ABSORPTION IN GIT

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Objectives

- Explain the mechanisms by which end products of digestion of protein, carbohydrate, and fat are absorbed into and through the cells lining alimentary canal
- Explain the factors which determine whether a molecule is absorbed into the blood or into the lymph

A Summary of Digestion of Carbohydrates, Proteins and Lipids

	(a) Carbohydrate digestion	(b) Protein digestion	(c) Nucleic acid digestion	(d) Fat digestion
Oral cavity, pharynx, esophagus	Polysaccharides (starch, glycogen) ↓ **Salivary amylase** Smaller polysaccharides, maltose			Lingual lipase
Stomach		Proteins ↓ **Pepsin** Small polypeptides		Gastric lipase
Lumen of small intestine	Polysaccharides ↓ **Pancreatic amylases** Maltose and other disaccharides	Polypeptides ↓ **Trypsin, Chymotrypsin** Smaller polypeptides **Aminopeptidase, Carboxypeptidase** Amino acids	DNA, RNA ↓ **Nucleases** Nucleotides	Fat globules ↓ **Bile salts** Fat droplets (emulsified) ↓ **Lipase** colipase Glycerol, fatty acids, glycerides
Epithelium of small intestine (brush border)	↓ **Disaccharidases** Monosaccharides	Small peptides ↓ **Dipeptidases Aminopeptidase,** Amino acids	↓ **Nucleotidases** Nucleosides ↓ **Nucleosidases** Nitrogenous bases, sugars, phosphates	

ABSORPTION OF NUTRIENTS

- **Absorption of Carbohydrates**

- form of **monosaccharides** - small fraction are absorbed as **disaccharides**

- **Glucose** Is Transported by a ***Sodium Co-Transport*** Mechanism

- First is **active transport of sodium** ions through the basolateral membranes of the intestinal epithelial cells **into the blood**, thereby depleting sodium inside the epithelial cells

ABSORPTION OF GLUCOSE

- Second, decrease of Na inside the cells causes Na from the intestinal lumen to move through the brush border of the epithelial cells to the cell interiors by a process of ***facilitated diffusion***

- Na ion combines with a ***transport protein***, but the transport protein will not transport the Na to the interior of the cell until the protein itself also combines with some other substance such as ***glucose***

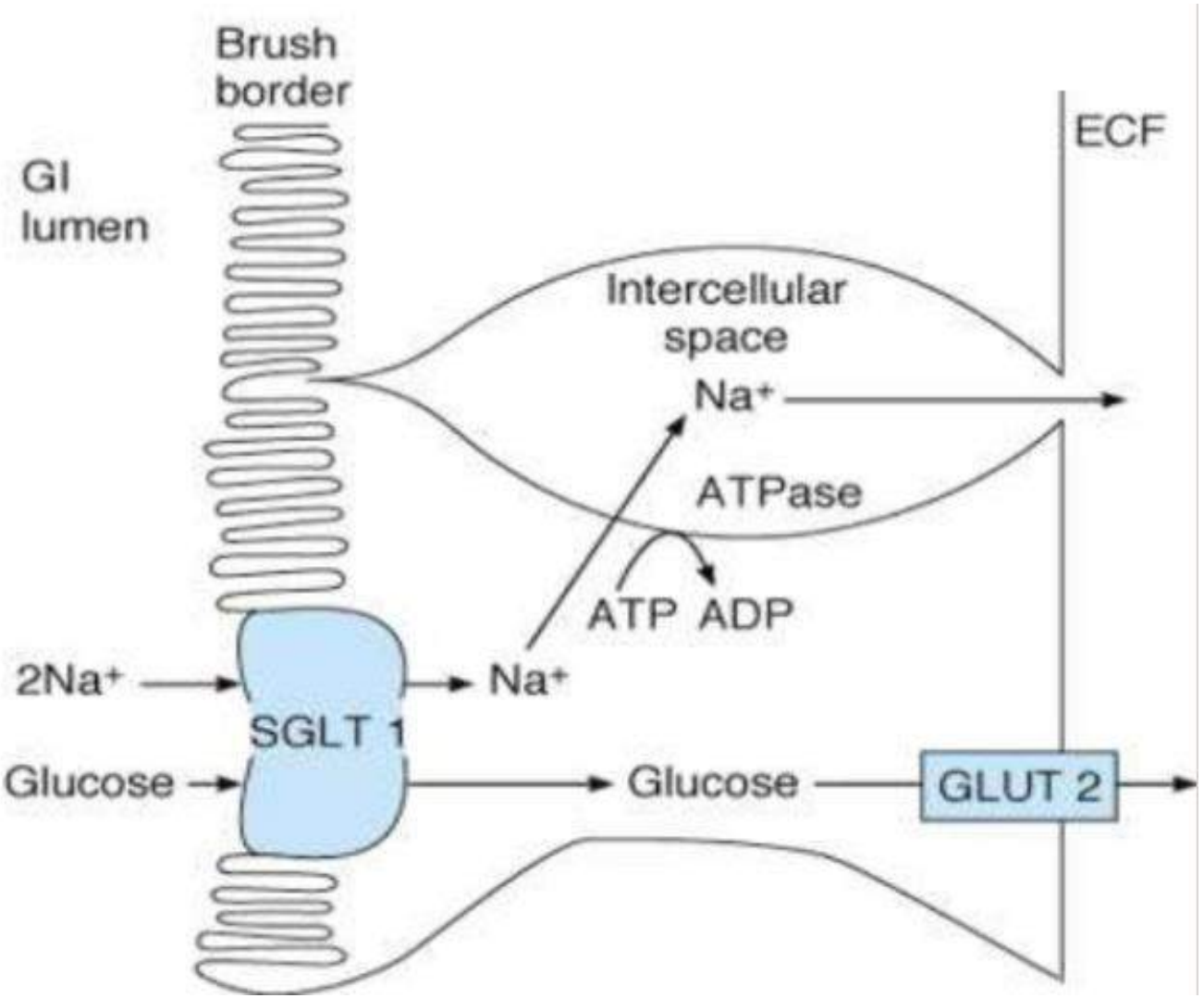
ABSORPTION OF GLUCOSE

- - the low concentration of sodium inside the cell literally "drags" sodium to the interior of the cell and along with it the glucose at the same time

- Once inside the epithelial cell, **transport proteins and enzymes cause facilitated diffusion** of the glucose through the cell's basolateral membrane into the paracellular space and from there into the blood

- Galactose – same as glucose

- Fructose – facilitated diffusion


Brush
border
GI
lumen
ECF
Intercellular
space
Na+
ATPase
ATP ADP
2Na+
Na+
SGLT 1
Glucose
Glucose
GLUT 2

ABSORPTION OF PROTEINS

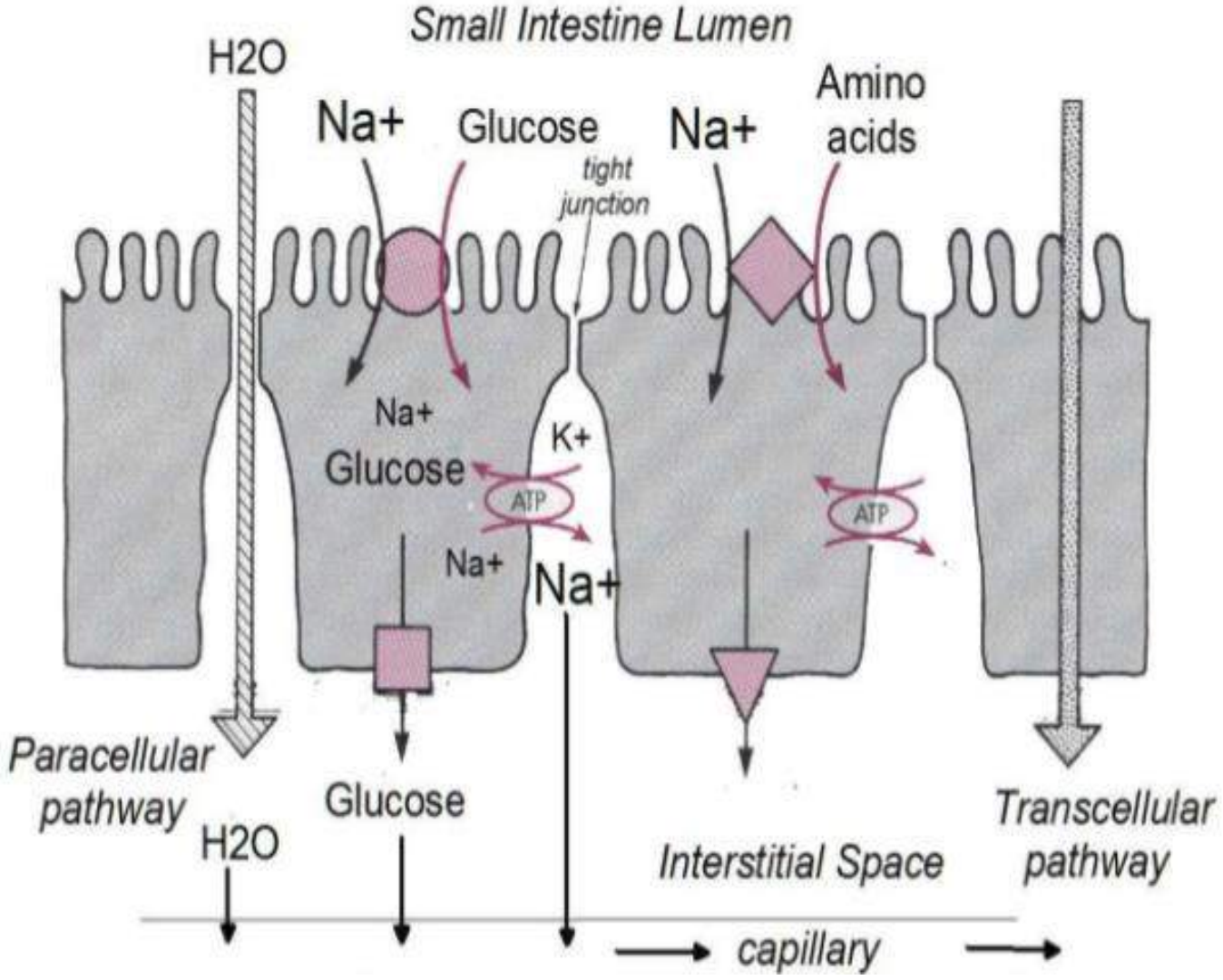
- in the form of dipeptides, tripeptides & free amino acids

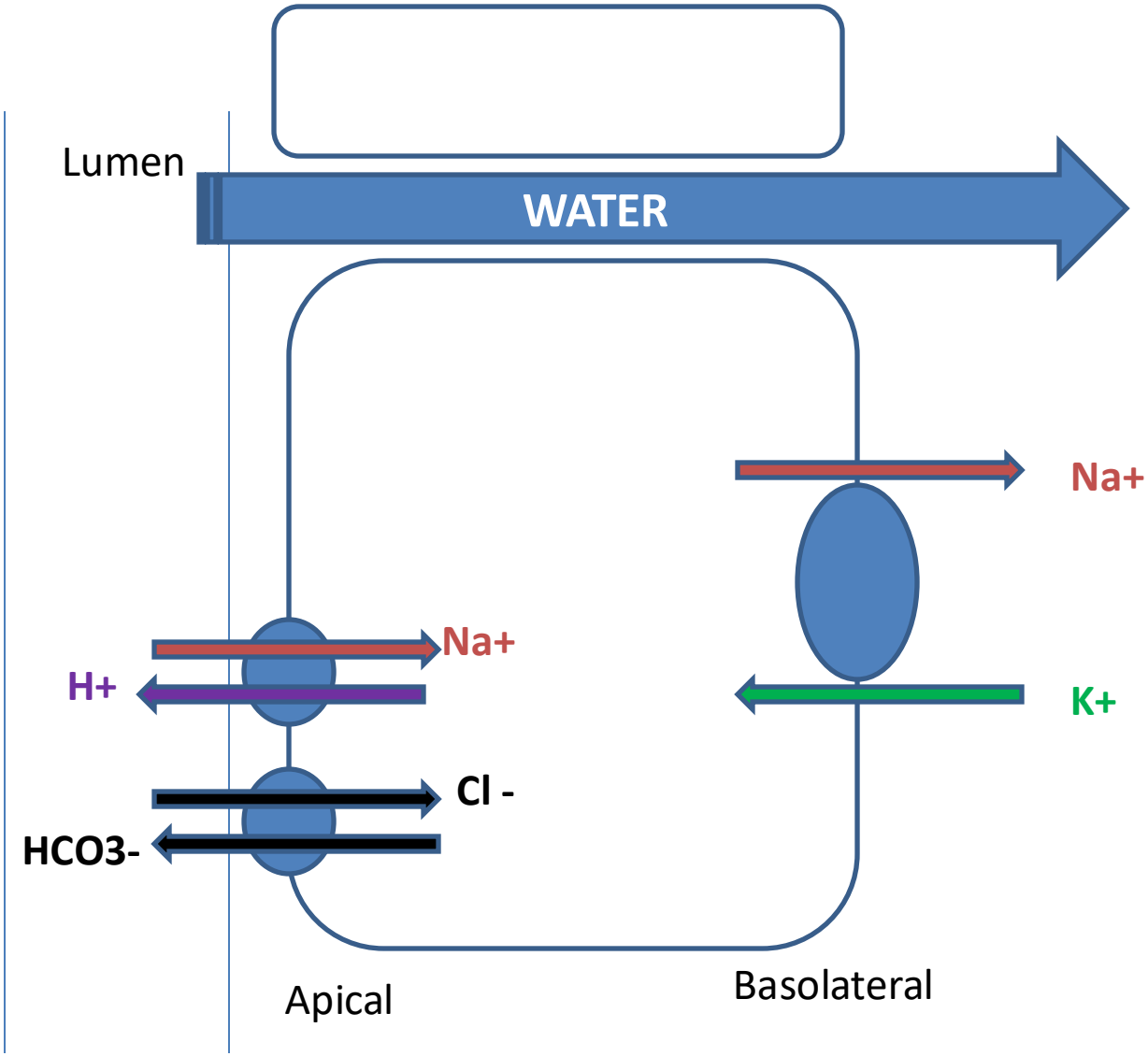
- **sodium co-transport mechanism**

- *secondary active transport*

- *Few amino acids via **facilitated diffusion***

- **five types of transport proteins** for transporting amino acids and peptides have been found in the luminal membranes of intestinal epithelial cells


Small Intestine Lumen
H2O
Na+
Glucose
Na+
Amino acids
tight junction
Na+
Glucose
K+
ATP
ATP
Na+
Na+
Paracellular pathway
H2O
Glucose
Interstitial Space
Transcellular pathway
capillary


Lumen
WATER
Na+
Na+
H+
K+
Cl -
HCO3-
Apical
Basolateral

Proximal Small Intestine

Colon

Tight Junctions more permeable

Tight Junctions less permeable

Absorption:
Nutrients
Vitamins
Minerals
Salt and Water

Absorption:
Sodium
Water

Mechanisms of Transcellular Transport

	Mechanism	Example
Primary Active Transport	Utilizes energy (ATP) to drive ion against electrochemical gradient	Na-ATPase
Secondary Active Transport	Co-Transport of molecules with (ATP-driven) ion transport	Na-GLUC cotransporter
Facilitated Diffusion	Specific transporters facilitate passive transport across epithelial layer	Glut-5 (fructose)

ABSORPTION OF FATS

- the **micelles perform a "ferrying" function** that is highly important for fat absorption

- In the presence of an abundance of bile micelles, about **97 per cent** of the fat is absorbed

- in the absence of the bile micelles, only **40 to 50 per cent** can be absorbed

ABSORPTION OF FATS

After entering the epithelial cell, the fatty acids and monoglycerides are taken up by the cell's **smooth ER**

↓

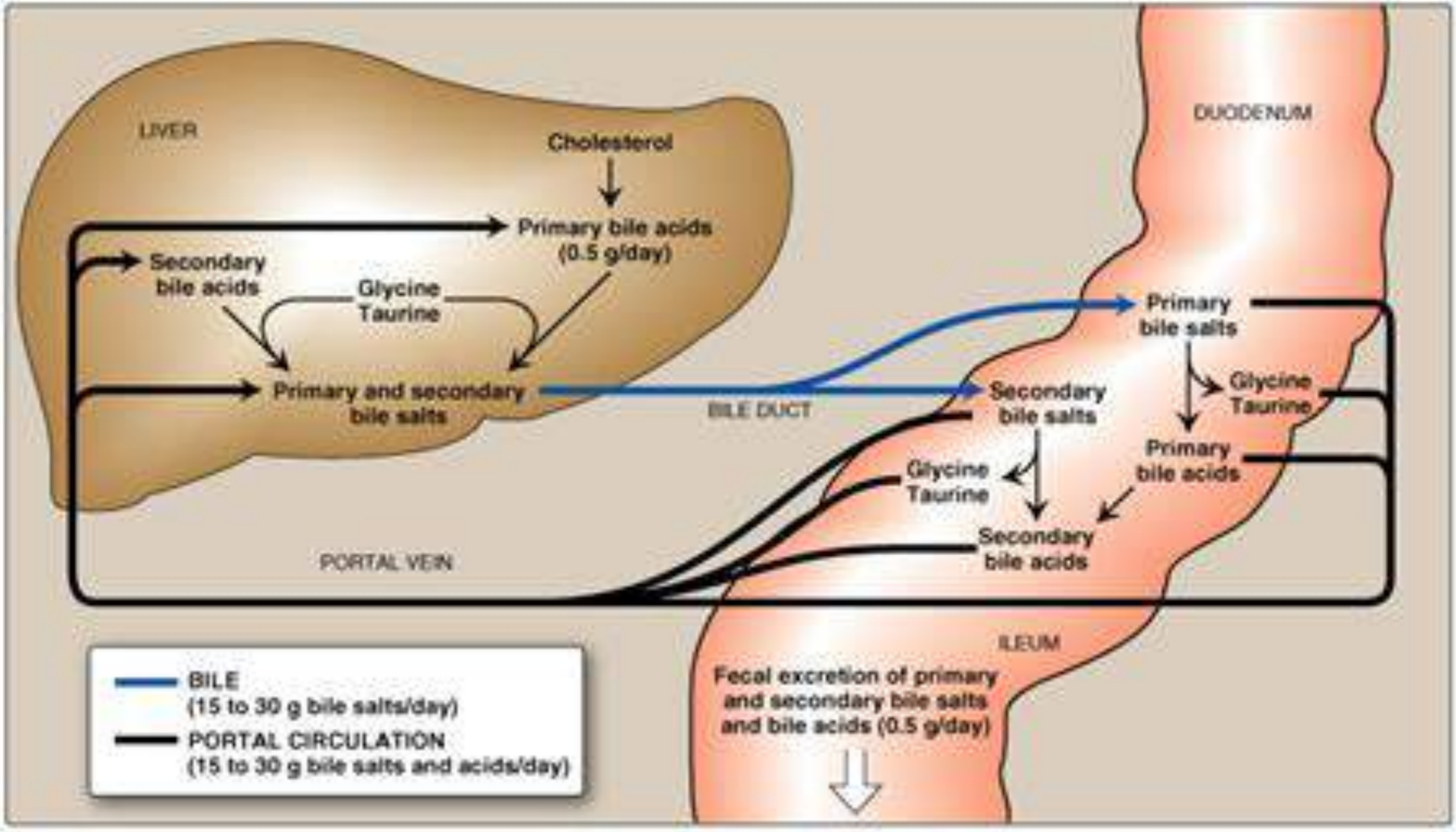
they are mainly used to form **new triglycerides** that are subsequently released in the form of ***chylomicrons*** through the base of the epithelial cell,

↓

flow upward through the ***thoracic lymph duct*** and empty into the circulating blood

- **short and medium chain fatty acids (more water-soluble)** are absorbed directly into the portal blood

Enterohepatic Circulation



Conjugated bilirubin

1. In the liver, bilirubin is conjugated with glucuronic acid by the enzyme glucuronyltransferase, making it soluble in water

2. Conjugated bilirubin is not absorbed and instead passes into the colon

3. There, colonic bacteria deconjugate and metabolize the bilirubin into colorless urobilinogen, which can be oxidized to form urobilin and stercobilin

4. Urobilin is excreted by the kidneys to give urine its yellow color and stercobilin is excreted in the feces giving stool its characteristic brown color

5. A trace (~1%) of the urobilinogen is reabsorbed into the enterohepatic circulation to be re-excreted in the bile

ABSORPTION IN LARGE INTESTINE

- About **1500 milliliters of chyme** normally pass through the ileocecal valve into the large intestine each day

- Most of the water and electrolytes in this chyme are absorbed in the colon, usually leaving **less than 100 milliliters of fluid to be excreted** in the feces

- **Proximal** half of the colon - absorbing colon

- **Distal** colon - storage colon

ABSORPTION IN LARGE INTESTINE

- active absorption of ***sodium*** - electrical potential gradient created by absorption of the sodium causes ***chloride*** absorption

- ***tight junctions*** between the epithelial cells of the large intestinal epithelium - prevents significant amounts of **back diffusion of ions**

- absorb **sodium** ions more completely – ***aldosterone***

- Secretion of **HCO_3** – absorption of **Cl**

ABSORPTION IN LARGE INTESTINE

- Absorption of **NaCl → water** by osmosis

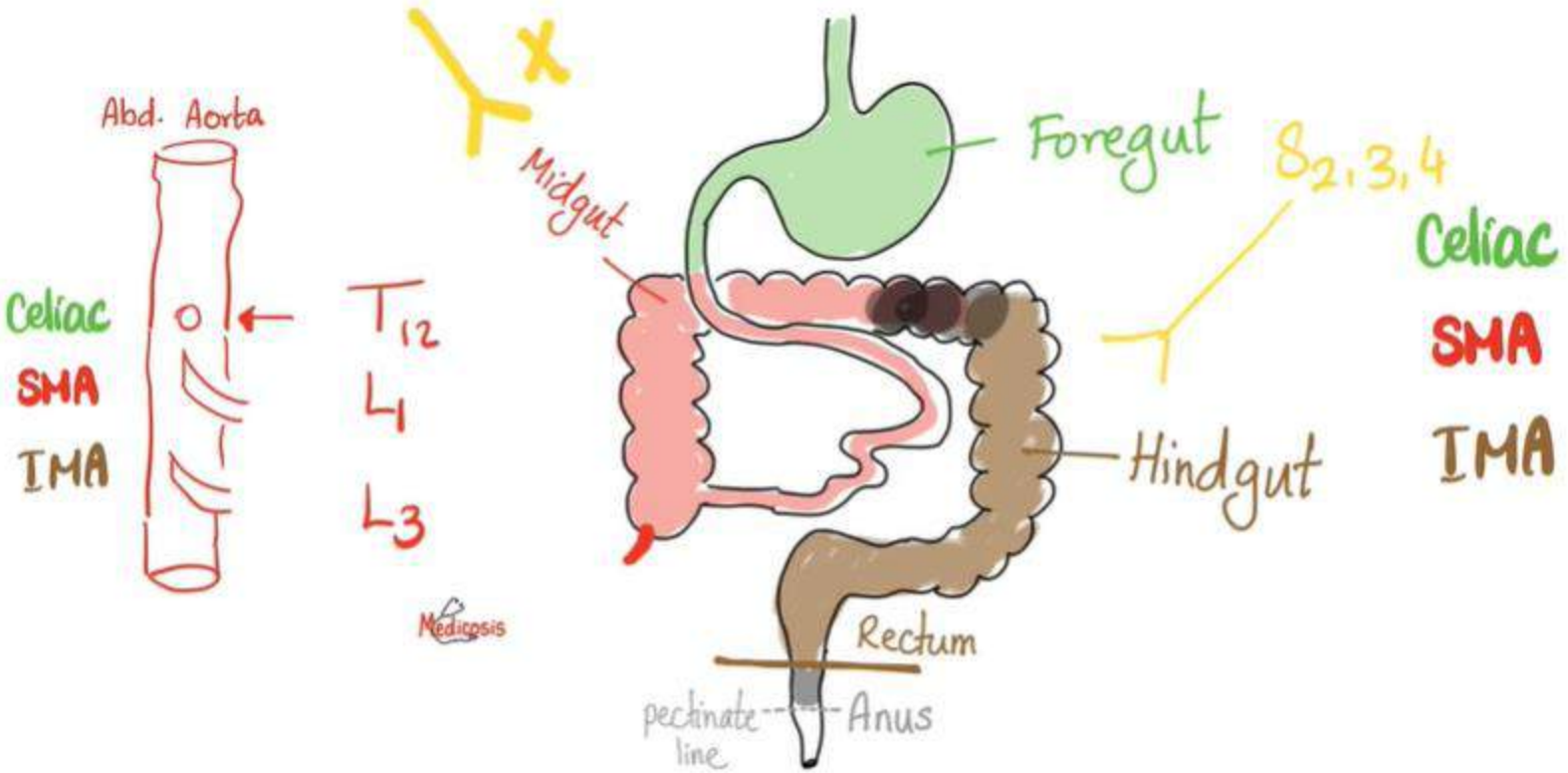
- large intestine can absorb a maximum of **5 to 8 liters** of fluid and electrolytes each day – when more than this – excess as ***diarrhea***

COMPOSITION OF THE FECES

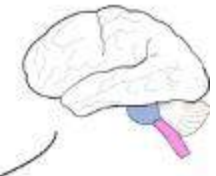
- $3/4^{th}$ water

- $1/4^{th}$ solid
- 30 per cent **dead bacteria**,
- 10 to 20 per cent **fat**,
- 10 to 20 per cent **inorganic matter**,
- 2 to 3 per cent **protein**,
- 30 per cent **undigested fiber** from the food, **bile pigment** and **sloughed epithelial cells**

- Colour due to **stercobilin**


Abd. Aorta
Celiac
SMA
IMA
T12
L1
L3
X
Midgut
Foregut
S2,3,4
Hindgut
Celiac
SMA
IMA
Rectum
pectinate line
Anus
Medicosis

The Defecation Reflex



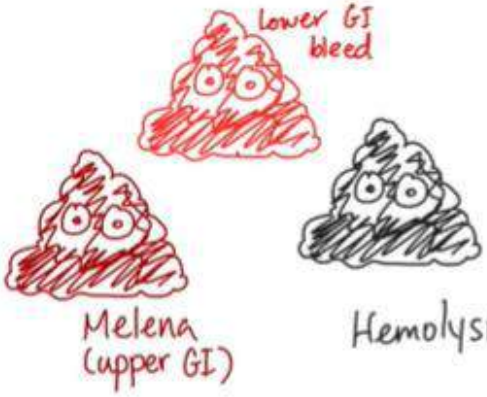
$P = \frac{F}{A}$

Stimulus	Presence of stool @ rectum → "roughage"
Receptor	Mechanical Receptors @ rectal wall
Afferent	Pelvic nerve
Center	$S_{2,3,4}$ @ spinal cord. (⊕ ⊖)
Efferent	Pelvic nerve
Effector organ	Smooth Muscles of the colonic wall
Response	Contraction of Smooth Muscles of the colonic wall → expulsion of feces

⊕ ⊖

By learning & training, your cerebral cortex will only allow Defecation

Clinical Pearls



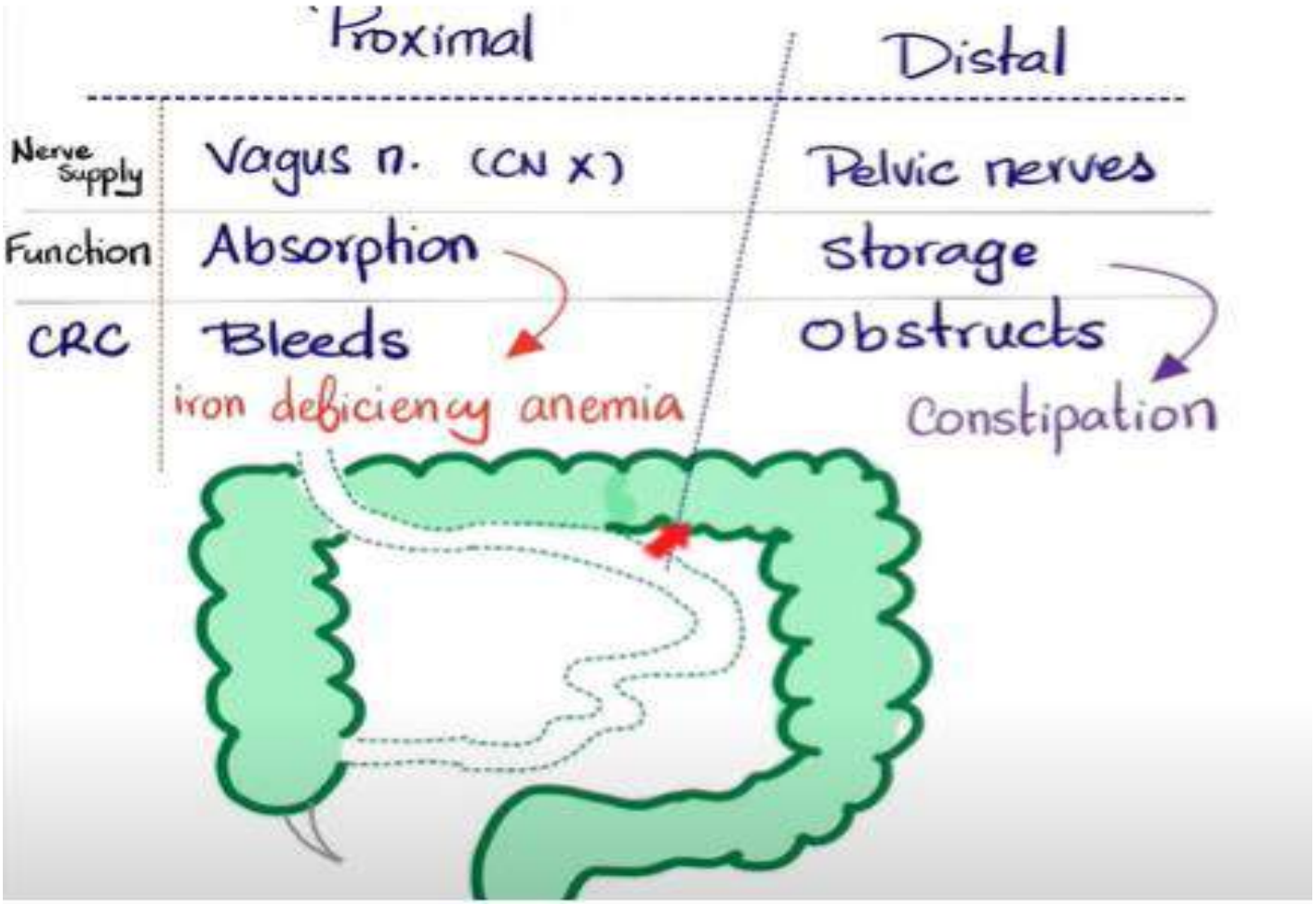
* Cholera toxin
  ↳ makes your intestine secrete > 10 liters of H_2O

Steatorrhea — Greasy, fatty, foul-smelling floats, difficult to flush.
↓↓ vit. (K, E, D, A)

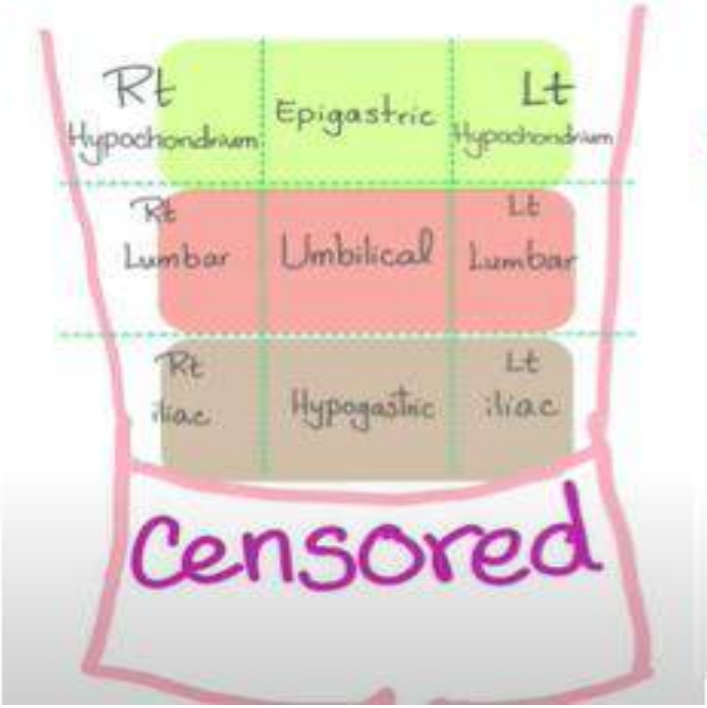
causes of steatorrhea:

- Liver/bile problem
- Pancreatic problem
- Bowel problem

- Obstructive jaundice
- Hepatocellular jaundice


Proximal
Distal
Nerve Supply
Vagus n. (CN X)
Pelvic nerves
Function
Absorption
storage
CRC
Bleeds
Obstructs
iron deficiency anemia
Constipation

Abdominal Regions



Abdominal Quadrants