

Small intestine (Digestion & Absorption)

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SMALL INTESTINE FUNCTIONS

Final digestion
Proteins &
Carbohydrate
→ Fat

(1) Mechanical digestion

- Peristalsis propels chyme along intestine
- Segmentation moves chymes back and forth to mix it thoroughly

(2) Chemical digestion

- Enzymes from pancreas and small intestine complete digestion of protein, starch, disaccharide sugars and fat
- Gallbladder empties bile into small intestine to aid in fat digestion

(3) Absorption of most substances

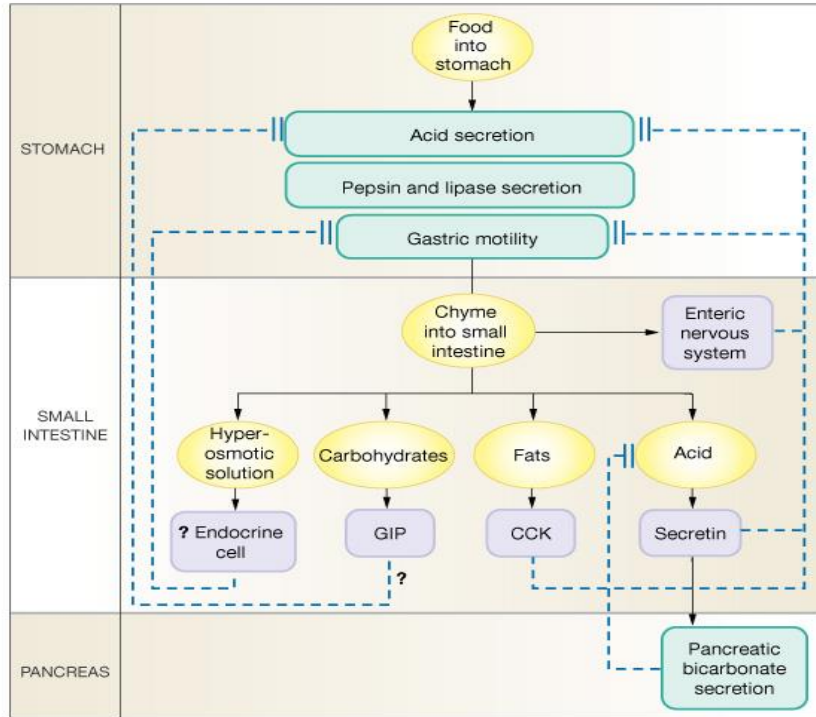
Microvilli

↓
↑ total surface area.
absorption

Intestinal Phase: Reflexes Direct Digestive Action

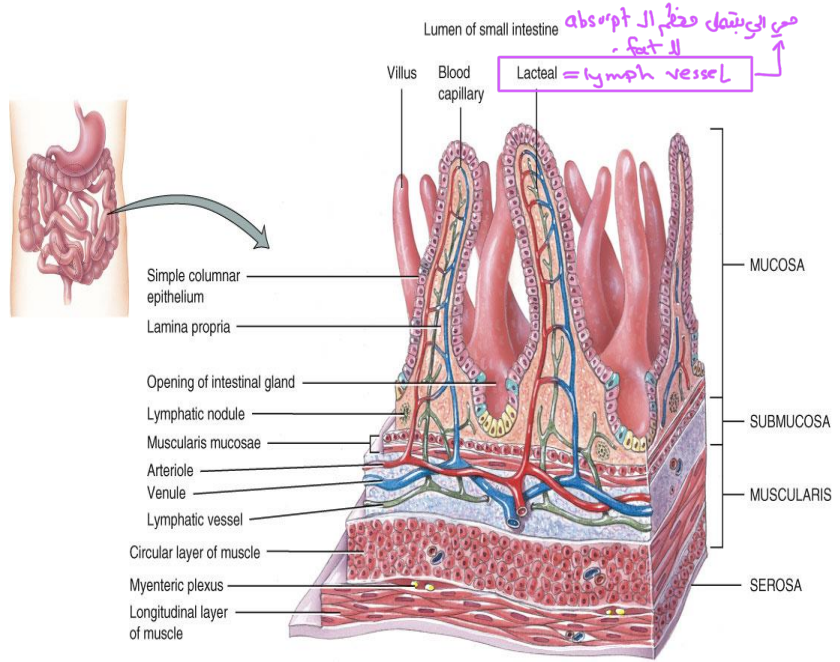
- Limit Chyme Entrance Rate & Motility by activating the enteric nervous system
- Neutralize HCl, Add Bile & Enzymes
- The presence of acidic chyme in the duodenum releases hormone secretin:
 - 1 - Inhibits acid production
 - 2 - Inhibits gastric motility
 - 3 - Slowing gastric emptying
 - 4 - Stimulates the production of **pancreatic HCO_3^-**
- Gastric secretion and/or motility are also inhibited by CCK, GIP and hyperosmotic chyme solution.

Intestinal Phase: Reflexes Direct Digestive Action



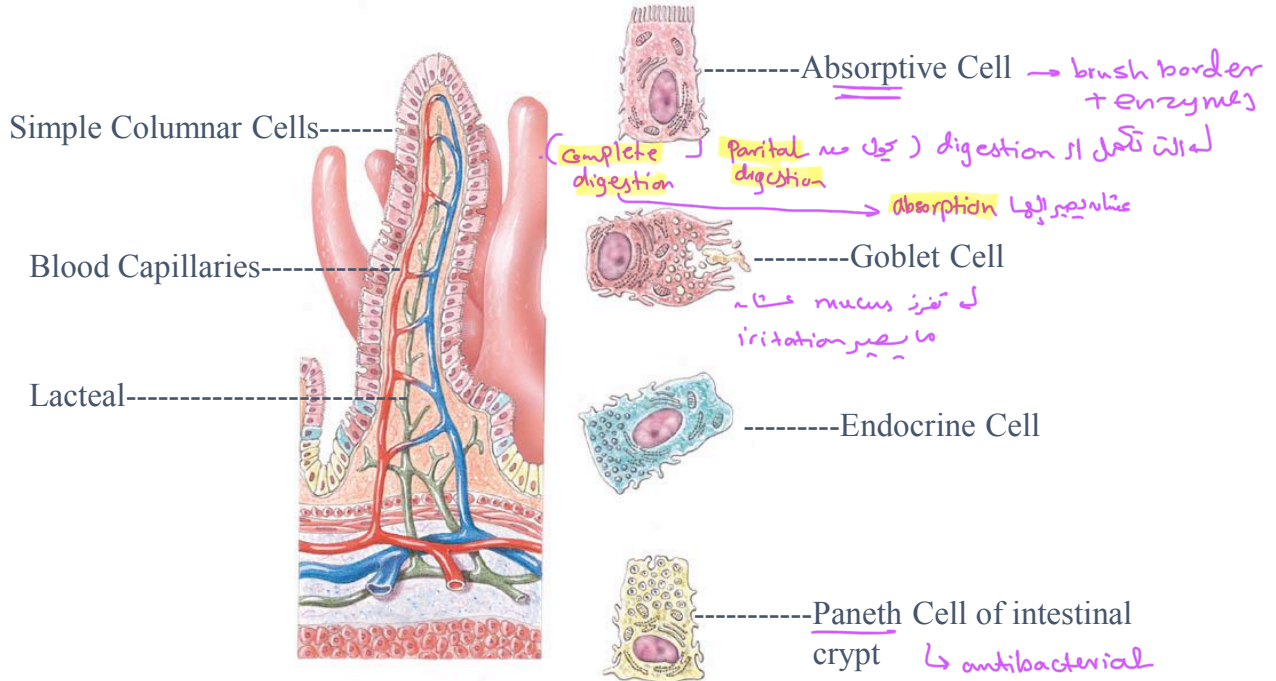
SMALL INTESTINE HISTOLOGY

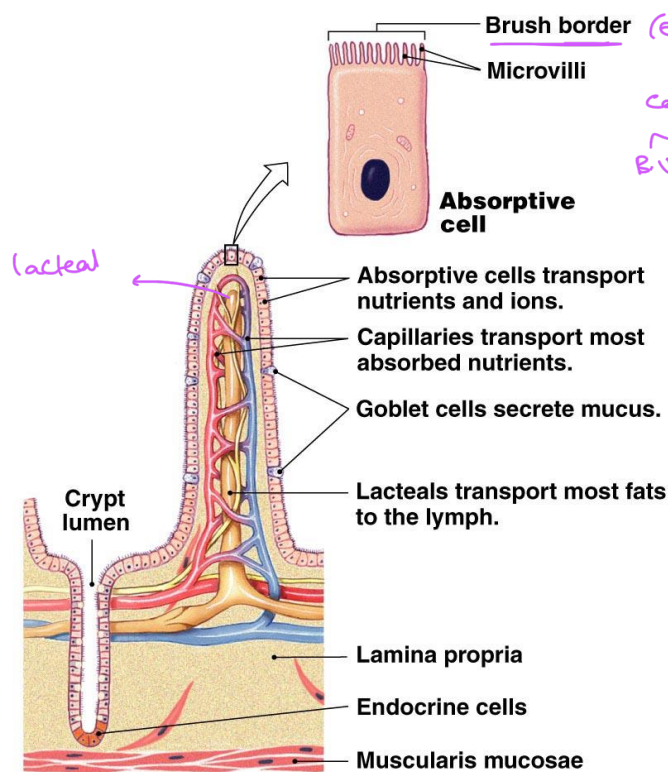
- Lined with about 4.5 million villi (villus)
 - Small finger like extensions
 - Covered with a simple columnar mucous membrane
 - Blood capillaries inside for absorbing most substances
 - Single lymph capillary called a **lacteal** for absorbing most fat



(a) Three-dimensional view of layers of the small intestine showing villi

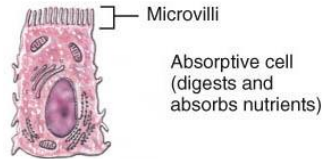
THE VILLUS





DIGESTION BY INTESTINAL ENZYMES

- Called brush-border enzymes
 - Located in microvilli of intestinal absorptive cells
 - Anchored to brush border cells by transmembrane proteins « stalks ».
 - Stationary, do not move with intestinal peristalsis.

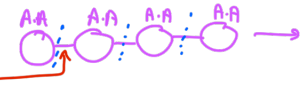
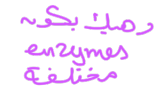


enterocytes

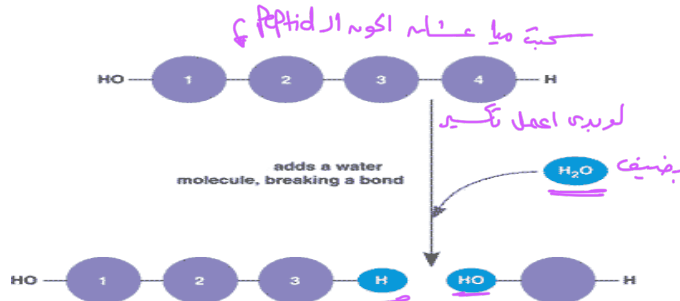
Peptidases digest peptides to amino acids
Others: disaccharidases and enteropeptidase.

هذه الانزيمات
لا تنز
انما المواد بتجيب لعضها

Digestion → تفسیر و رابط

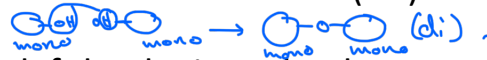
- The major foods on which the body lives are:
 - Carbohydrates
 - Proteins → Peptides →  → 

مکمل ب ۳۰ ملین اقسام
رومیک بکون
enzymes
مختلفه
 - Fats
 - Small quantities of minerals and vitamins
- These cannot be absorbed in their nature forms through the mucosa of the GI tract and so have to be broken down or DIGESTED into small compounds suitable for absorption
- Fats, proteins and carbohydrates are all broken down by HYDROLYSIS → اضمیف میا
- The difference between how each are broken down depends of the enzymes used
- Hydrolysis** is a reaction involving the breaking of a bond in a molecule using water



Digestion of carbohydrates $\Rightarrow$ مبدئي آكر روابط هور عبارة monosaccharides , غاليته glucose

- Almost of the carbohydrates in the diet as polysaccharides or disaccharides
- These are combinations of several monosaccharides by condensation
 - Condensation is when a hydrogen ions is removed from one monosaccharide (H^+) and a hydroxyl ion is removed from another (OH^-)
 - The monosaccharides then join from the + and - charges left by the ions that have been removed
 - The H^+ and OH^- then join to form H_2O as a waste product
- When carbohydrates are digested this process happens in reverse to break down the disaccharide to a monosaccharide by adding H_2O (Hydrolysis).



- The three main sources of carbohydrate in the diet are:
 - Sucrose (a disaccharide found in sugar)
 - Lactose (a disaccharide found in milk)
 - Starches (large polysaccharides found in all non-animal foods e.g. grains and potatoes)
 - Cellulose is a carbohydrate but we are unable to digest it - not a source of food

نبي السطاط
والصكرونة

مصدر النباتات

اميلاز digestion مابيصير الها
الذي يستطيع تكسيره هو الكيترا

Digestion of carbohydrates

(لكي ما نبي وقت كافي عشان يصير Proper digestion)
↑

- Digestion of carbohydrates **starts in the mouth** (contain on Lingual amylase)
 - Parotid salivary glands release the digestive enzyme PTYALIN in the saliva when we chew. Ptyalin is an **amylase** enzyme
 - This hydrolyzes **starch into the disaccharide MALTOS**
 - *Food only in the mouth a short time* so only 5% of all starches hydrolyses by the time the food is swallowed
- Digestion of starches continues in the **fundus of the stomach** →

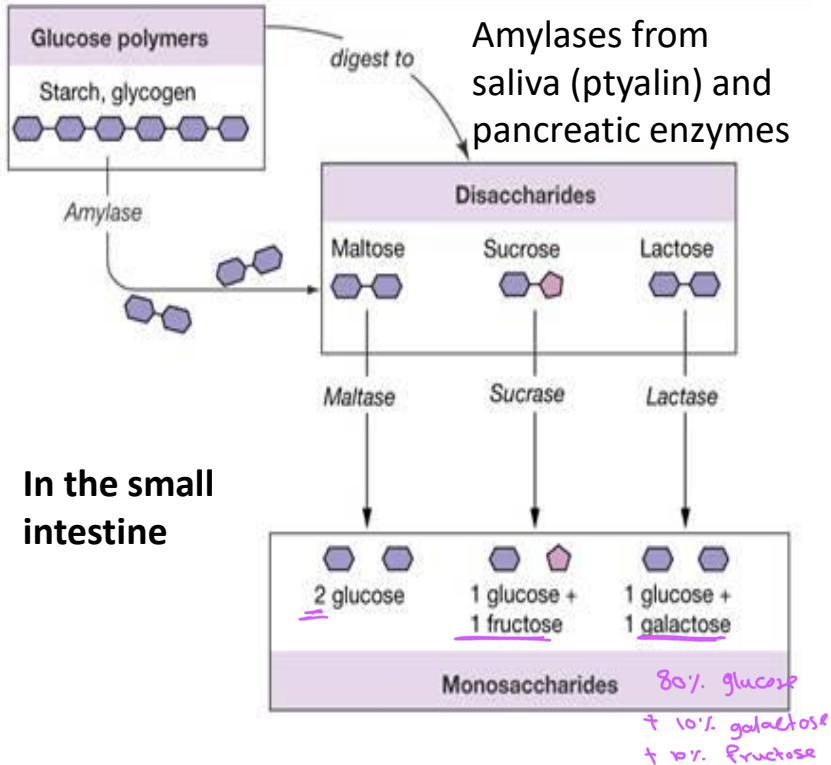
ماتزيداد الحمضية ما بقدر
يستغل الانزيم

 - Once in the stomach the digestion of starches by the saliva can continue for a period
 - This stops when the pH of the stomach falls below 4.0 as this inactivates the PTYALIN enzyme
 - This extra time for the ptyalin to work in the stomach and allows for 30-40% of starches to be converted to maltose by the time the pH reaches 4 and the food has mixed with gastric secretions

معظم الانزيمات
- Chyme enters the **duodenum** and **pancreatic secretions** containing a very powerful amylase enzyme breaks down the remaining starches to disaccharides in 15-30 minutes
 - **All carbohydrates now disaccharides before the chyme reaches the ileum**

❖ قبل ما يصل ال duodenum لازم يكونه كل الكربوهيدرات تحول لـ disaccharide عشان ال enterocytes بتاكلها لـ monosaccharide

Digestion of carbohydrates

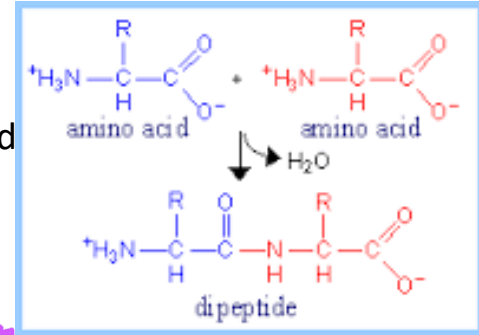


In the small intestine

- The **enterocytes** lining the villi of the small intestine contain enzymes:
 - **Lactase**
 - **Sucrase**
 - **Maltase**
- These enzymes split the disaccharides into monosaccharides
- **All the monosaccharides are soluble in water and are absorbed into the portal blood**
- As starches make up more of our diet, the final products of digestion are 80% glucose monosaccharides, 10% fructose and 10% galactose

Digestion of proteins

- Proteins are formed from multiple amino acids that are held together by peptide linkages
- Different amino acid sequences make different proteins
- Each peptide linkage is formed through condensation (a OH⁻ ion has been removed from one amino acid and a H⁺ ion from the other)
- Digestion occurs via hydrolysis** - proteolytic enzymes are used to return the H⁺ and OH⁻ ions to form water and split the protein into amino acids
- Pepsin** is the proteolytic enzyme contained **in the stomach**
 - It is most active when the pH is 2-3
 - It is inactive when the pH is 5 or more
- Pepsin is able to digest collagen - contained in meats in their connective tissues
 - This must be digested first or the rest of the meat cannot be digested - if a person has no pepsin cannot digest meat
 - Pepsin break proteins into polypeptides**
 - This is only **10%** of all protein digestion



ال Pepsin يفتت في
(large) Primary protein
↓
(small) Peptid

تبدأ في
له الذي يحدد سرعة العملية
البروتينات يتكون في شكل tertiary
هذه العملية تسمى Primary denaturation

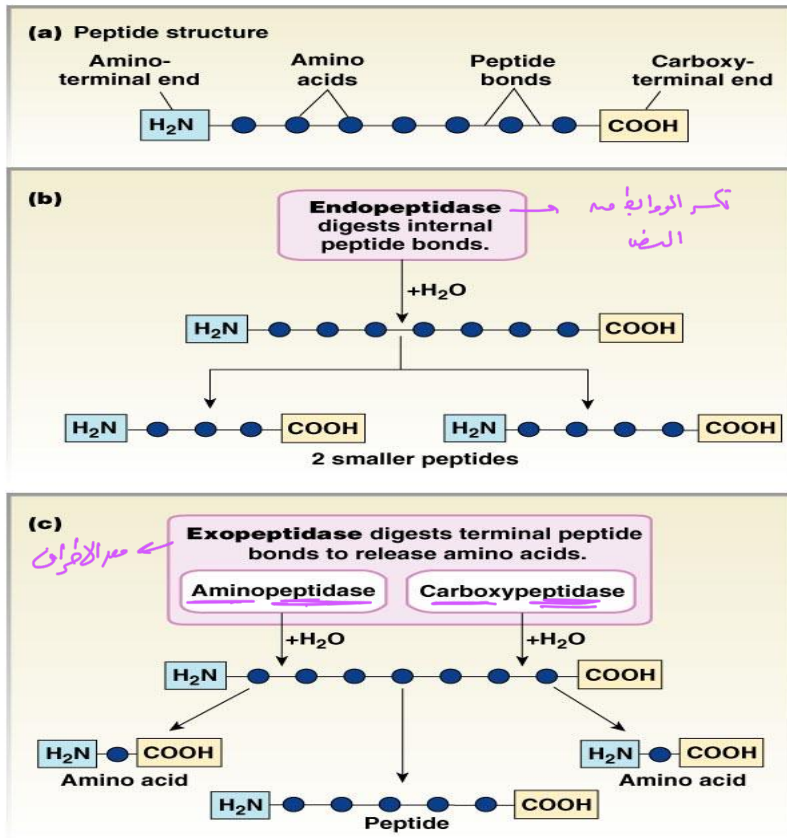
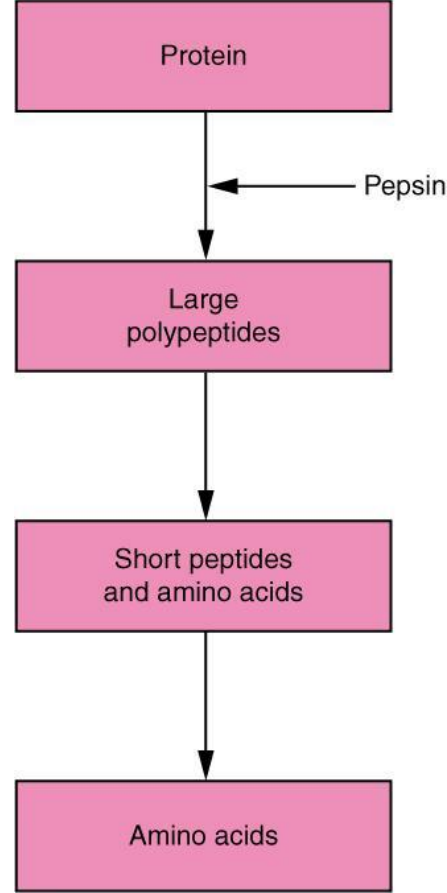


Figure 21-16 - Overview

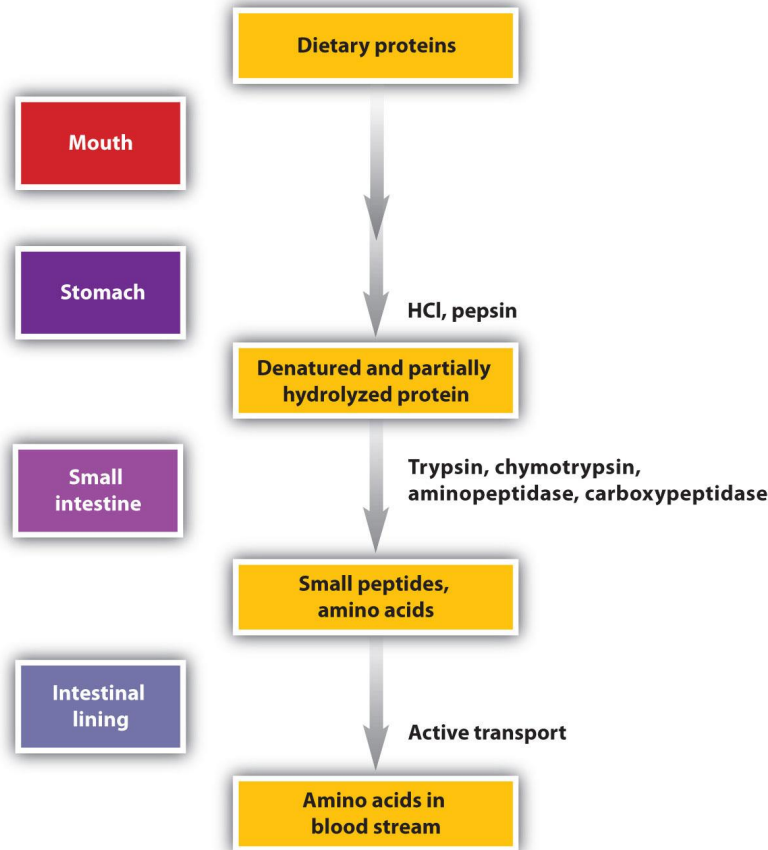
Digestion of proteins

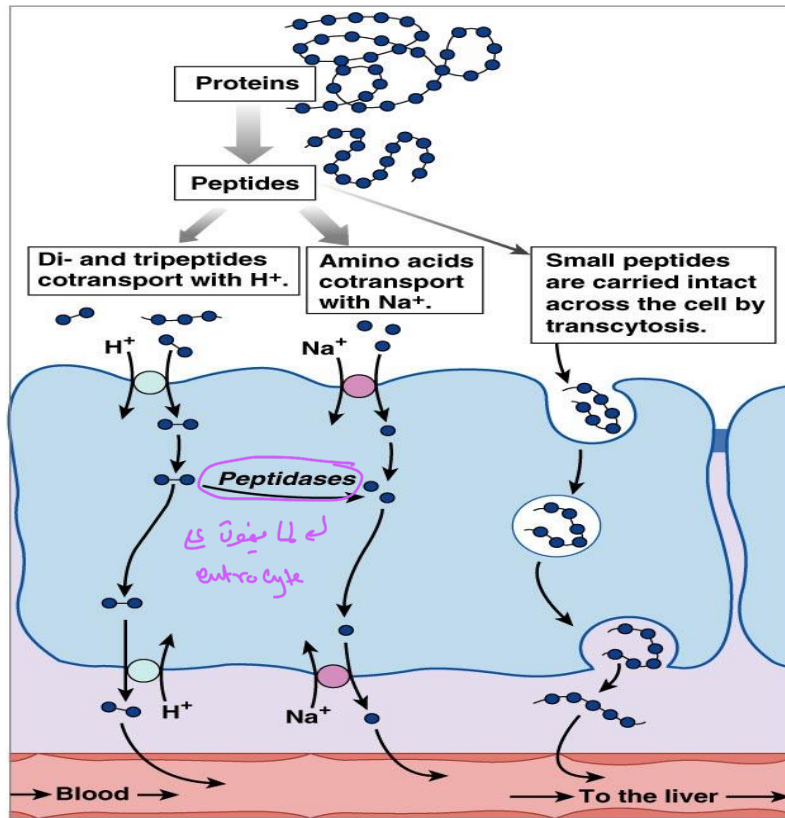
- **Most protein digestion occurs in the duodenum and jejunum** by proteolytic enzymes in pancreatic secretions:
 - Trypsin
 - Chymotrypsin
 - Proelastase
 - Carboxy-polypeptidase
- Trypsin and chymotrypsin break protein molecules into polypeptides
- Carboxy-polypeptidase break the polypeptides into amino acids
- Proelastase breaks down elastin fibers that help to partially hold meats together
- Not all proteins are digested to single amino acids - some remain as **di and tripeptides** at this stage



Digestion of proteins

- The last stage of protein digestion is in the **enterocytes of the villi** - the villi have microvilli and the microvilli contain **peptidases** → *الخلايا المعوية*
- The peptidases are called:
 - Amino Polypeptidase
 - Dipeptidases
- These break the remaining proteins into di and tripeptides and single amino acids
- **Amino acids & di and tripeptides are then absorbed through the microvilli** membranes into the enterocytes
- The **enterocytes** have other peptides that **break the di and tripeptides into amino acids** which are absorbed into the blood
- 99% of proteins are made into amino acids





Digestion of fats

① Enzymes
② Bile

لنقل في lymph vessel
ما ينقل في blood vessels

- The largest amounts of fats in our diet are triglycerides
 - This means each molecule is composed of a glycerol molecule and 3 chains of fatty acids
 - These fats are found in food of animal origin
- Cholesterol and phospholipids can be found in small quantities in the diet and are considered fats
- Digestion of fats begins in the stomach
 - This is via **lingual lipase enzyme** which is **secreted from the lingual glands and swallowed with the saliva**
 - Digests **10%** of triglycerides
 - **Consider not to be important as it is such a small amount**
- The rest of fat digestion occurs in the small intestine
 - Helped by the stomach which mixes the fat with the other products of digestion to make chyme!
 - The first process is the emulsification of fats (breaking fats into smaller fat globules so water soluble digestive enzymes can act on them)

بواسطة Bile salts

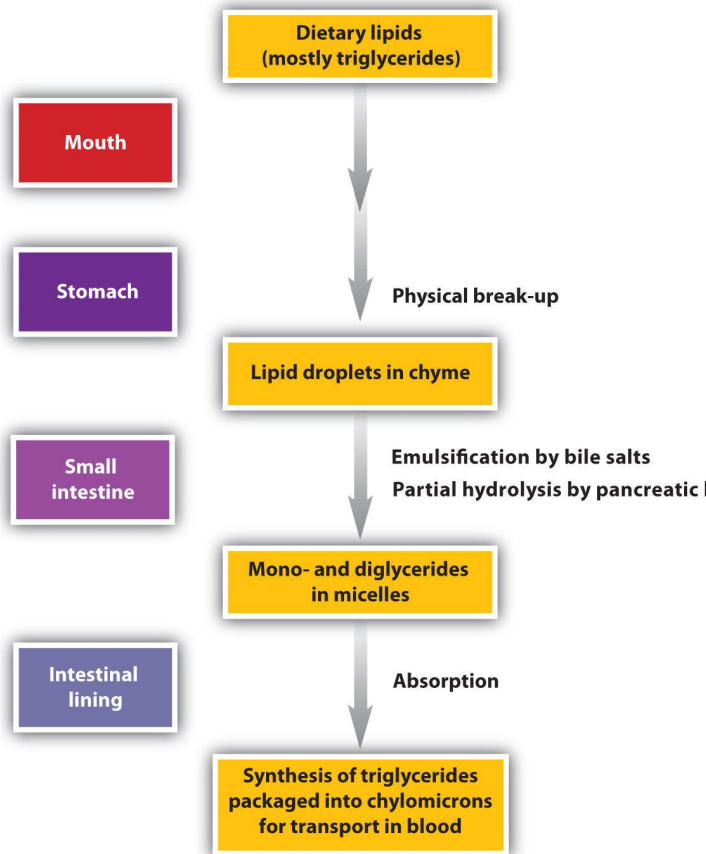
(micelles) بنية حويصلة وكمية Bile salts

one-to-one ratio 1 Lipase + Co-Lipase

العملية digestion (tri-glyceride) → glyceride
2 free fatty acid

Digestion of fats

- Emulsification occurs in the bile which contains bile salts and the phospholipid lecithin
- These work to make fat globules fragment into smaller parts and mix them with water in the small bowel - like a house detergent used for removing grease!
- Each time the diameter of the fat globule decreases this increases the surface area of the fat
- The **pancreas secretes lipase enzymes** which helps to digest via hydrolysis
- The pancreatic lipase splits the fat into fatty acids
- The **enterocytes secrete enteric lipase** but this is usually **not needed**



Bile salts and fat digestion

- The hydrolysis of triglycerides is highly reversible
- If there are a lot of monoglycerides and free fatty acids, this will stop further digestion of fats in that area
- Bile salts are used to remove the monoglycerides and fatty acids to allow digestion of fats to continue

- **The bile salts when in a high concentration in water form**

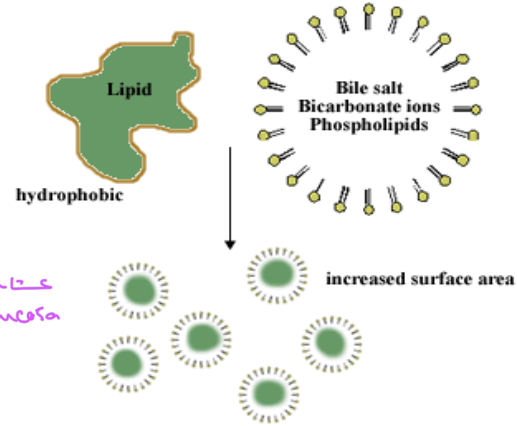
MICELLES (small globules of bile salts)

- Bile salts have a fat soluble and water soluble component in each salt

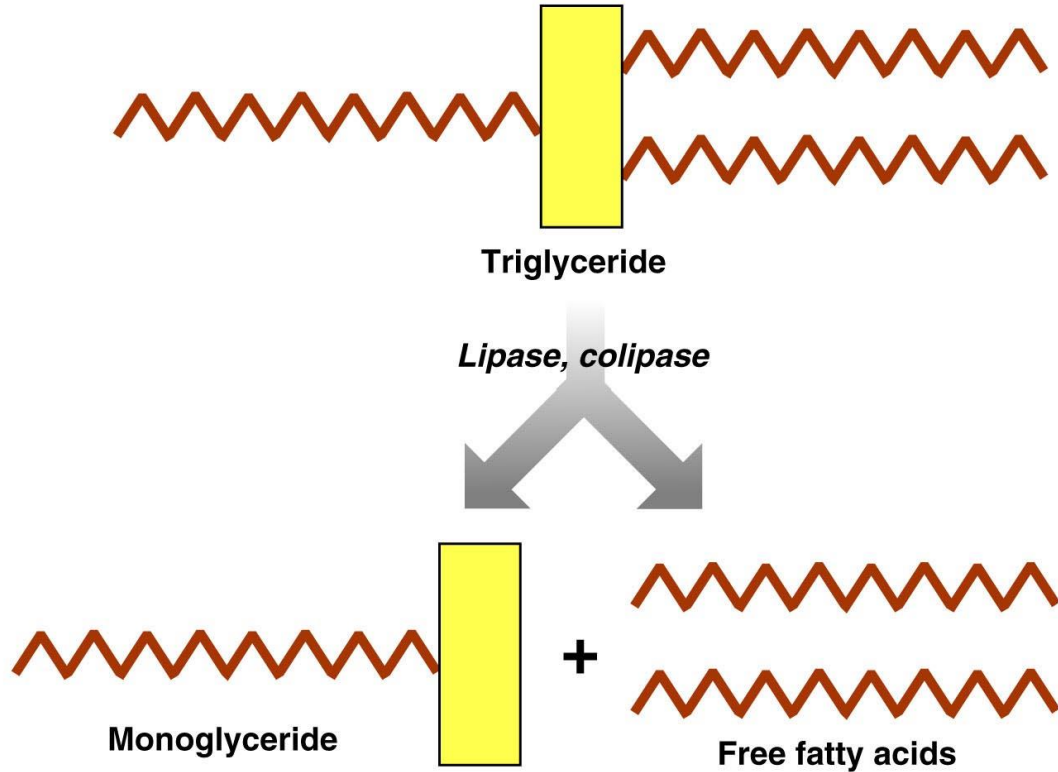
- The fat soluble end surrounds the fat globules to form a fatty core in the micelle. The water soluble part of the bile projects out to cover the surface of the micelle.

- Because the water soluble part is on the surface - this makes the **micelle water soluble**

- Bile salts use micelles as a **way to transport fatty acids and monoglycerides** (which would be insoluble) to the epithelium of the small intestine



- At the intestine the monoglycerides and fatty acids break free of the bile salt and are absorbed
- The bile salts are released back to the chyme for re-use



Bile salts and fat digestion

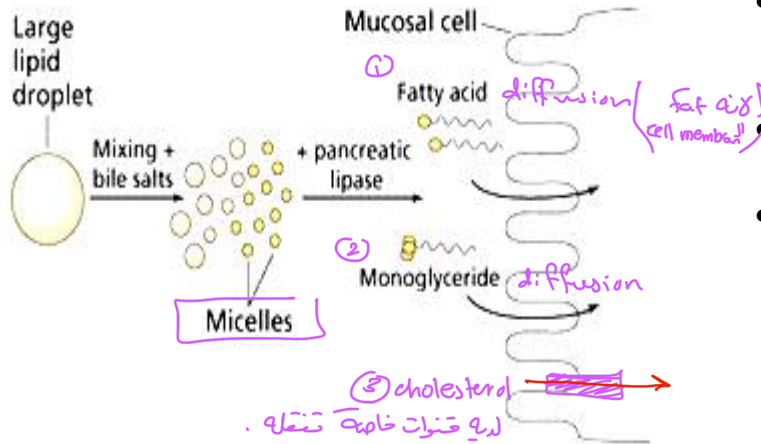
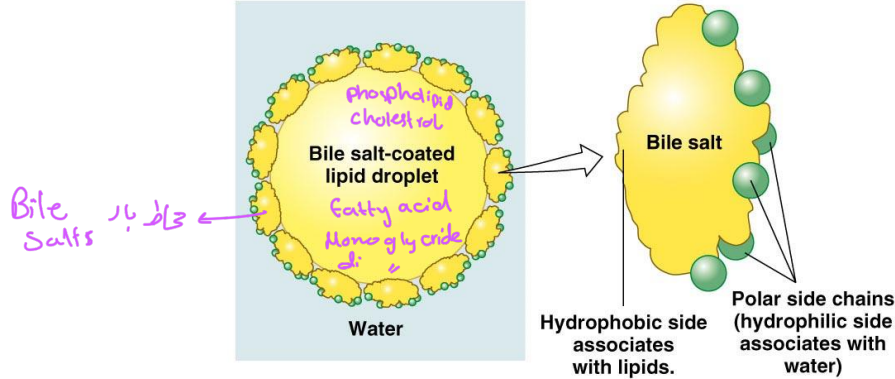


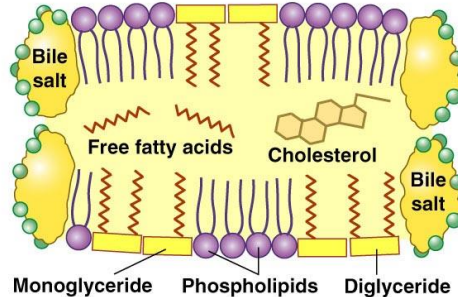
Figure1. Mechanism of Fat digestion and absorption

- Cholesterol in the diet is in the form of cholesterol esters (cholesterol bound to a fatty acid)
- Phospholipids also contain fatty acids in their molecules
- These are both hydrolyzed by two other lipases found in pancreatic secretions:
 - Cholesterol ester hydrolase - for cholesterol hydrolysis
 - Phospholipase A2 for the phospholipid hydrolysis
- Micelles are used here also in the same way - helping transport and dissolving!

(a) Bile salts coat lipids to make emulsions.



(b) Micelles are small disks with bile salts, phospholipids, fatty acids, cholesterol, and mono- and diglycerides.



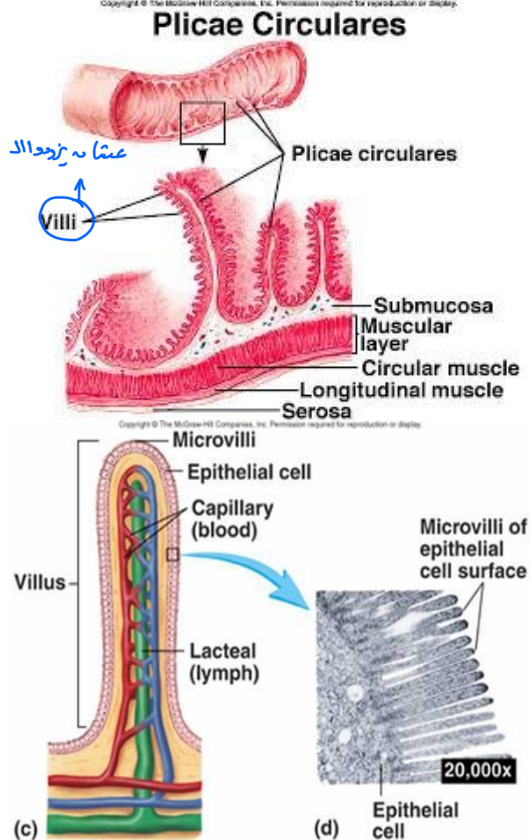
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Absorption

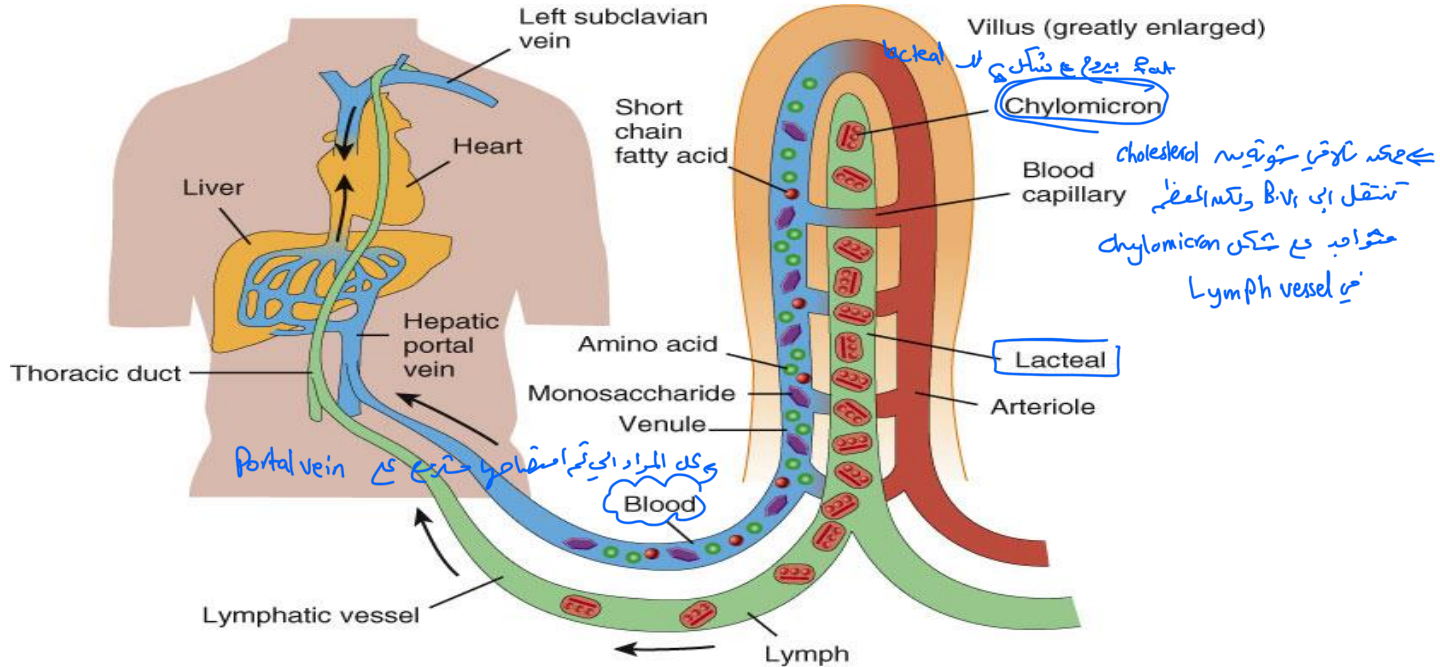
- Each day the intestines must absorb the same amount of fluid that is ingested
 - This is usually 1.5L of ingested liquids and 7L made up of gastric secretions
 - Total = 8-9L
 - The small intestine usually absorbs all except 1.5L
 - This means only 1.5L enters through the ileocaecal valve into the colon
 - The **stomach is not involved** in absorption due to a lack of villi in the mucosa and cause the *epithelial cells are packed tightly together*
 - **Only lipid soluble substances** e.g. alcohol and aspirin can be absorbed in the stomach (but in small amounts)
- **The small intestinal mucosa is adapted to increase absorption here**
 - The small intestine contains many folds called **valvulae conniventes (Folds)** → increase surface area
 - Many valvulae conniventes in the duodenum and jejunum
 - The epithelium also contain **villi** → increase surface area and increase absorption (x10)
 - The villi are *in the small intestine only* and stop at the level of the ileocaecal valve
 - The villi are arranged close together in the duodenum and jejunum but are arranged further apart in the ileum

Absorption

- Each intestinal epithelial cell also has a **brush border of microvilli** → increases the surface by x20 *مساحة أكبر بـ 1000 ضعف*
- The combination of the valvulae conniventes, villi and microvilli increase the area for absorption by up to **x1000**
- Total surface area = 250m² for the small intestine (size of a tennis court)
- Each villa is made up of:**
 - Vascular bundle of an **artery/vein** to help maintain gradient for absorption and to transport dissolved material to the portal circulation
 - Central **lacteal** - lymph vessel for the absorption of lymph *عنبر افنة كل المنطقة يمر مسج عنائسا عطفاي الحرة*
- The **microvilli contain actin** filaments *absorption of substance.*
 - Cause rhythmical contraction to cause continual movement of the microvilli to expose them to new quantities of intestinal fluid → increase absorption

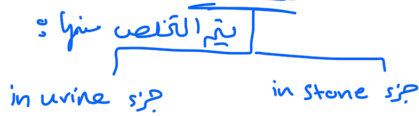


Intestinal Absorption



(b) Movement of absorbed nutrients into the blood lymph

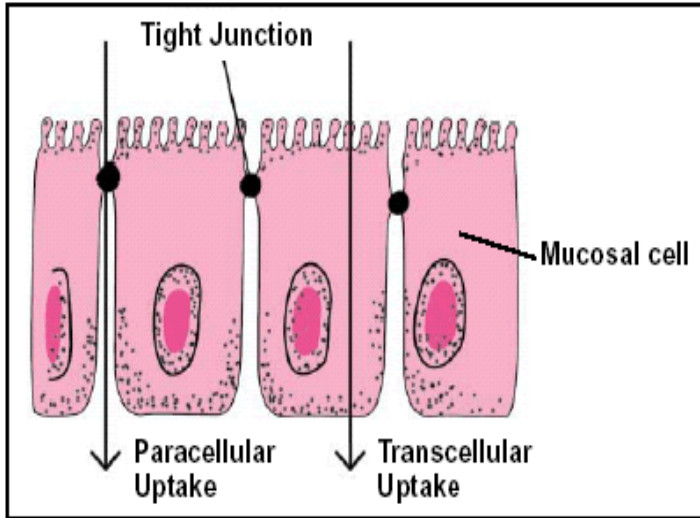
Absorption of water and ions



* تقريباً 7L ماء الماء موجودة في الـ intestine وفي Ions جزء بسيط
خلازم الحمل absorption.

- Water is transported through the intestinal lumen to the blood **by osmosis** (Low salts → high salt) (لدينا البقي Osmolarity و يكون هناك Osmolarity هو الاملاح (Na⁺))
- Osmosis** - the spontaneous movement of solvent molecules through a semipermeable membrane from a **region of high concentration to one of low concentration** higher solute concentration - aims to equalize the solute concentrations on the two sides.
- Diffusion** moves H₂O through **paracellular spaces** → diffusion and osmosis takes it into the capillary
- Water can also move in a **transcellular way** → via osmosis it moves into the epithelial cell and then out again into the paracellular spaces via osmosis

Absorption of water and ions



Osmosis also occurs between the chyme and the plasma

When the stomach and duodenum releases enzymes into the chyme this makes the chyme very concentration

Water then moves from the plasma to the chyme to make the concentrations in each equal - also called ISOTONIC

Absorption of Na ions

- Each person eats 5-8 grams of sodium a day
- Normally less than 0.5% of sodium is lost to the faeces → *الباقى بيمصير absorption*
- Sodium ions are in greater conc in the intestinal lumen than in the epithelial cells

There are many mechanisms by which *sodium enters the epithelial cell* from Lumen:

- **Diffusion** → *(high) enterocyte ↓ (low) Lumen*
- Via **exchange pumps** (Na/H⁺ exchange pumps)

Once *inside the epithelial cells* there are mechanisms to remove the sodium from the cells to keep the concentration gradient from the lumen (high to low)

- Sodium leaves the epithelial cell to the paracellular spaces (between cells) and also at the basal portion of the cell (towards the capillaries). This can occur by:

- **Active transport** → *استعمل دخول الـ Na⁺ وادخل معه glucose or amino acid.*
 - This requires an input of energy from the cell (ATP)

Exchange pumps (Na/K⁺ exchange pump)

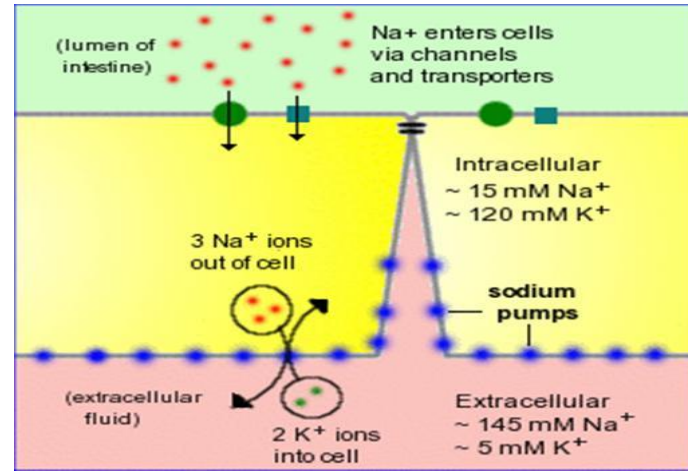
high له وجود الـ Na⁺ في الخلية حسيه هو

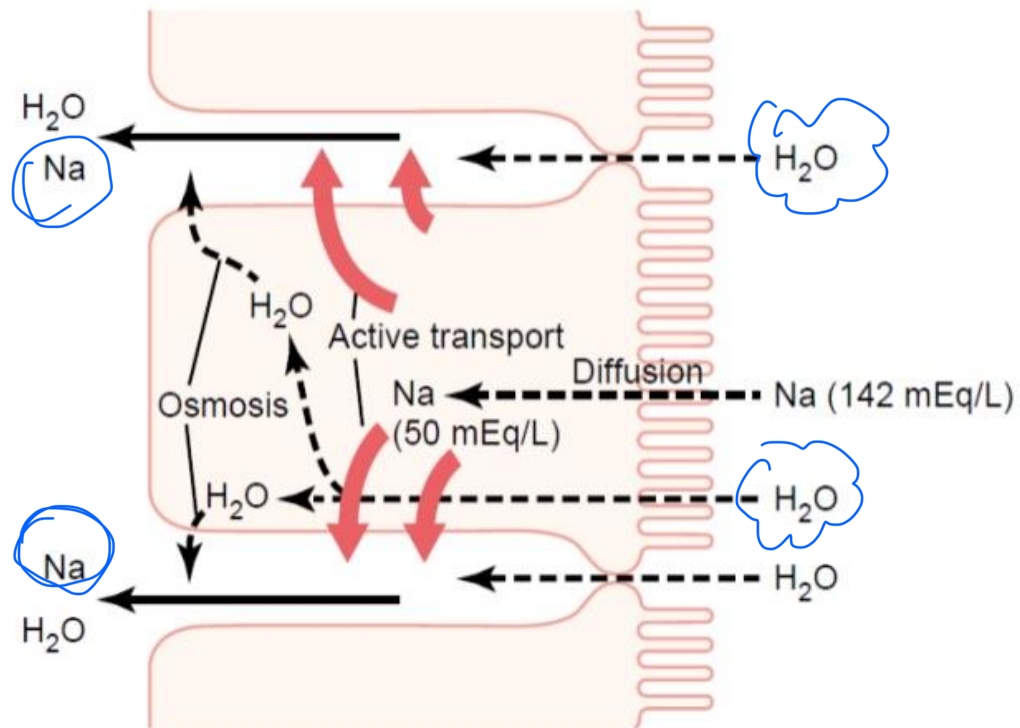
درا تـ Na⁺ ← Low

فكيف يطلع من الخلية ويردع عن Blood عن طريق Na⁺ K⁺ exchanger

n of ions

- **Diffusion of sodium into the cell** and **exchange of Na out at the basal layer** via the **Na/K⁺ exchange pump** can be seen
- For each 3 Na ions removed from the epithelial cell → 2 K⁺ ions move in.
- This keeps the potassium concentration inside the cell high (K⁺ is an intracellular ion)
- There is also a **Na/H⁺ pump** on some epithelial cells which exchanges Na into the cell and H⁺ out (*duodenum and jejunum*)
- As the sodium moves out of the epithelial cell it causes water to move out of the cell by osmosis.





Absorption of sodium ions and water

- In the duodenum and jejunum also there is **absorption of chloride ions**
- As the positive Na^+ ions move into the cell this **creates an electrochemical gradient**
- This means as the positive Na^+ ions move they drag negative Cl^- ions with them
- The **small intestine must absorb sodium** so that it is all not lost to the faeces
 - If this occurs (e.g. with diarrhea) the body reserves of sodium are reduced and sodium can be depleted to lethal levels within hours
- **Aldosterone secretion can increase sodium and water absorption from the small intestine (like in the kidneys)**
- When a person becomes dehydrated large amounts of aldosterone are secreted from the adrenal glands
- Within a few hours the aldosterone increases all the ways by which sodium is absorbed into the cell
- The increased sodium absorption increases the movement of chloride ions and water

aldosterone ↑
reabsorb ↓
 H_2O & Cl^- secretion ↓
in Na^+ & K^+ secretion

الـ Cl^- ions حركته Na^+ حركته
diffusion
على الامعاء زيادة في الخلية
حينئذ الامعاء
high salt low salt
له كيرت انتقال لا glucose A.A
يدونه
aldosterone هو الذي يتحكم في حركة الـ Na^+
(hormonal control)

Absorption of ions

(duodenum + jejunum) apical في منطقة في QT في
distal part in colon & Part in small intestine
عنه reabsorption خلف

When sodium enters the cell via a **Na/H+** pump there is sodium absorption and release of H⁺ from the cell

H⁺ are created when CO₂ diffuses into the cell

These H⁺ ions enter the lumen and bind with bicarbonate ions to form carbonic acid. The carbonic acid then breaks down to form carbon dioxide CO₂ and water

The water enters the chyme

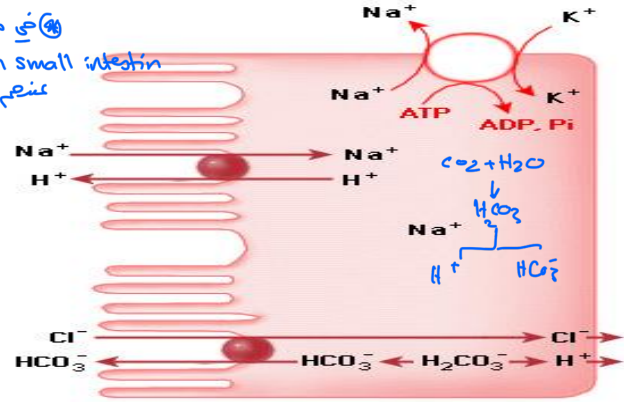
The carbon dioxide is absorbed into the blood and expired by the lungs

This is good as it helps to remove the large amounts of bicarbonate that have been secreted into the duodenum in the pancreatic secretion and bile

This process only occurs in the duodenum and

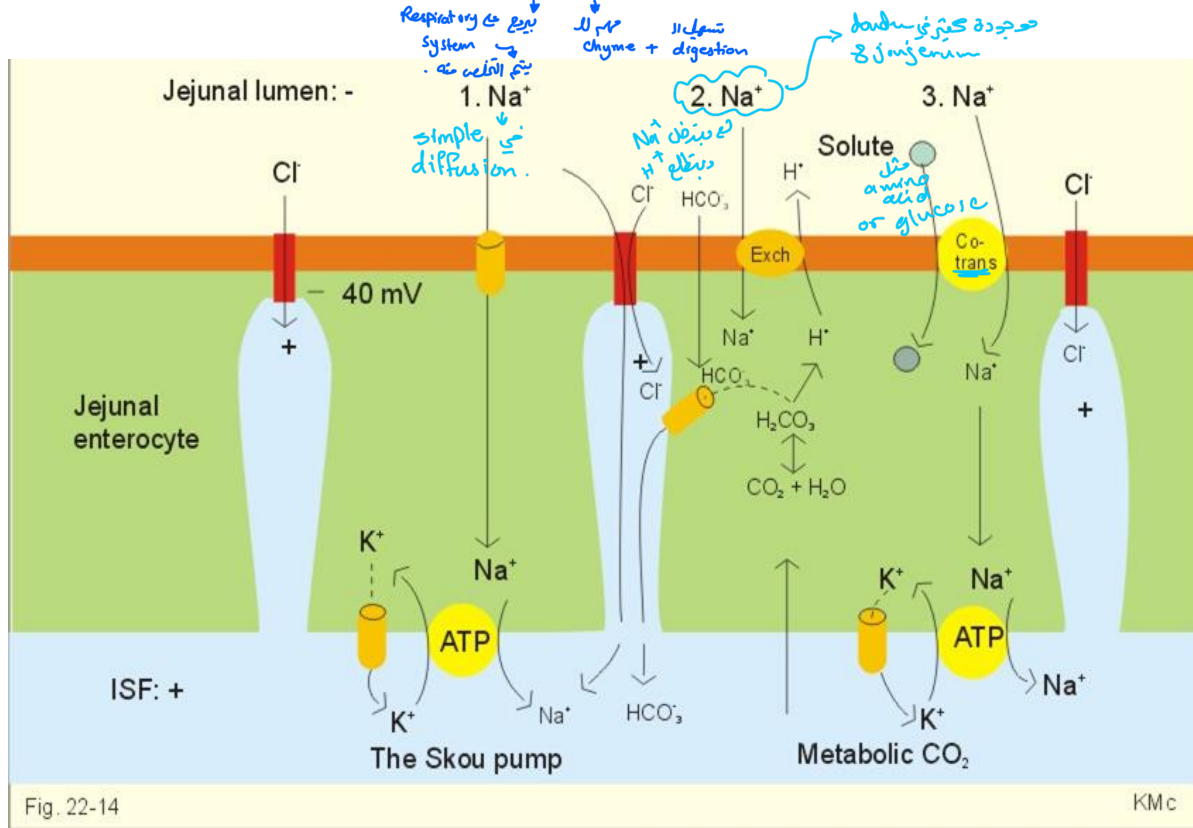
jejunum

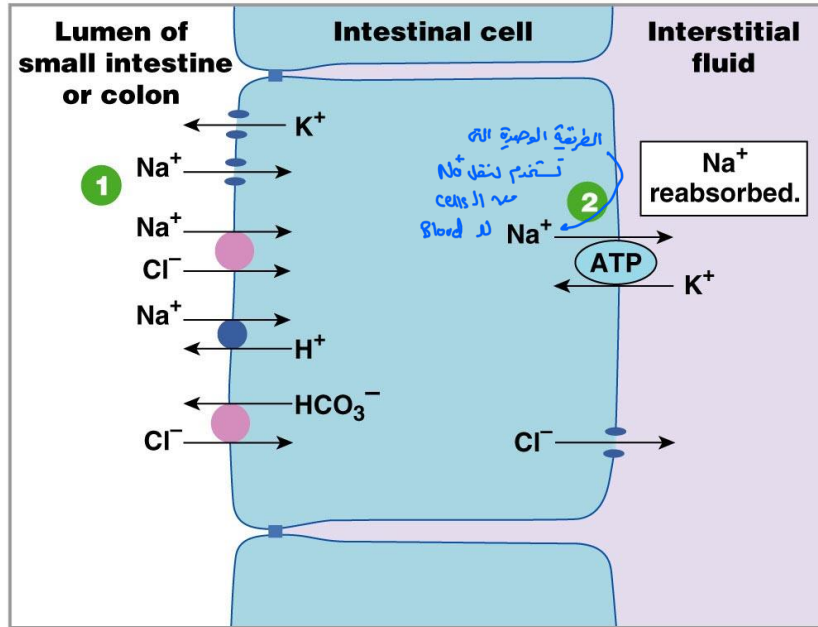
لأنه في هذه المنطقة البكتيرية شحال بيخزن HCO₃⁻
يعني الـ HCO₃⁻ + H⁺ + H₂O → CO₂ + H₂O
في الـ lumen في الـ jejunum
يعني الـ HCO₃⁻ + H⁺ + H₂O → CO₂ + H₂O
في الـ lumen في الـ jejunum
يعني الـ HCO₃⁻ + H⁺ + H₂O → CO₂ + H₂O
في الـ lumen في الـ jejunum



- In the **ileum and large intestine** there is a **HCO₃/Cl pump** on the surfaces of the epithelial cells
- This pump then secretes HCO₃⁻ into the lumen of the intestine in exchange for Cl⁻ (**distal part of colon**)
- This bicarbonate secretion is important as it **neutralises** the acid formed from bacteria

- We can see everything working together
- The H^+ ions in the cell are created when CO_2 diffuses in and breaks down to form carbonic acid then bicarbonate and hydrogen ions



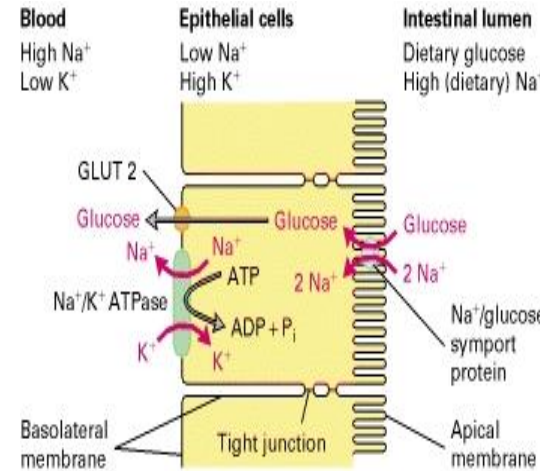


1 Na^+ enters cells by multiple pathways.

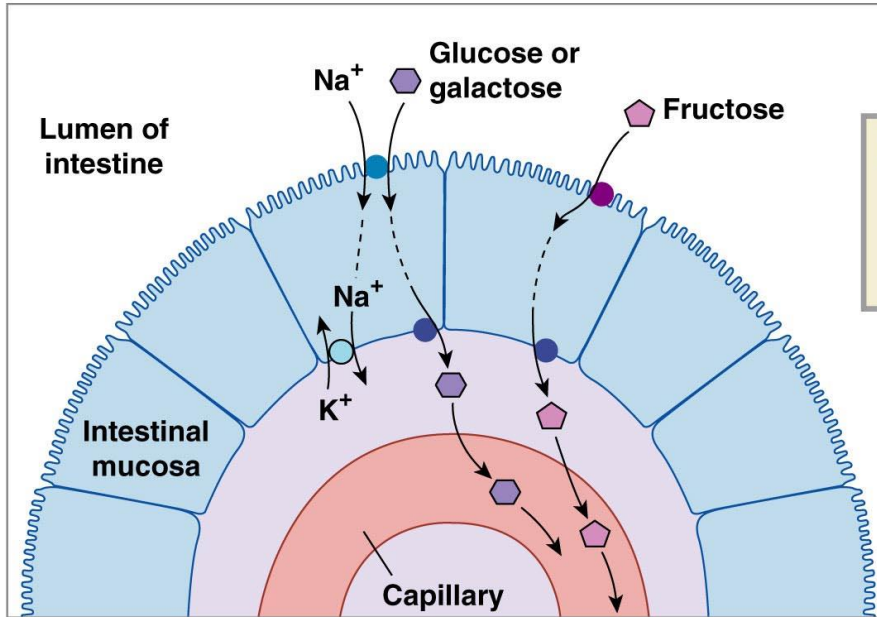
2 The Na^+ - K^+ -ATPase pumps Na^+ into the ECF.

Absorption of carbohydrates

- The majority absorbed as glucose (80%)
 - The rest are absorbed as galactose and fructose from milk and digested sugar respectively
- Glucose requires the presence of sodium ions for absorption
- This is via a **sodium glucose co-transporter** *الطريقة الوحيدة لامتصاص الجلوكوز*
 - This means that sodium binds to a transport protein but it cannot be taken inside the epithelial cells without a glucose molecule binding
 - Once the glucose combines both molecules are transported into the epithelial cell
 - Once inside the cell the glucose enters the capillaries by **facilitated diffusion**. This means it moves from its high concentration inside the cell to the low concentration in the capillaries but is helped across the membrane via a transmembrane protein (channel)



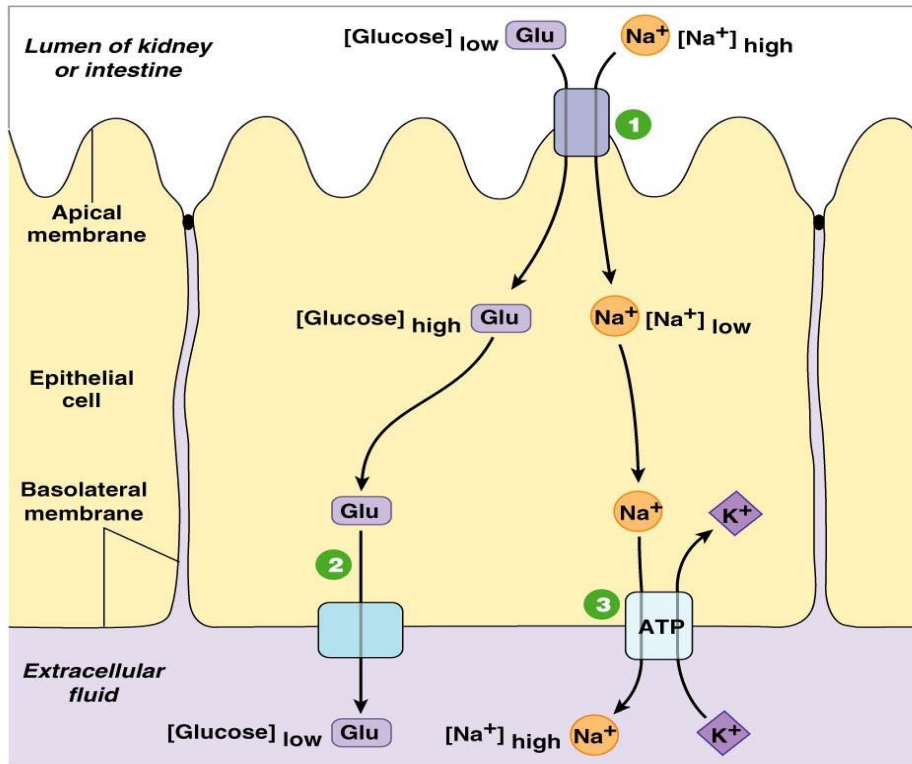
- **Galactose** is transported in the same way *Galactose, Na⁺ co-transport*
- **Fructose** enters the cell by **diffusion**, there it is phosphorylated and converted into glucose *الامتصاص*
- Less efficient than the glucose mechanism



KEY

- SGLT
- GLUT2 → *Glucose transporter - 2.*
facilitated diffusion
- GLUT5

Glucose enters the cell with Na^+ on the SGLT symporter and exits on GLUT2. Fructose enters on GLUT5 and exits on GLUT 2.



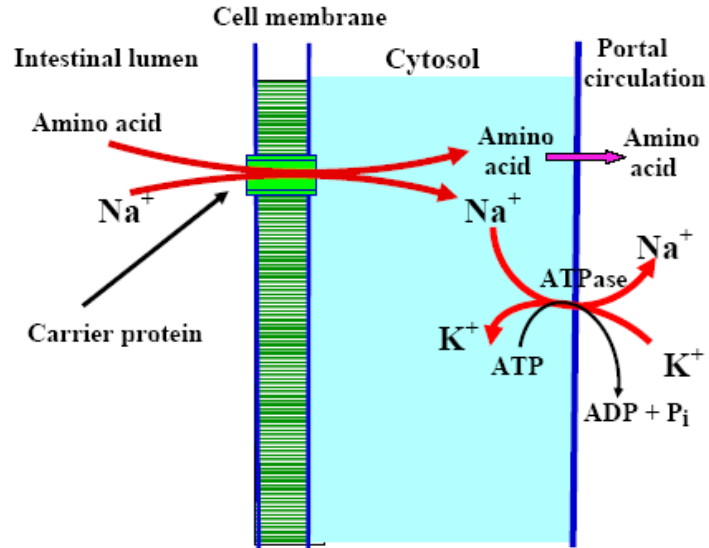
1 **Na^+ -glucose symporter** brings glucose into cell against its gradient using energy stored in the Na^+ concentration gradient.

2 **GLUT transporter** transfers glucose to ECF by facilitated diffusion.

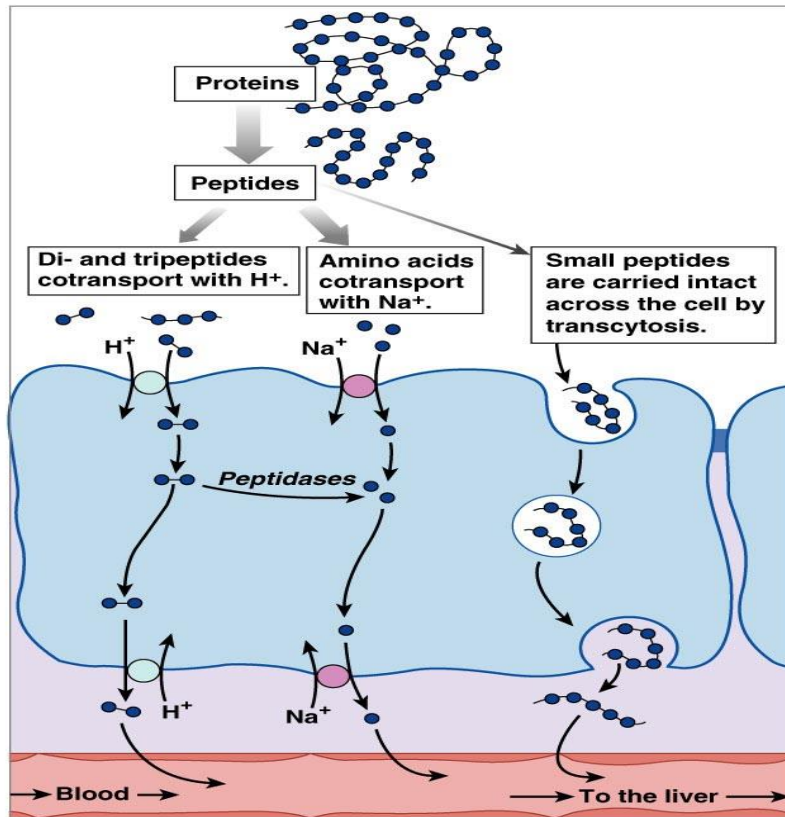
3 **Na^+ - K^+ -ATPase** pumps Na^+ out of the cell, keeping ICF Na^+ concentration low.

Absorption of proteins → انقلها عقداً مع Na^+

- After protein digestion the final dipeptides, tripeptides and amino acids are absorbed through the intestinal epithelial cells via a co-transported system like glucose
- The co-transported here is a sodium system also
- The amino acids etc bind with a transport protein on the microvilli surface of the epithelium
- Sodium then binds
- After the sodium binds it moves down the electrochemical gradient from very positive charge outside the cell to a less positive area inside the cell
- As the sodium moves the amino acids move into the cell with it



Carrier Protein Transport System

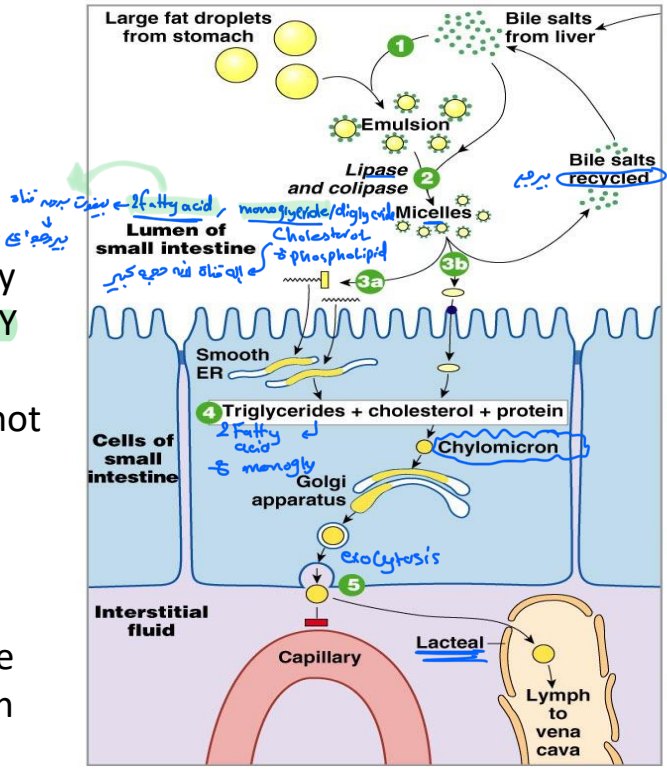


Absorption of fats

- There are two ways to absorb fat:
1. **Micelles** are formed from the **monoglycerides** and **free fatty acids** when mixed with **bile salts**. This creates a lipid core and a water soluble exterior.
- Micelles then carry monoglycerides and free fatty acids to the microvilli membrane
 - At the microvilli the monoglycerides and fatty acids separate from the villi and diffuse through the epithelial membrane (once they break from a micelle they are no longer water soluble but are now fat soluble)
 - The epithelial cells can allow lipids to **diffuse** through as they have a fat soluble membrane
 - The **bile** micelles remain in the **chyme** and they can be used again for transporting more products of fat digestion
 - The micelles are very important for transport. When there are a lot of micelles **97%** of fat ingested gets absorbed but when there are none only **40-50%** gets absorbed
 - In the epithelial cells the **monoglycerides and fatty acids** from the micelles are used by the endoplasmic reticulum to form new **triglycerides** which are released as **CHYLOMICRONS** through the base of the epithelial cell into a **LYMPH DUCT**

2. Small amounts of short and medium chain fatty acids are absorbed directly via diffusion into the epithelial cell

- These then diffuse directly into the **BLOOD CAPILLARY**
- These are not converted into triglycerides and do not enter the lymphatics
- This occurs because short and medium chain fatty acids are more water soluble and do not require micelles or transformation into triglycerides to help them get absorbed



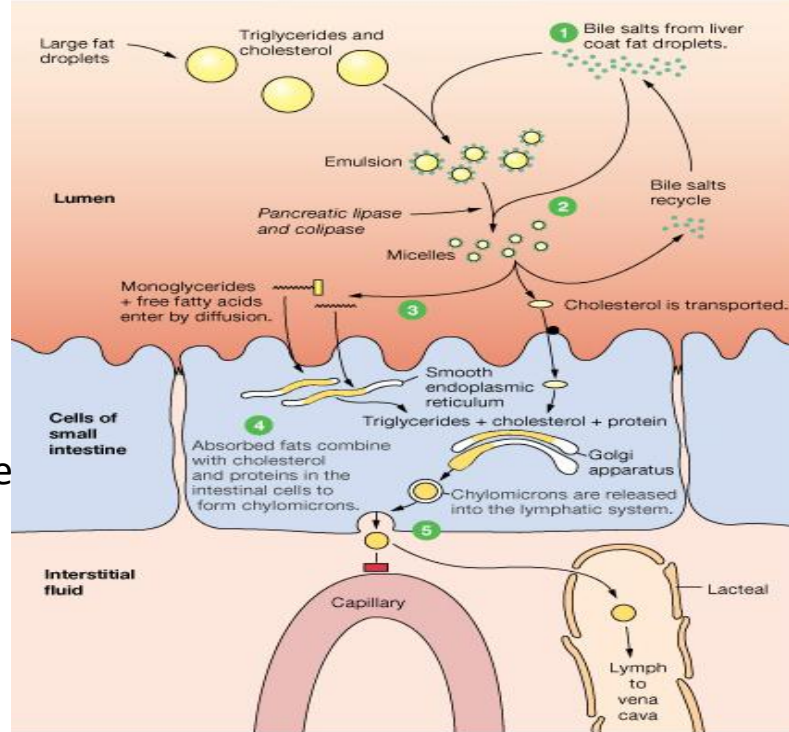
- 1** Bile salts from liver coat fat droplets.
- 2** Pancreatic lipase and colipase break down fats into monoglycerides and fatty acids stored in micelles.
- 3a** Monoglycerides and fatty acids move out of micelles and enter cells by diffusion.
- 3b** Cholesterol is transported into cells by a membrane transporter.
- 4** Absorbed fats combine with cholesterol and proteins in the intestinal cells to form chylomicrons.
- 5** Chylomicrons are released into the lymphatic system.

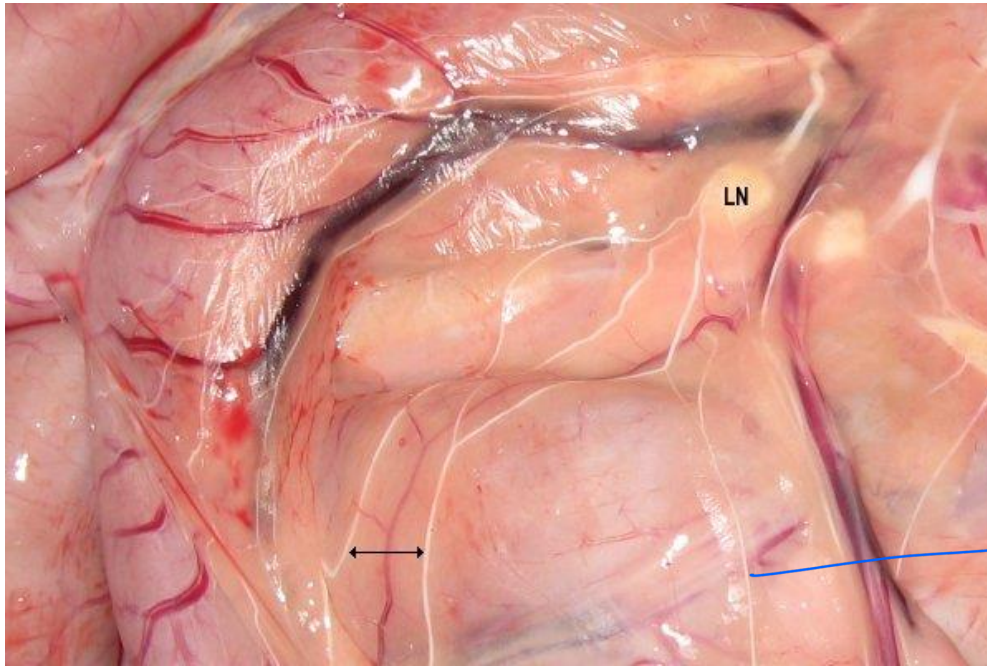
Fat Absorption

- Triglycerides and other lipids (cholesterol) combine with protein to form small water soluble particles called **chylomicrons**
- Chylomicrons will be packaged into secretory vesicles and leave the cell through **exocytosis**.
- Chylomicrons absorbed into lymph of **lacteals**
- Some shorter fatty acids go to blood.
- Bile salts are not altered during fat digestion, it will be transported back to the liver from the ileum through the portal circulation.
- Bilirubin and other wastes will be excreted in **faeces**.

Handwritten notes in Urdu:

Bile salts → recycle کئے جاتے ہیں
 → Liver کی
 → Large intestine
 → Liver portal vein
 → Liver کی

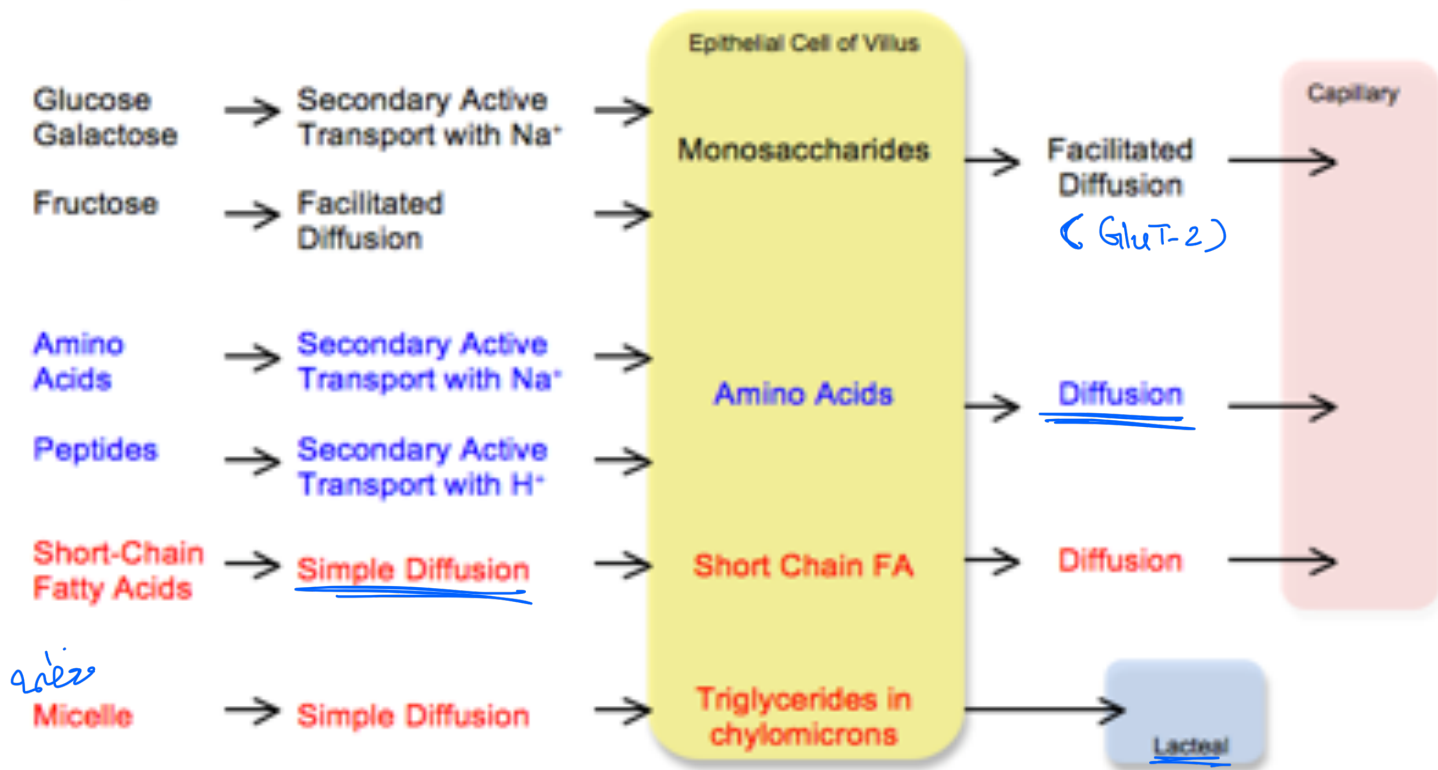




Lymph vessels
chylomicron ~ 1 μ m $\rightarrow$

The lymph draining from the small intestine appears milky and the lymphatics are easy to see. In the image above, the fine white lines (arrows) are **intestinal lymphatics** packed with **chylomicrons**

Absorption in the Small Intestine



Absorption of B₁₂

Storage in Liver

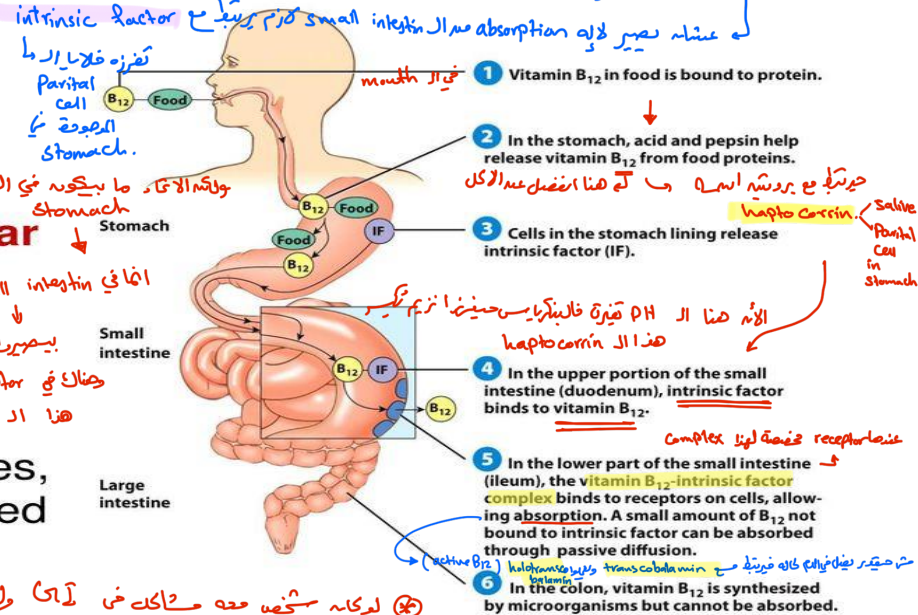
- Needs intrinsic factor (protein produced in the stomach) and gastric acid.

- Absorbed in the ileum.

- If the GI tract is not healthy, B₁₂ must be given by intramuscular injection.**

- Nasal spray B₁₂ supplements are available.

- With high dietary intakes, the excess can be stored accumulatively in the liver.



في الحقن

افا في upper portion of small intestine

بصير complex
هنا ال complex
receptor تقبل

Large intestine

لدينا مخزن مع مائة في ال liver و انت بلك تقطع B₁₂ supplement

ما تقطع ال B₁₂ لانه خلاصه من حبي ال absorption و حبي كل في feces
عنه كدة ال افضل اعطاه و انتا injection

- 1) Dietary vitamin B12 is normally bound to proteins in food
- 2) Pepsin and acid pH in the stomach will degrade these food proteins and release vitamin B12.
- 3) free B12 then binds to one of the three vitamin B12 binding proteins, called **haptocorrin**, produced by the salivary glands and the parietal cells in the stomach. In the duodenum the pH is now less acidic and this allows pancreatic proteases to degrade the haptocorrin, and vitamin B12 (both newly ingested and from the bile duct) is released again and binds tightly to Intrinsic Factor produced by parietal cells.
- 4) In distal ileum the vitamin B12-Intrinsic Factor complex bind to receptors.

- 5) Vitamin B12 then enters the blood bound to another binding protein, **transcobalamin**, the complex is known as **holotranscobalamin (Active B12)**

3] Vit. Lipid soluble ← حُتَقَل زَي مَا يَتَقَل الـ Fat
 Vit. Water soluble ← حُتَقَل مَر الـ water

- 6) Holotranscobalamin (Active B12) is the biologically active fraction of vitamin B12 in the blood as it is in only this form that vitamin B12 is delivered to all the cells of the body.

2] لِمَا لِه نَقَص ← لِه صِهْم يَه تَصْنَع
 خلايا الـ RBCs
 حَيَر الـ anemia

- 7) Vitamin B12 absorbed in the intestine gets transported to the liver via the portal system.

memory , الـ DNA synthesis

- 8) There is extensive enterohepatic circulation of vitamin B12 and B12 is transported from the liver, via the bile duct, to the duodenum.

1] ← عِنْدَه بَلْتَمَر الـ large intestine مَر فَوَازْهَا اِنْهَا تَصْنَع B12 , Vit K ← بَر مَر
 حَيَر بَنِيْنَا هَنَه المِكْتَرِبَة عَرُوجَة فِي آخِر الِاعْصَار وَالْحَبْم مَر حَقِيْقَر لِيَحِلَه الـ absorption الثاني
 حَقِيْقَر فِي Feces

Migrating Motor Complex (MMC): Myoelectric complex

لله حركة في المعدة أثناء الـ Fasting state ← تبدأ في Stomach وتنتهي في نهاية الأمعاء الدقيقة Small intestine
لله وظيفة / تزيل السموم → تضيء قنوات العضلات إلى ماصاتها large intestine تخرج في الأمعاء الكبيرة
حركة الـ MMC (في وقت مبكر الوجبة)

- A) Bursts of intense electrical and contractile activity
- B) During fasting, the predominant pattern of activity is the migrating myoelectric complex (MMC), a cyclically occurring pattern of electric and mechanical activity
- C) Propagation from stomach to ileum (moves food from stomach and small intestine into colon)
- D) Repeats every 90-120 min (repeated cycles between meals)
- E) The MMC is thought to be partially **regulated by motilin**, which is initiated in the stomach as a response to vagal stimulation

لله يقووا صومعة
هوائي يبهل
هذه الحركة .

Migrating Motor Complex (MMC): Myoelectric complex

له بنادق ساعة ريثم تتكرر
له لوبك توقفها ← تاي (أول ما يصل إلى المعدة تتوقف هذه الحركة).

Phase (1) 45-60 min

slow waves with very few to no action potentials (contraction صت)

Phase (2) 15-30 min

له لوبك استرخائية

Irregular AP and contractions, gradual increase in intensity and freq → Pyloric بكونه فاع

Phase (3) 3-6 min

في هذه الفترة

Intense electric and contractile activity

Phase (4) كله يرجع لحالة الاسترخاء

Rapid decline of electrical and contractile activity, and back to phase 1.

MMC phase

I

II

III

IV

Gastric antrum

ساعة

Duodenum

5g
1 minute

Myoelectric complex importance:

- This activity Expels food to the Caecum
 - Slow movement to allow good absorption
 - Inhibits the migration of colonic bacteria into the terminal ileum
 - Unidirectional flow
- الهجرة
الهجرة في اتجاه واحد →
- Phase-1
or Phase-4 → لأنه مصفٍ وقتها في Phase-1
أو Phase-4
- التي يتكون
حركة بصرية
- لها ملابيح
Bacteria
- حركاتها تمنع انه اليكتيرا تهاجر منه ال
Small large