
# TISSUES AND ORGANS

## PART 1

Animals and plants are multicellular (made of many cells). Cells become specialised according to their function

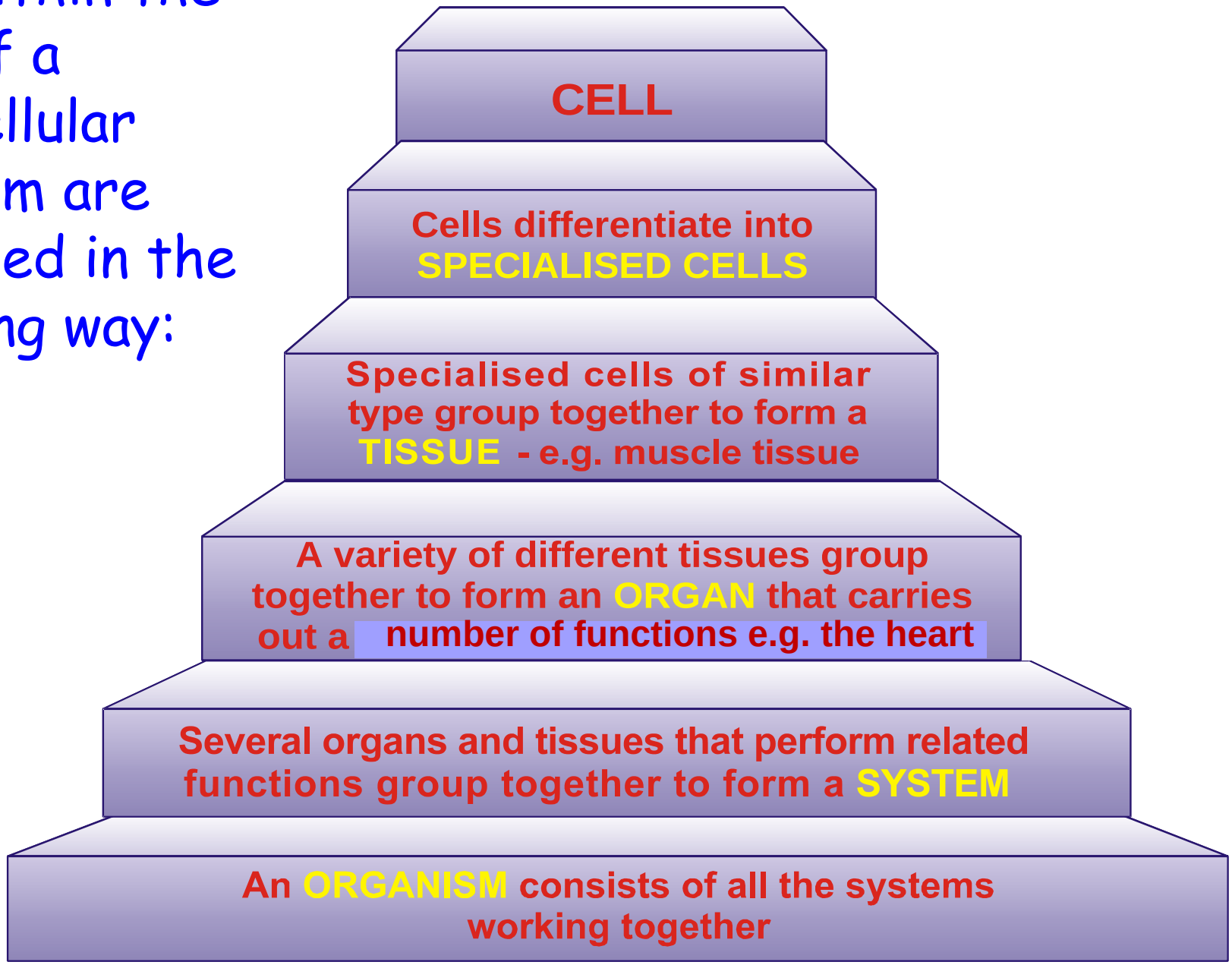
**Tissues:** *Many cells that perform one or several functions; they are often made of the same type of cell e.g. epithelia. Epithelial cells line organs and separate internal tissues from air, blood, food and waste travelling through tubes in the body. In the plant, the epidermis secretes a waxy cuticle to prevent desiccation (drying out)*

We can study the individual structure and function of tissues that make up whole organs e.g. the leaf and the ileum

**Organs:** *Structures made of several tissues working together to carry out a number of functions.* The leaf and the ileum both contain layers of different tissues that allow these organs to carry out necessary functions

**Organ systems:** *Groups of organs working together to perform main body processes* e.g. the digestive system of a mammal has to digest and absorb food, and also eliminate undigested material. A range of organs are involved e.g. mouth, oesophagus, stomach, small and large intestines, liver, gall bladder and pancreas

Cells within the body of a multicellular organism are organised in the following way:



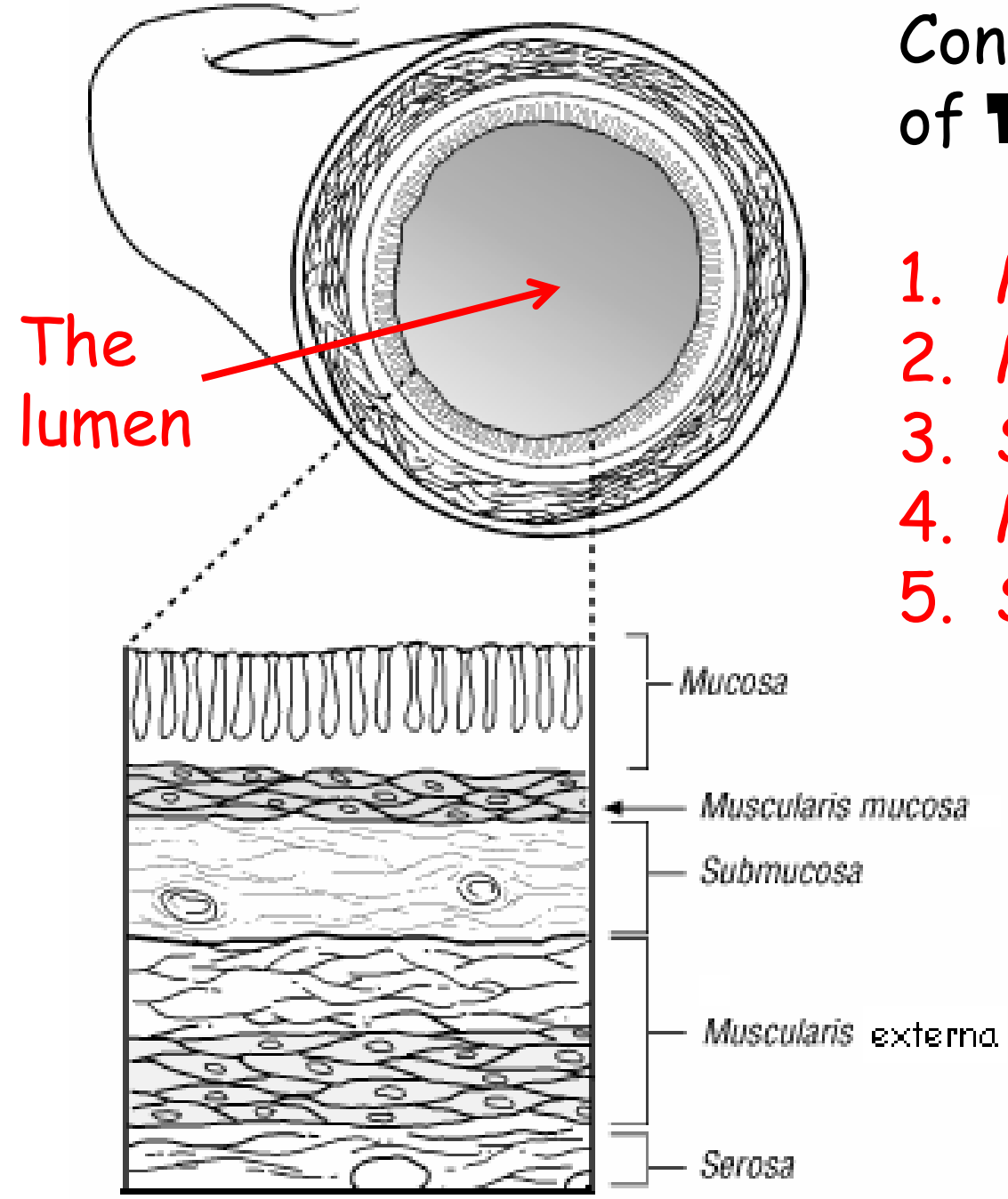
# Structure and function of the ileum (a mammalian organ)

- The region of the small intestine where the final stages of the digestive process are completed
- This is where most of the absorption of the products of digestion occurs
- It has a very large surface area for digestion and absorption due to:

*- The wall of the ileum being folded*

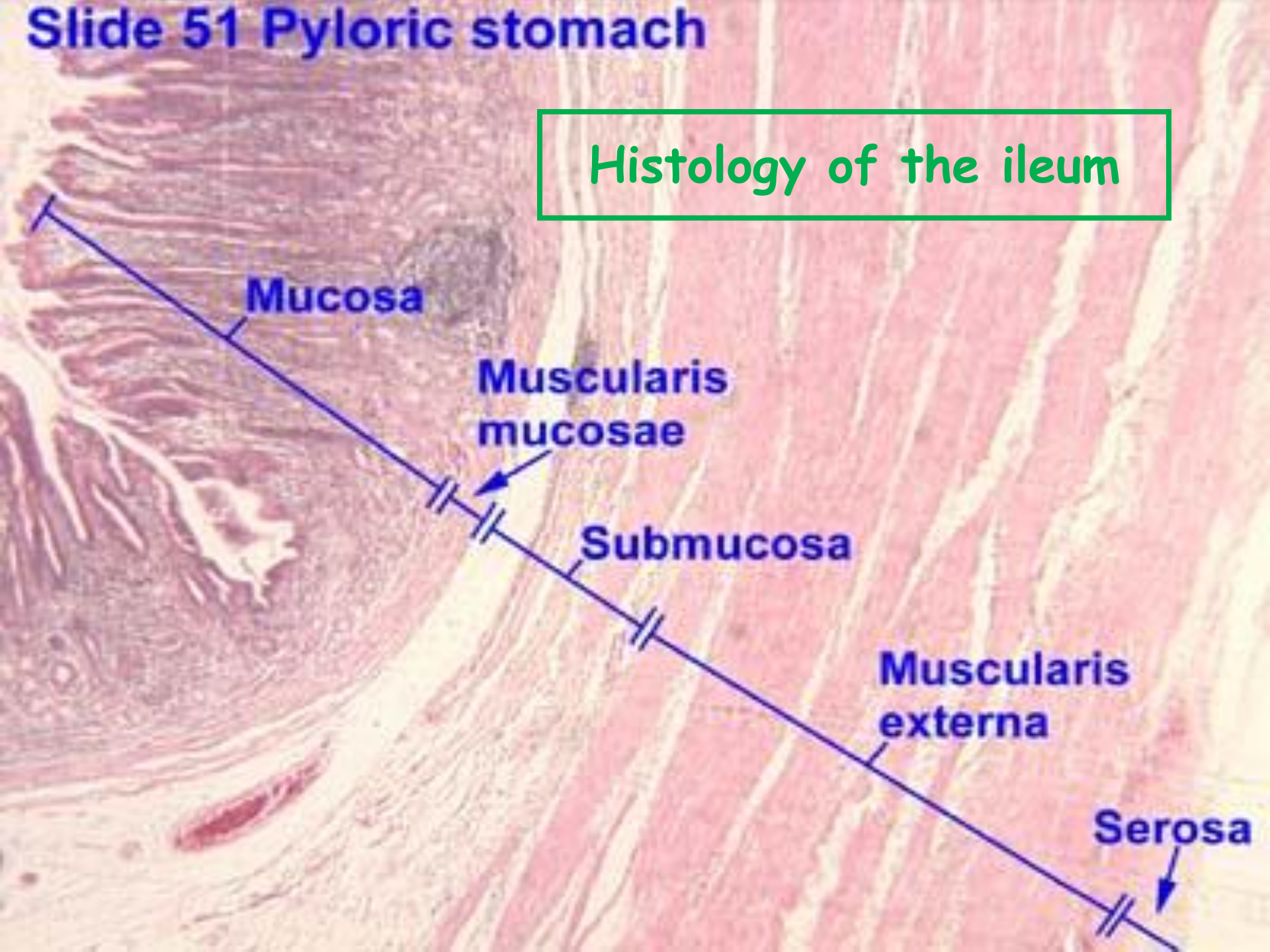
*- The presence of villi on these folds*

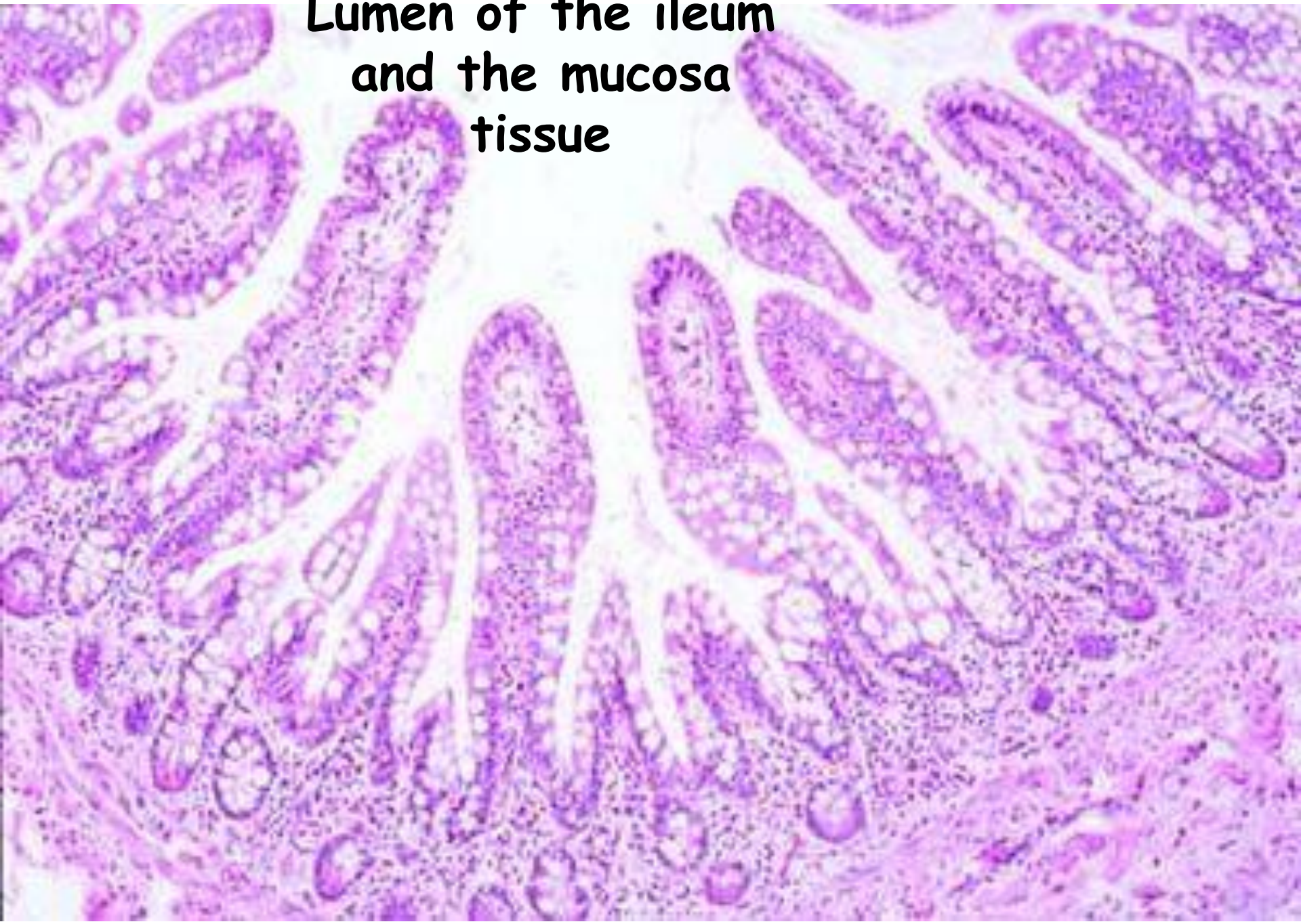
*- The presence of microvilli on the cells lining the villi*



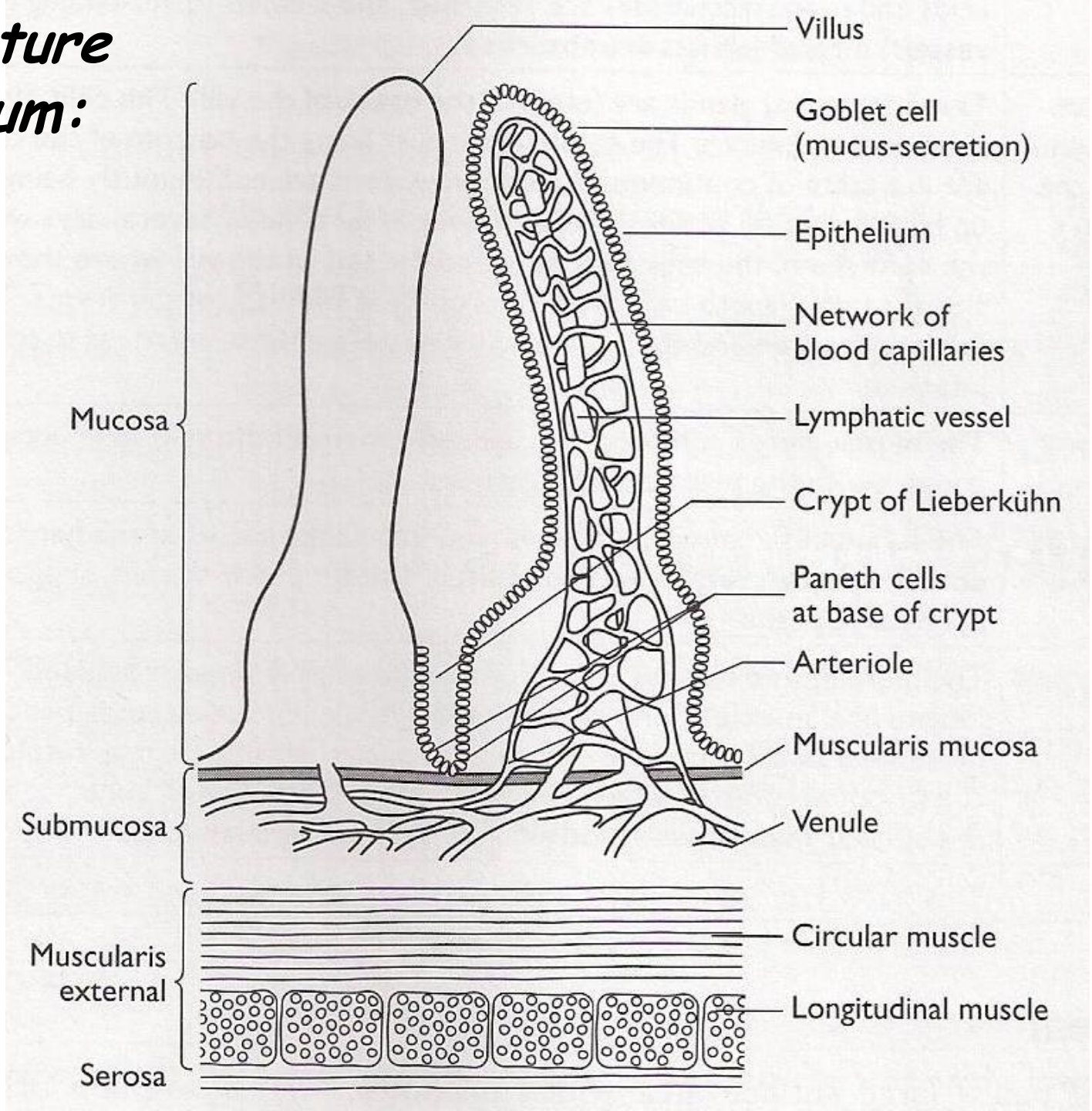

Contains 5 distinct layers of **TISSUE:**

1. Mucosa *(innermost layer)*
2. Muscularis mucosa
3. Submucosa
4. Muscularis externa
5. Serosa *(outermost layer)*

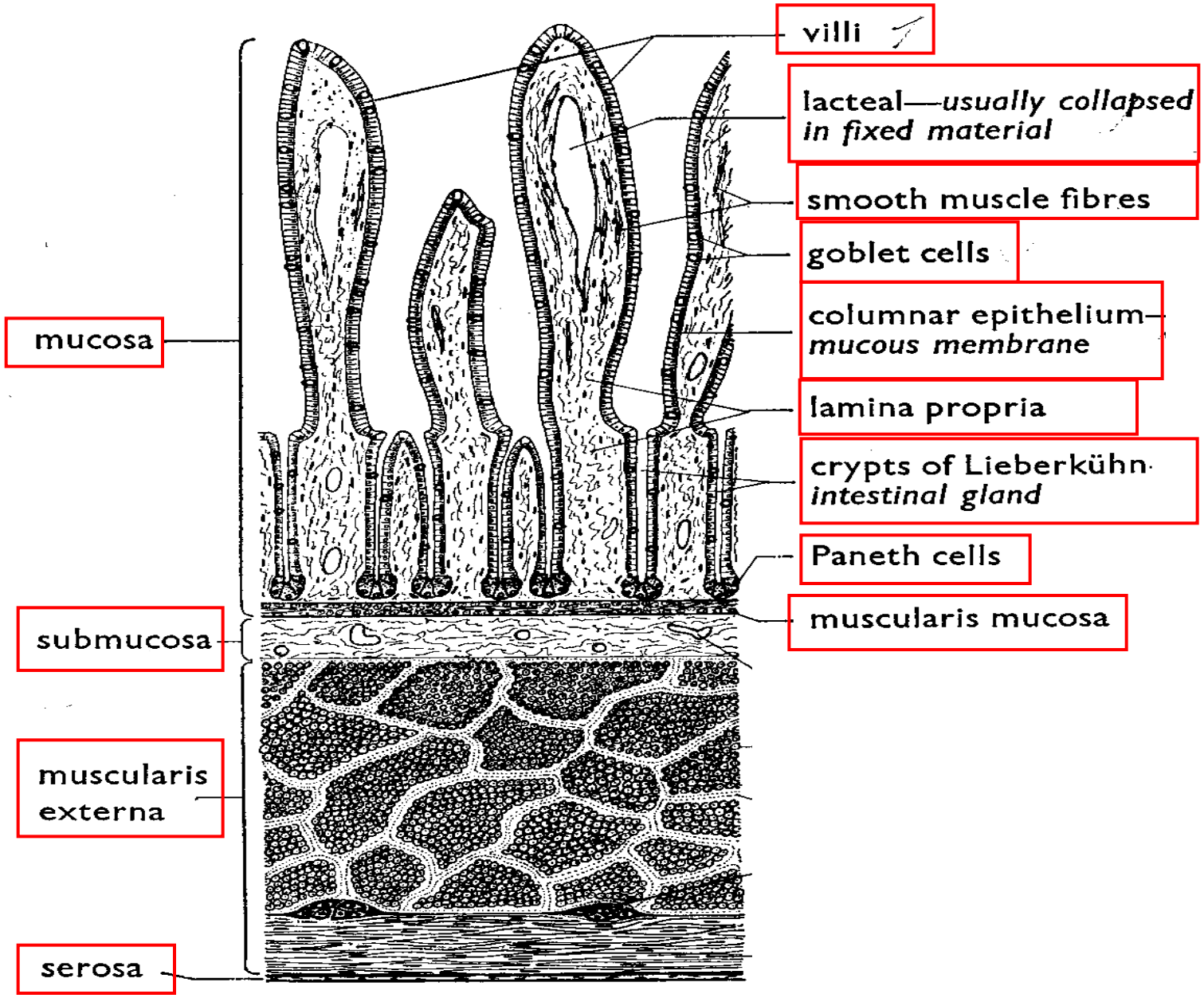

Slide 51 Pyloric stomach
Histology of the ileum
Mucosa
Muscularis mucosae
Submucosa
Muscularis externa
Serosa


Lumen of the ileum
and the mucosa
tissue

# The structure of the ileum:



# Cross section of the tissues of the ileum:



# Mucosa – the innermost layer

*The innermost layer of tissue in the ileum – on the folds are numerous finger like villi. At the villus base are the Crypts of Lieberkühn. On the villi there is a brush border of columnar epithelium cells (with microvilli), amongst which goblet cells are also found*

## Villi:

- Finger like projections that increase the surface area for absorption of the products of digestion
- They contain a network of blood capillaries – for amino acid and monosaccharide absorption e.g. glucose, fructose
- And they contain lacteals (lymph vessels that end in the villus (blind ending)) to absorb fats

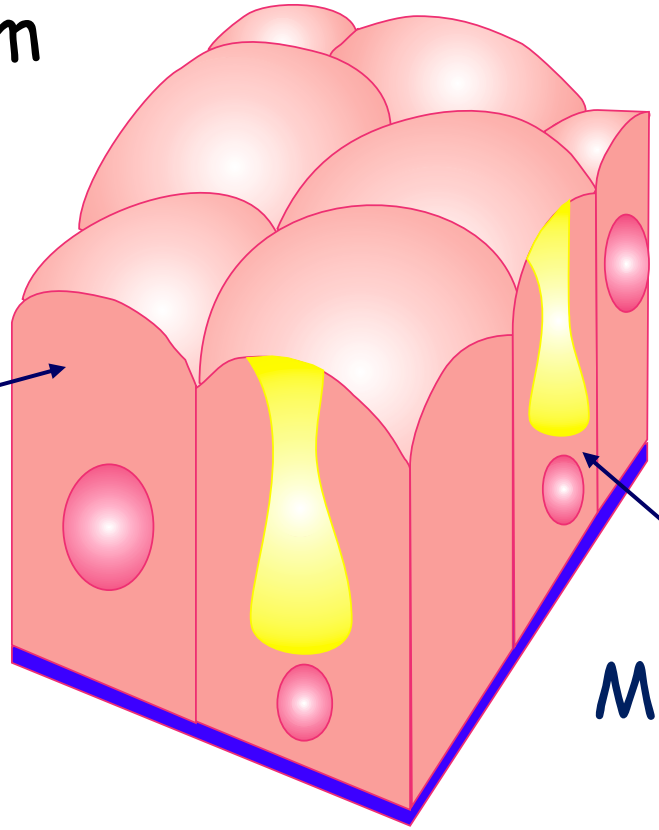
## Columnar epithelium:

- Column shaped cells that line the intestine (on villi)
- On their free surfaces (facing the lumen of the ileum) the cells have microvilli which form a brush border
- Digestive enzymes and protein carriers are found in the microvilli membrane
- These provide a huge surface area for digestion and absorption of the products
- Some substances are taken up partly by diffusion and partly by active transport, and others are taken up by pinocytosis
- These cells contain a lot of mitochondria to provide ATP for active transport
- These cells are short lived and are replaced by new ones pushed up from the crypts of Lieberkühn

## Goblet cells:

Contained in the epithelial lining for the secretion of mucus (slimy):

- To protect the epithelium from the action of digestive enzymes
- To lubricate the lining and help solid food move through the ileum



Columnar epithelium (in the epithelial lining)

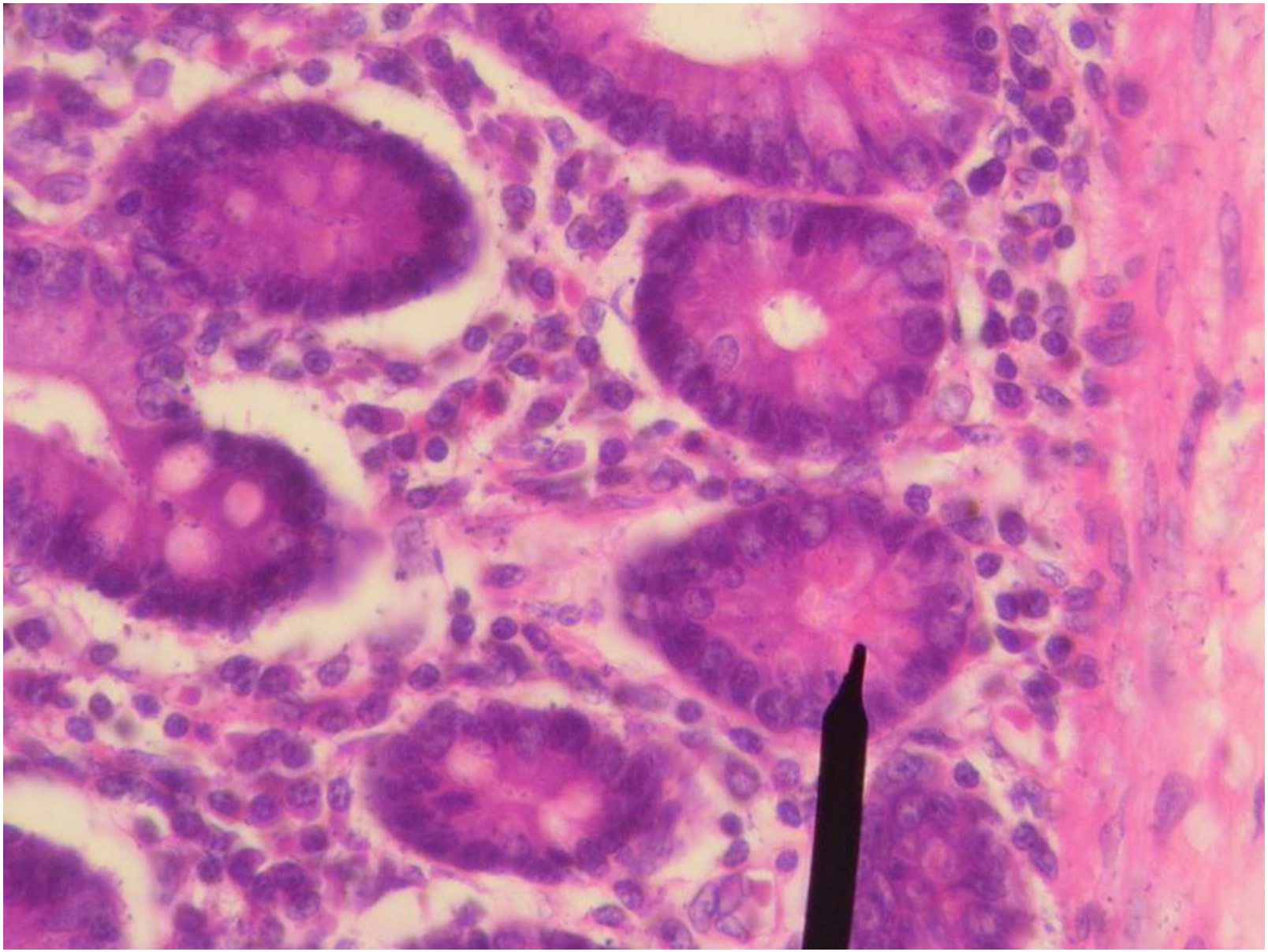
Mucus producing goblet cell

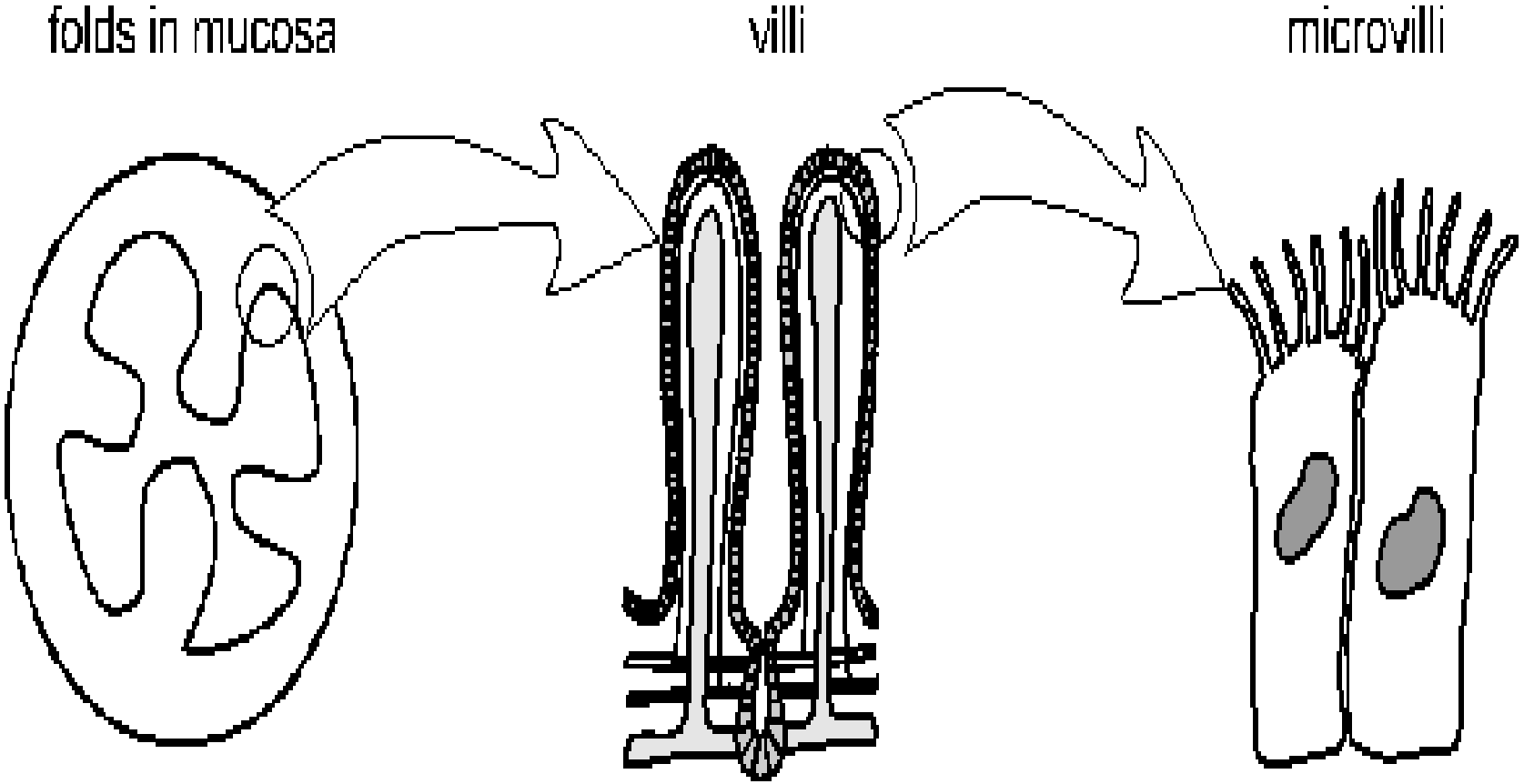
Goblet cells and columnar epithelial cells with microvilli at their surface are visible in this photomicrograph of the inner lining of the small intestine

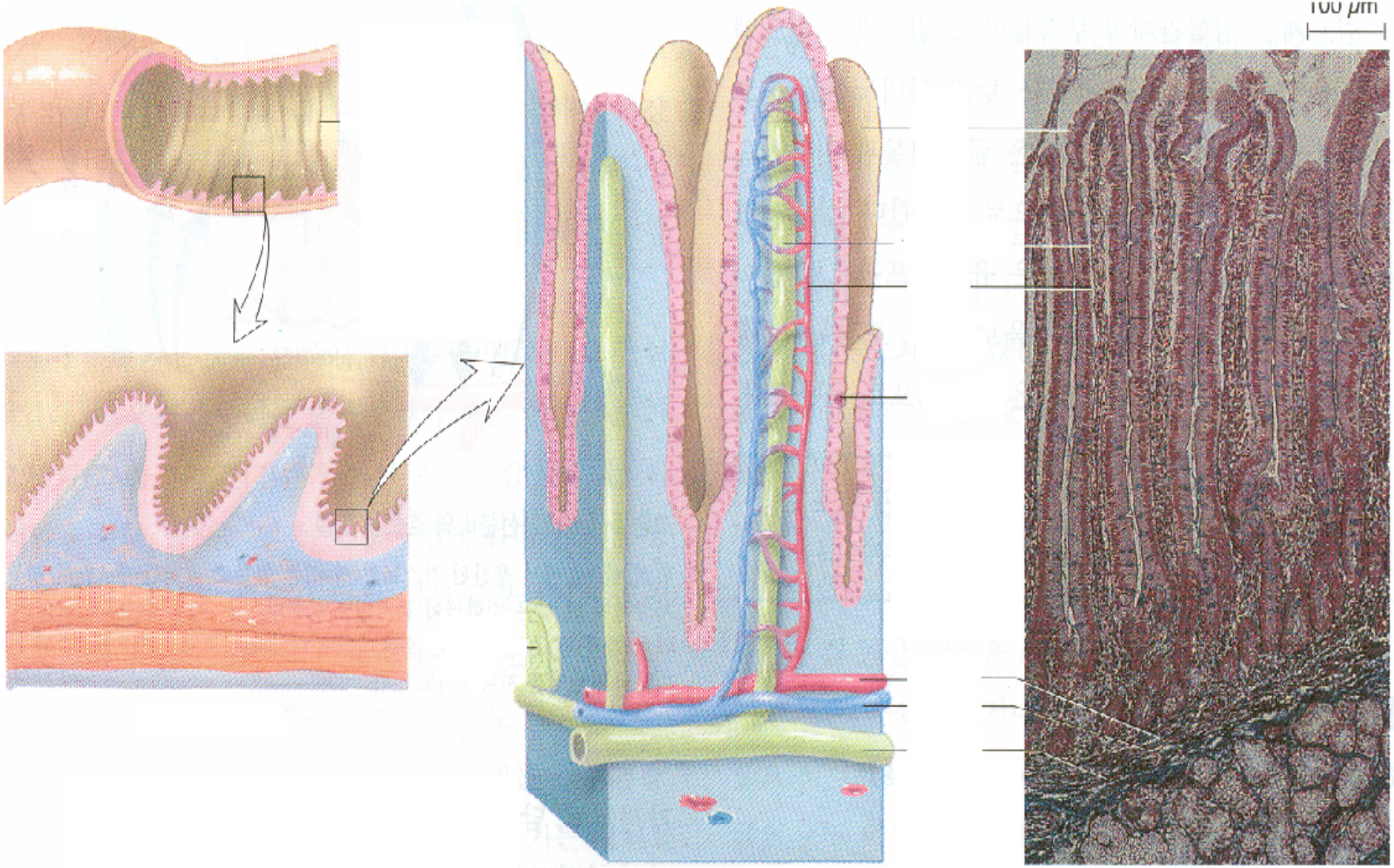
# Crypts of Lieberkühn:

- Intestinal glands that are found at the base of the villi
- Cells along the side of them secrete mucus
- Stem cells line the bottom which are in a continuous state of division (repeating mitosis) – new cells are continually being pushed up by dividing cells below
- They spend several days in the epithelium and are pushed to the tips of the villi where they are sloughed off (shed off)
- Paneth cells are found at the base of the crypts to defend the actively dividing cells against microbes in the small intestine (they can lyse certain bacteria)
- (Paneth cells also have a minor role in secreting digestive enzymes)

# *Human Paneth cells at the base of a Crypt of Lieberkühn:*




folds in mucosa
villi
microvilli

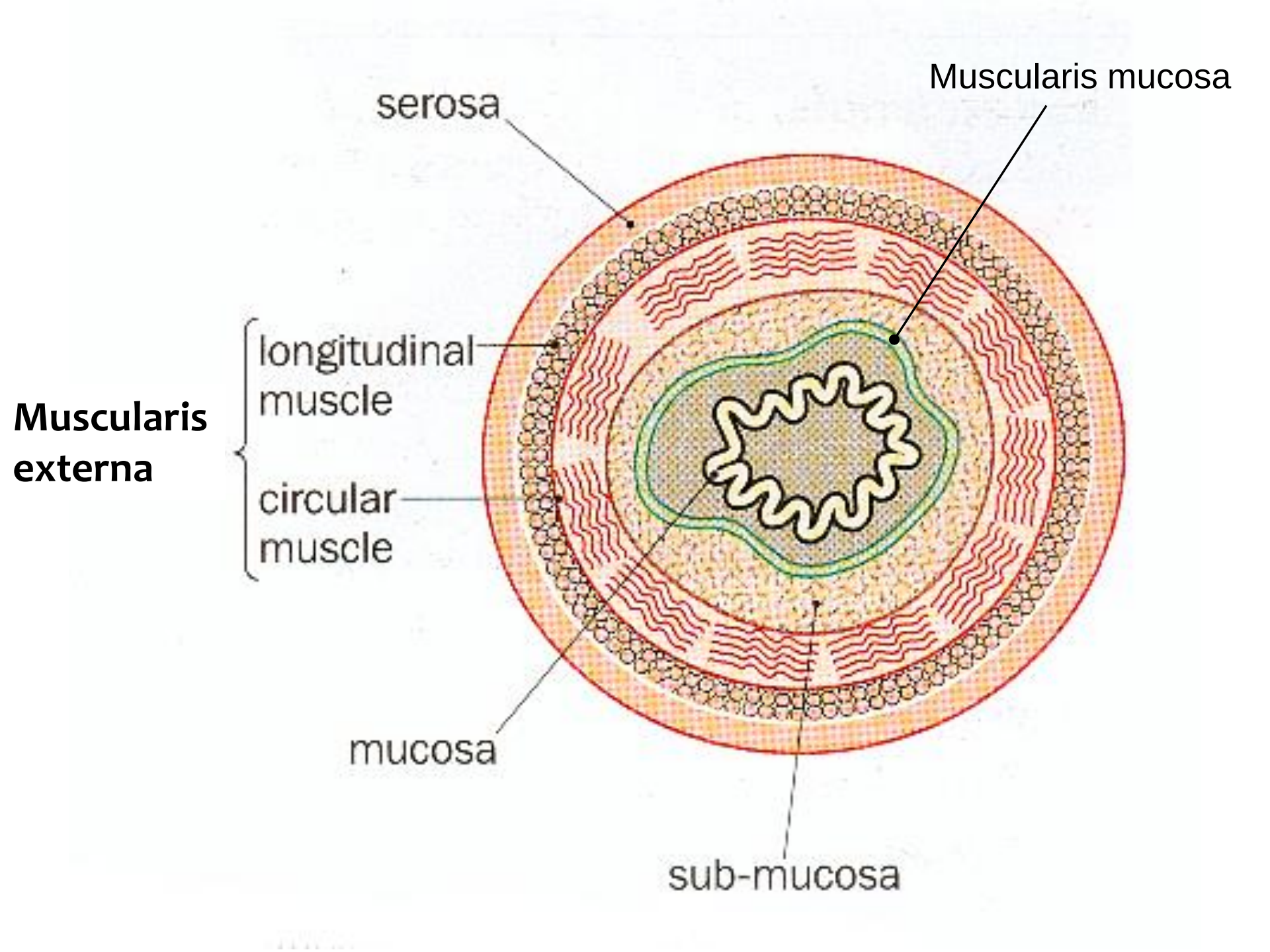

100 µm

# Muscularis Mucosa

- Layer of tissue found below the villi
- Contains involuntary muscle fibres which cause the movement of villi
- This improves the contact with the products of digestion travelling through the ileum
- It also enhances diffusion gradients for absorption

# Submucosa

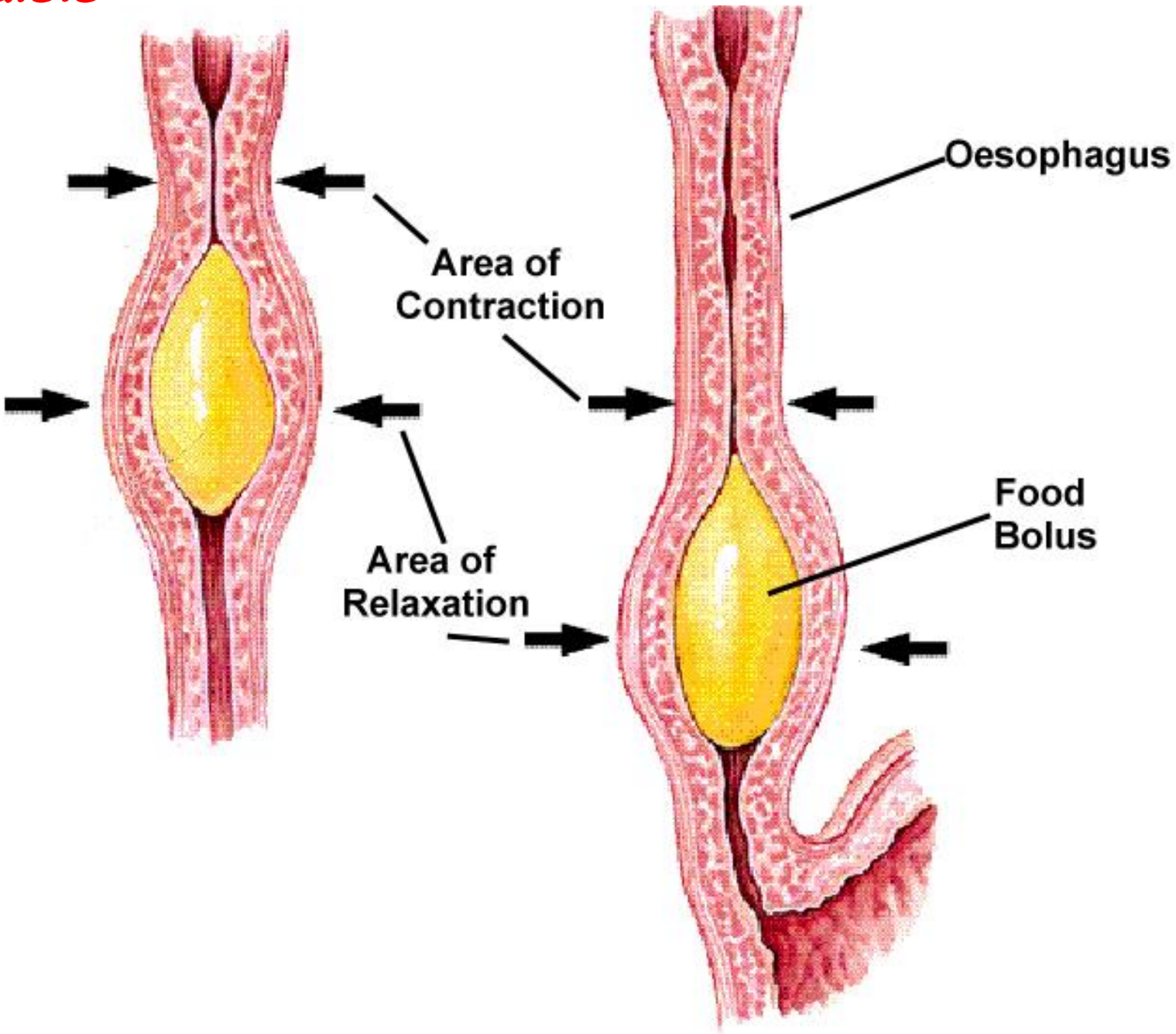
- Contains a rich supply of blood vessels and lymphatic vessels
- These carry absorbed nutrients away
- Glucose and amino acids move into venules of the hepatic portal vein and are taken to the liver
- Fats move into the lymphatic system
- Has connective tissue for support
- Contains nerve fibres that coordinate muscular movement in peristalsis


Muscularis mucosa
serosa
longitudinal muscle
circular muscle
Muscularis externa
mucosa
sub-mucosa

# Muscularis externa

- Contains 2 layers of involuntary muscle (requires no conscious thought to be stimulated):
  - Innermost Circular muscle layer contracts to cause local constrictions (churns food). When contractions of the circular muscle are coordinated, food is pushed through the gut by peristalsis
  - Outermost Longitudinal muscle layer contracts to cause pendular movements of the gut (back and forwward); this also churns and mixes the food
- The 2 types of muscle work antagonistically (against each other i.e. while one is contracting the other is relaxing)

# Peristalsis:



# Serosa

- This layer of connective tissue is the outermost tissue layer in the ileum
- Protects gut wall from friction with other organs in the abdomen and supports the gut
- The mesentary connective tissue connects the small intestine to the peritoneum; the membrane that encloses the organs within the body cavity

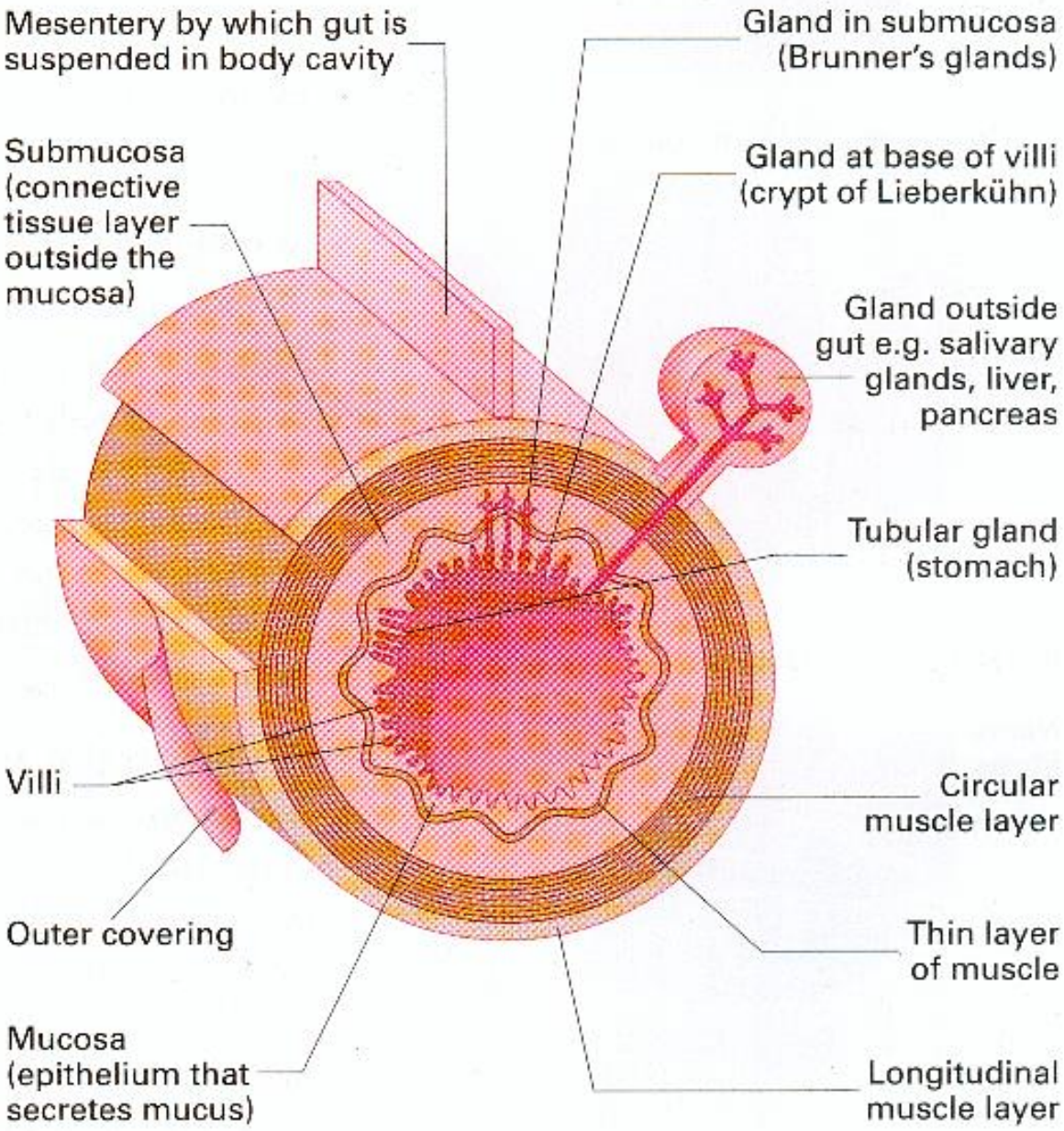


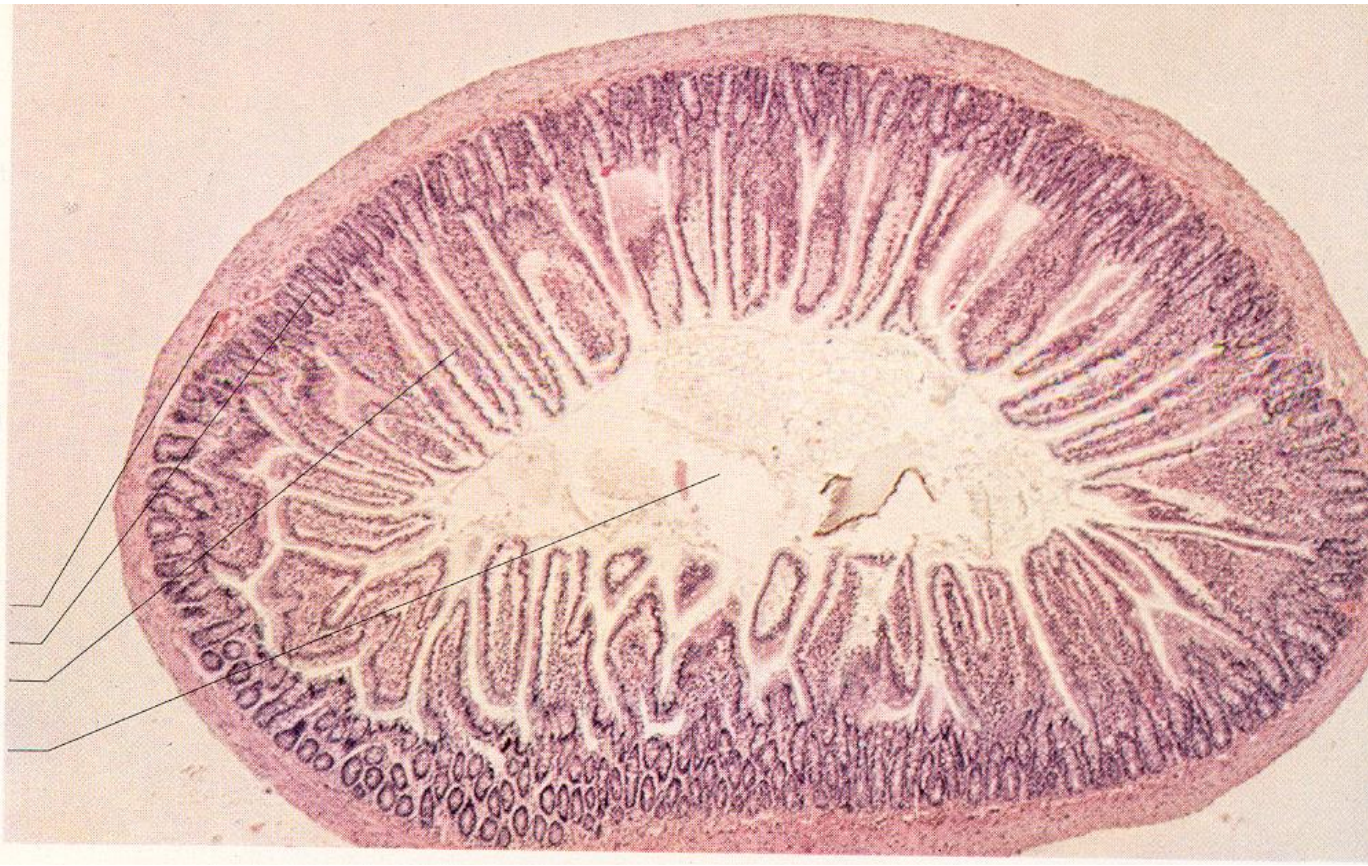

***Figure 3*** *Generalised structure of the wall of the mammalian gut, showing the main layers.*

## Alimentary canal

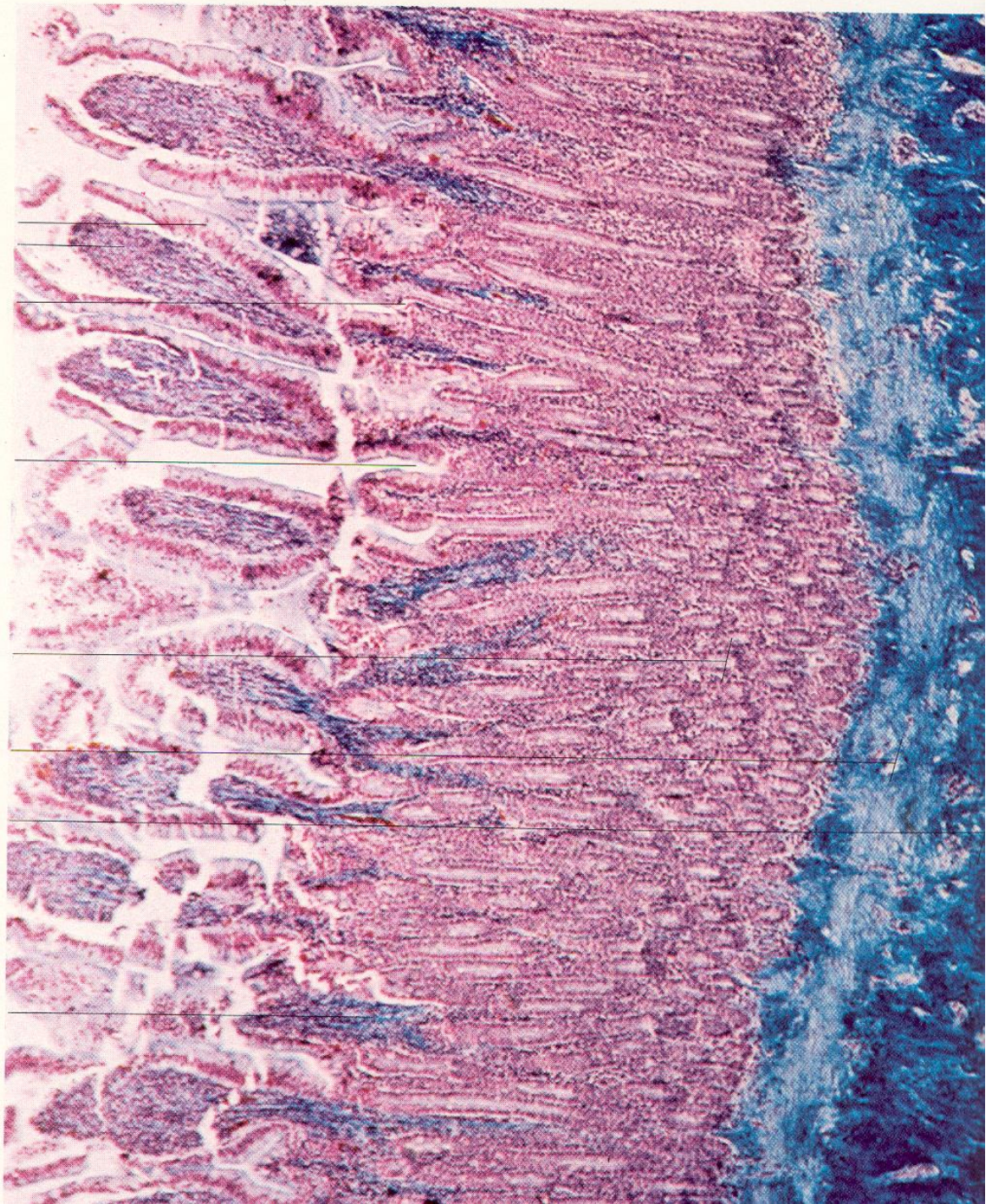
*Transverse section of the small intestine (ileum). × 22*

The surface of the epithelium—the area of absorption—is greatly increased by the presence of numerous projections, the villi. The epithelial layer contains many large mucus secreting cells. See also pp. 12 and 74.

Final digestion occurs in the small intestine, by means of enzymes secreted by glands (crypts of Lieberkühn) in the intestinal wall.

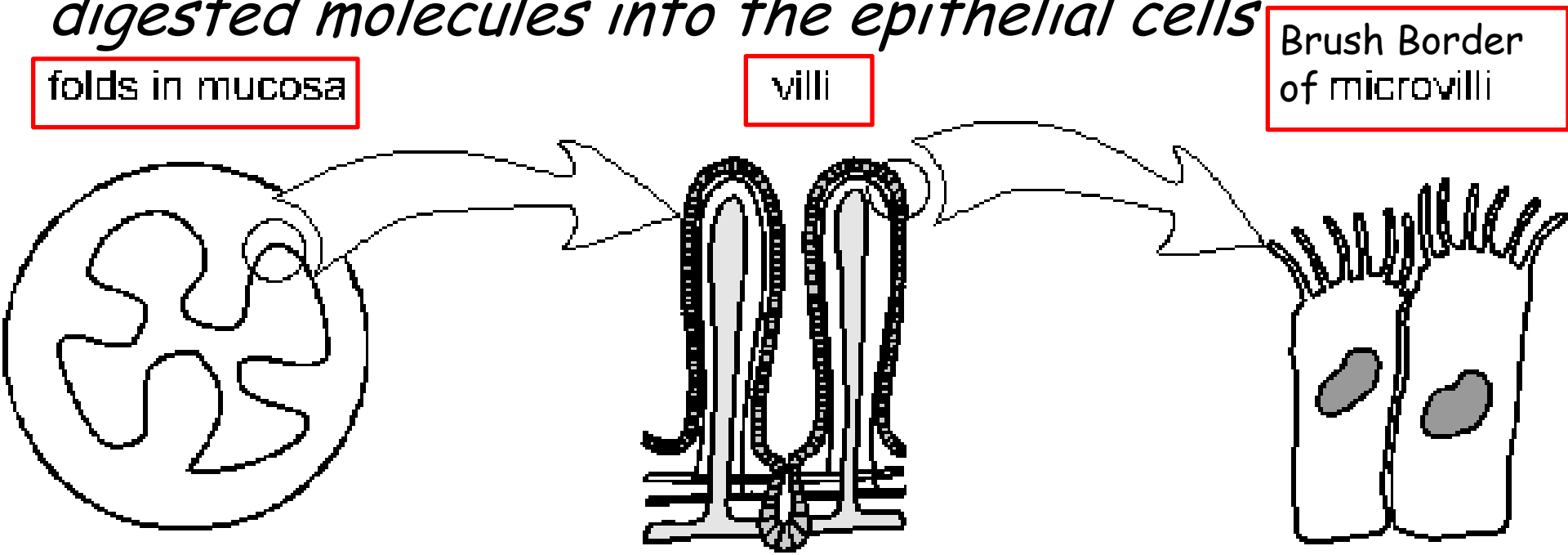


*Part of the small intestine (ileum) wall showing villi and glands. × 160*
Beneath the gland layer, separated by a layer of connective tissue (lamina propria) is a muscle layer.



# Adaptations of the epithelium for absorption

- *Surface area increased by folding of ileum wall/mucosa layer, presence of villi, presence of brush border of microvilli on the columnar epithelium cells on the villi*
- *Microvilli surface membrane contains protein carriers*
- *Numerous mitochondria for active transport of digested molecules into the epithelial cells*



# Absorption in the epithelium of the ileum – 3 processes

- Diffusion
- Active transport
- Pinocytosis

# DIFFUSION

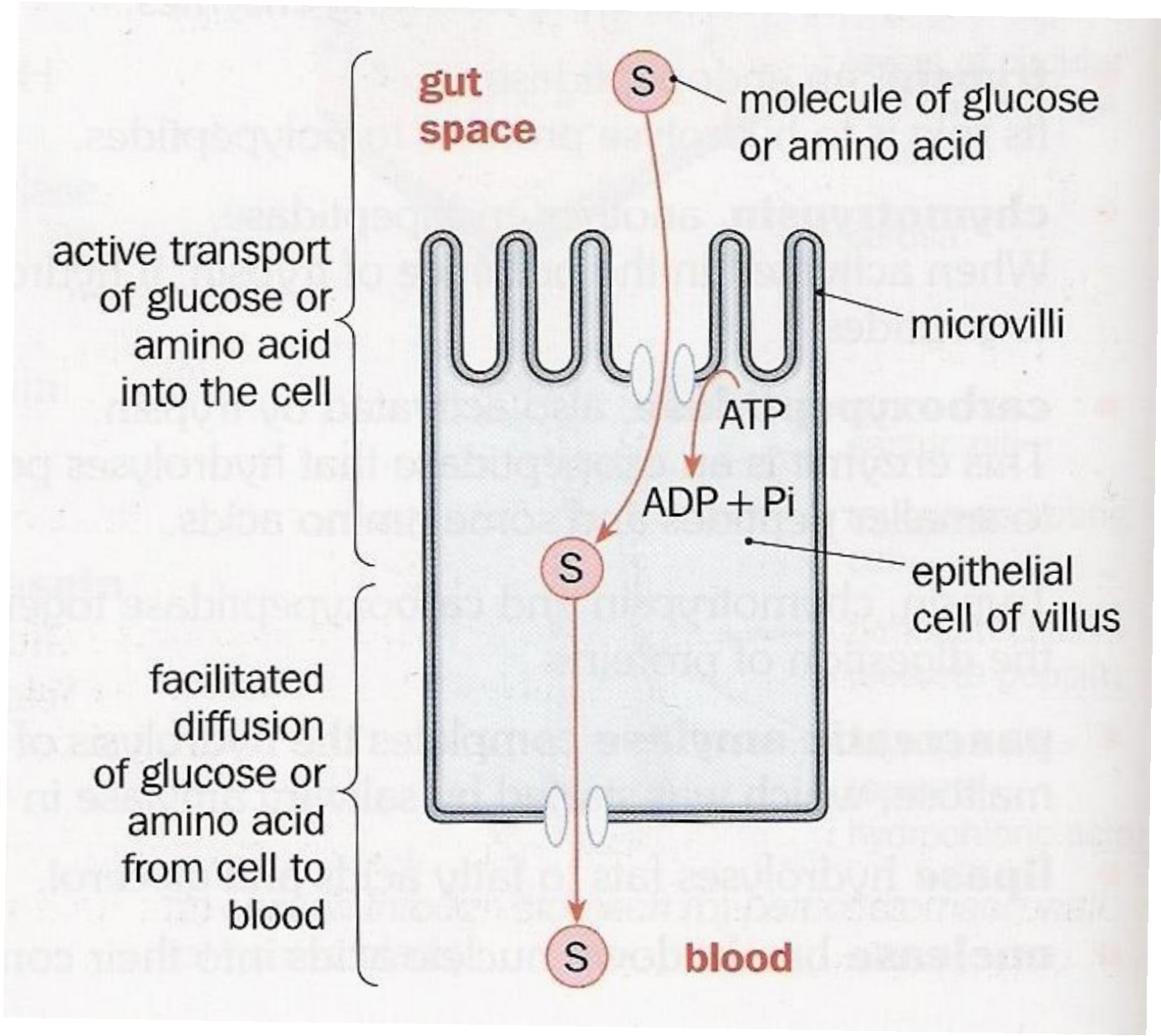
- Fatty acids, glycerol and most vitamins are not water soluble so they form micelles which fuse with the membrane of the epithelial cells
- They therefore diffuse easily into the epithelial cells
- Fatty acids and glycerol recombine inside the epithelial cells to form triglycerides
- These leave the epithelial cells and enter the lacteals which take them to the lymphatic system

# Active transport

- Epithelial cells use energy from ATP to take up glucose, amino acids, dipeptides (2 amino acids joined) and some salts. Uptake of glucose and amino acids is linked to the active transport of sodium ions
- Dipeptides are digested intracellularly into amino acids
- Simple sugars (monosaccharides), amino acids, salts and vitamins that have been absorbed pass out of the epithelial cells into a blood capillary inside the villus by facilitated diffusion
- They are then transported by the hepatic portal vein to the liver

# Active transport of glucose and amino acids in gut epithelial cells

Energy in the form of ATP is needed for this process so **these epithelial cells contain numerous mitochondria**



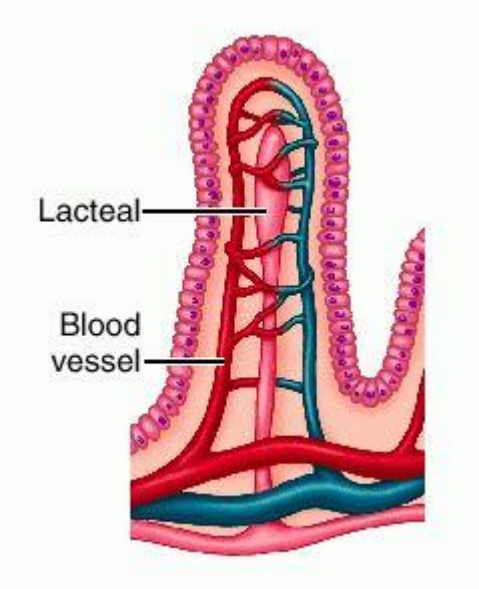
# PINOCYTOSIS

- When the cell takes in fluid ("cell drinking")
- Cell membrane wraps around the material to be endocytosed and then a part pinches off to form a vesicle in the cytoplasm containing the material that has been brought in
- Happens in the epithelial cells of the villi
- Some proteins can be absorbed this way
- Antibodies are absorbed by newborns from their mother's milk this way

# Absorption of digested molecules in the ileum - remember

- Absorption of amino acids and monosaccharides is into blood capillaries in the villi

- Absorption of fats is into lacteals in the villi



# PRACTICAL WORK

- Examine stained sections of the ileum using the light microscope
  - Recognise villi (and associated blood capillaries and lacteals), crypts of lieberkuhn and Paneth cells), mucosa, columnar epithelium, goblet cells, muscularis mucosa, submucosa, muscularis externa, serosa