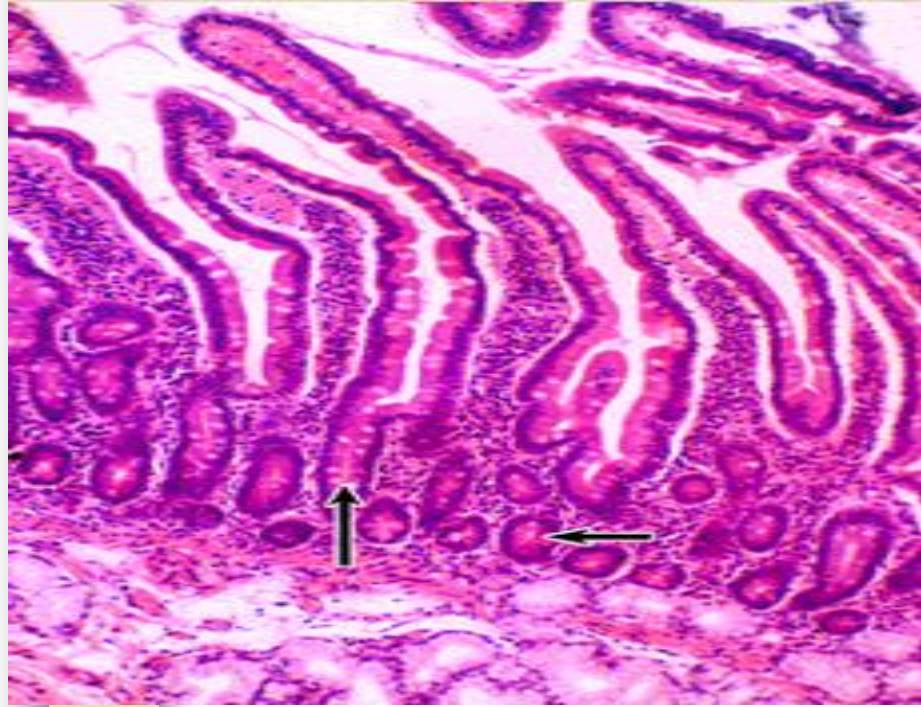
SUMMARY



1. **Light Microscopy**: a beam of transmitted light
 - **Bright-field Microscopy**: resolution 0.2 μm
 - HE staining: acidophilic, basophilic
 - Special microscopy
 - Fluorescence Microscopy
 - Phase-contrast Microscopy
 - Confocal Laser Scanning Microscopy
2. **Electron Microscopy**: beams of electrons; resolution 3 nm
 - Transmission electron microscopy, TEM: insides
 - Scanning electron microscopy, SEM: surfaces
3. **Histochemistry/Cytochemistry**:
 - Glycogen: PAS reaction
 - Lipids: Sudan dyes
 - Enzymes: colorful reaction with substrate
4. Autoradiography
5. Tissue Culture
6. Immuno-cytochemistry
7. In situ Hybridization

} Self-study

} Self-study





Review Questions

- How is the **H&E staining method** applied in the study of Histology?
- What are the features of the **electron microscopy**? How to apply it?

THE END

