

## BIOLOGY

103

Subject

Final Exam - Chapter Forty One

تحذير: محاضراتنا (الملخصات) متوفرة فقط لدى:  
 (1) أكاديمية القصور بفروعها. (2) جمعية التصوير الطبية (مدرج التمريض).

للإستفسار والتسجيل

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ساعات الدوام الرسمي

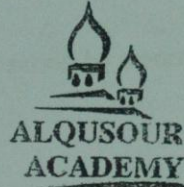
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# Biology

مدة الدورة

10

ساعات

و التسجيل سيبقى مستمراً

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معاً نرسم خطوط النجاح والتفوق

## Animal Nutrition

### Mammalian Digestive System

-Simply mammalian digestive system consists of the alimentary canal and various accessory glands that secrete the digestive juices into the canal through duct.

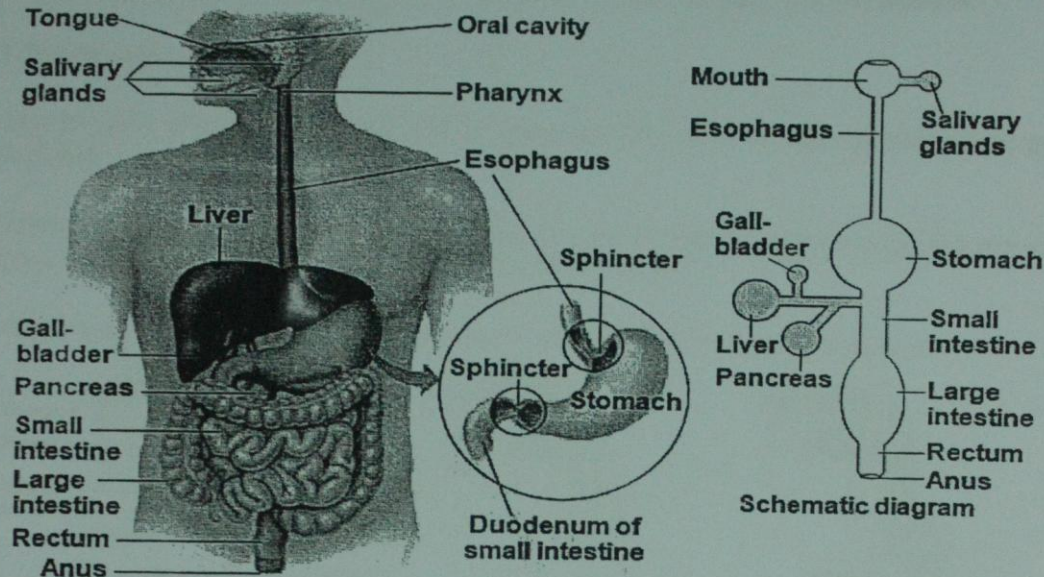
-Peristalsis: it's a rhythmic wave of contraction by smooth muscles in the wall of the canal, pushes the food along the tract.

-Sphincters: muscular ring-like valves which close off the tube, regulating the passage of food between chambers of the canal.

The Mammalian accessory glands are:

1. Three pairs of salivary glands
2. The pancreas
3. The liver
4. The gallbladder, which store a digestive juice

The oral cavity, pharynx, and esophagus initiate food processing



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### 1. The oral cavity

-Physical and chemical digestion of food begin in the mouth

-During chewing teeth will cut, smash, and grind the food to increase its surface area & make it easier to swallow

-The presence of food in the mouth or even smelling or looking to food will stimulate the salivary glands to secrete saliva, in humans nearly more than a liter of saliva is secreted per day

Saliva contains:

1. **Mucus**, which is a viscous mixture of water, salts, cells, and glycoproteins, which protect the soft lining of the mouth and lubricate the food for easier swallowing
2. Buffer to prevent tooth decay by neutralizing the acid in the mouth
3. Antibacterial agent: kill bacteria in the food
4. Salivary amylase: - an enzyme hydrolyzes carbohydrate (starch and glycogen) to smaller polysaccharide and disaccharide (maltose), that's the chemical digestion in the mouth.

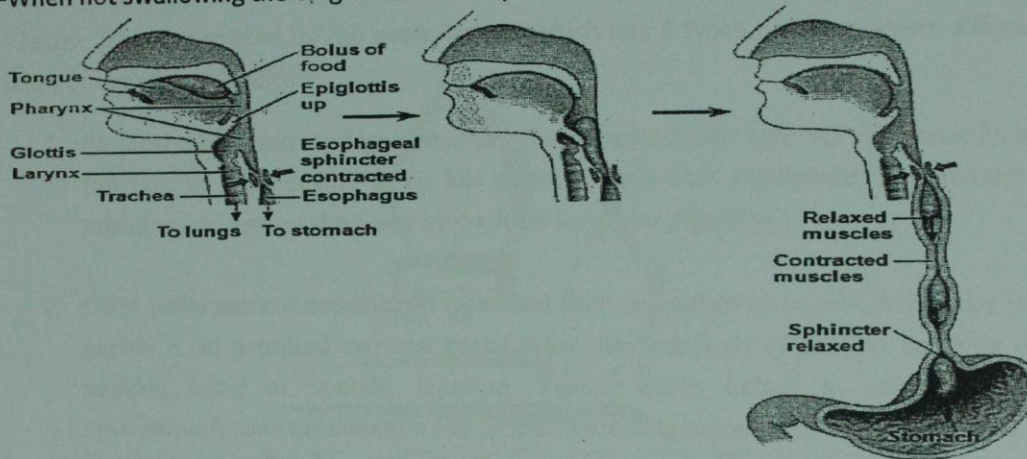
2. The tongue: taste food, shape it into a ball called bolus and push it to the pharynx.

### 3. The pharynx:

-The throat or pharynx is the junction that opens into both the esophagus and the windpipe (trachea).

-When swallowing the glottis (the top of the windpipe) moves up and the epiglottis moves down to close the windpipe so that no food enters the lungs.

-When not swallowing the epiglottis moves up and the glottis is down and opened.



-Food or liquid may go wrong way because of the swallowing reflex didn't close the opening of the windpipe in time

-The resulting blockage of the airflow, choking, stimulate coughing, which usually expels the material, so Coughing occurs when the swallowing reflex fails and food or liquids reach the windpipe

### 4. The esophagus

-The esophagus conducts the food from the pharynx down to the stomach by peristalsis

- It takes 5-10 seconds for it to pass down the esophagus to the stomach

-The upper part of the esophagus is voluntary (striated muscle) but the lower part is involuntary (smooth muscle).

## 5. The stomach stores food and performs preliminary digestion

-The stomach is located in the upper abdominal cavity, below the diaphragm.

-It has folds and very elastic wall so that it can stretch to store up to 2 liters of food.

-Besides storing food, stomach secretes a digestive fluid called **gastric juice** and mixes this juice with food.

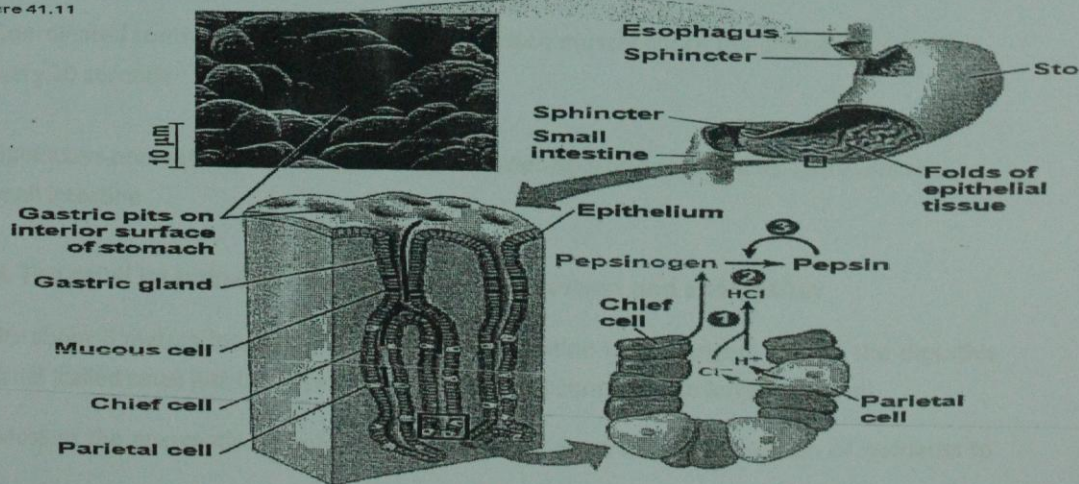
-Gastric juice is made up of hydrochloric acid (HCl) and **pepsin**

-Gastric juice is secreted by the gastric gland which has **3 types** of cells secrete different component of gastric juice:

1. **Parietal cells:** - secrete high concentration of hydrochloric acid HCl (pH about 2), the function of high acidity is to kill most bacteria that swallowed and denatures proteins and disrupt the bond in the food for easier digestion.
2. **Chief cells:** secrete pepsinogen (inactive) then converted to pepsin (active) by HCl, pepsin is an **protease enzyme** that begins the hydrolysis of protein breaking the peptide bond at specific location. Pepsin works better in strongly acidic environment. Low pH denature the protein; increasing exposure of the peptide bond to pepsin.
3. **Mucus cells:** secrete mucus which lubricates and protects the wall of the stomach.

-Now the food in the stomach called **acid chyme**

Figure 41.11





What prevent pepsin from destroying the cells of the stomach???

1. Pepsin is secreted in an inactive form (pepsinogen) and not activated until it reach the lumen of the stomach (away from cells) where HCl activate pepsinogen to pipsin, also pepsin can activate pepsinogen (positive feedback) .
2. Mucus protect the stomach lining
3. Stomach lining regenerate itself every 3 days by mitosis

#### Stomach Diseases

-Gastric ulcer: lesions in the lining, Caused mainly by acid tolerant bacterium *Helicobacter pylori*.

-Treatment: by antibiotic, may worsen if pepsin and acid destroy the lining faster than it can regenerate.

-Heart burn: occasional back flow of acid chyme.

-Most of the time stomach is closed from both ends:

1. The upper end by **cardiac orifice (sphincter)** which opens only when bolus reach the stomach
2. The lower end by **pyloric sphincter** which regulate the passage of chyme into the intestine, it takes about 2-6 hrs after eating for the stomach to empty.

#### Stomach Dynamics

-Coordinated contraction and relaxation of stomach muscle churn the stomach's contents every 20 seconds

-Sphincters prevent chyme from entering the esophagus and regulate its entry into the small intestine

#### 6. The small intestine is the major organ of digestion and absorption

-Its about 6 meters long, with this long small intestine is the longest part of the digestive canal (called small just because its diameter is small compared to large intestine).

-Most of the enzymatic hydrolysis of the food and most of the absorption of nutrients to

blood occurs in small intestine, so it is the major organ of digestion and absorption.

-The first 25 cm of small intestine called **duodenum**, here the chyme from the stomach mixes with digestive juices from the **pancreas, liver, gallbladder, and gland cells of the intestinal wall itself.**

a. **The pancreas:** produces several hydrolytic enzymes and an alkaline solution rich in bicarbonate acting as buffer to neutralize the acidic chyme.

-Proteases (protein digesting enzymes) are among the enzymes produced in the pancreas; which are then activated when enter the duodenum.

b. **The liver produce bile** (mixture of substances) which stored in gallbladder until needed.

-Bile does not contain any hydrolytic enzyme it contains bile salts which help in fat digestion and absorption.

-Bile also destroys nonfunctional red blood cells

c. **Epithelial lining of the duodenum:** is called brush border; it is the source of several digestive enzymes.

### Enzymatic Action in Small Intestine

1. **Carbohydrate digestion:** small intestine continues carbohydrate digestion which begun by salivary amylase in the oral cavity, now **pancreatic amylase** hydrolyze starch, glycogen and smaller polysaccharides into disaccharides.

-Another family of enzymes called **disaccliaridases** build in the intestinal wall split disaccharides into two simple sugars such as **maltase** breaks maltose, **sucrase** breaks sucrose and **lactase** breaks lactose.

2. **Protein digestion:** small intestine continues protein digestion which begun by pepsin in the stomach, now **pancreatic trypsin** and **chymotrypsin** breaks the proteins into small polypeptides by cleaving peptide bond at specific sites just like pepsin.

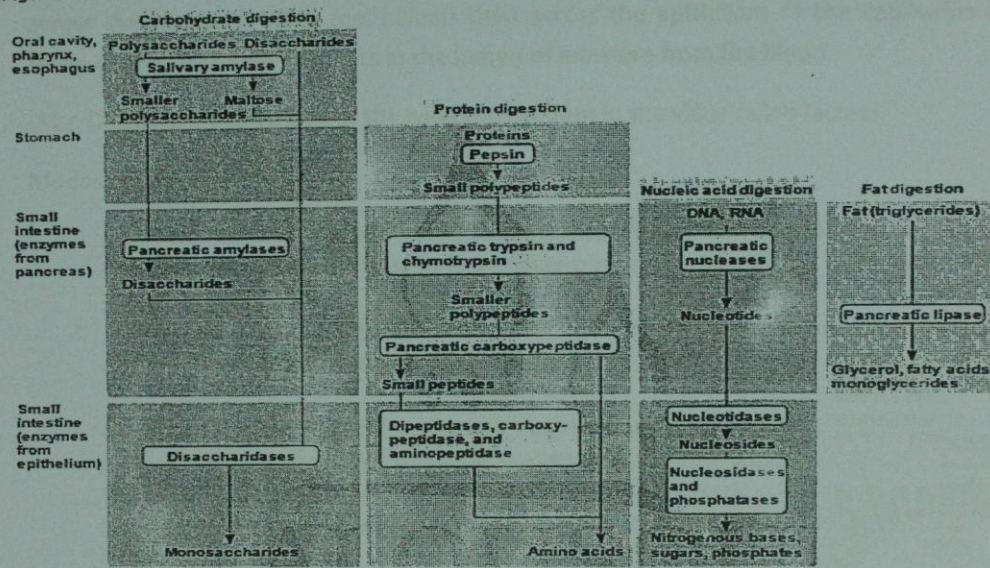
-Enzymes called pancreatic **dipeptidases** split small polypeptides into amino-acids

-**Carboxypeptidase** split off one amino acid at a time, beginning at the end that has free carboxyl group, while **Aminopeptidase** works in the opposite direction (cut at the end that has free amino group).

3. Nucleic acid digestion: group of enzymes called nucleases break DNA and RNA into nucleotides.

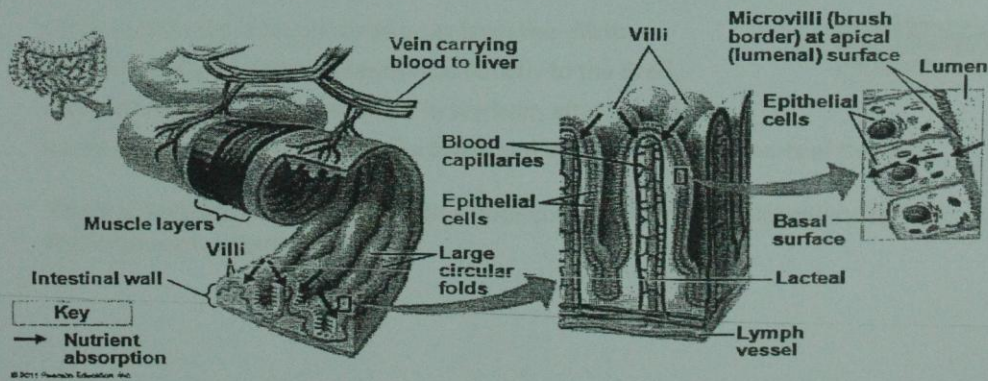
4. Fat digestion: fat molecules are insoluble in water, bile salts from gallbladder coat tiny fat droplets and keep them from aggregation in a process called **emulsification** (Increasing exposure to lipase), and these droplets are exposed to **lipase** which hydrolyzes fat molecules into glycerol, fatty acid, glycerides

Figure 41.12-4



-Most digestion is completed in the duodenum, the remaining parts of the small intestine (the jejunum and ileum) function mainly in the absorption of nutrient and water

### Absorption of Nutrients





-Few nutrient are absorbed in the stomach and large intestine, most absorption occurs in the small intestine to the blood over a period of 5-6 hours

-Small intestine has a surface area about 300m<sup>2</sup>, large folds in the lining make fingerlike projection called **villi**, each cell in the villus has microscopic appendages called **microvilli** which increase the rate of absorption.

-A net of blood vessels (capillaries) found in the core of each villus, nutrient are absorbed across the intestinal lining (epithilium) then across the epithilium of the capillaries only these 2 layers separate nutrients in the lumen of intestine from the blood.

-Also there are small vessels of the lymphatic system in the villus called **lacteal**.

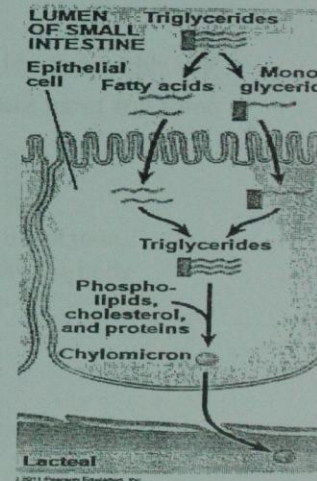
#### Modes of Absorption:

1. Some nutrients are absorbed by passive transport such as fructose from high concentration (the intestine) to low concentration (the blood).
2. Other nutrients are pumped by active transport against the concentration gradient, such as amino acids, vitamins, and glucose.
3. Fat enter the epithelial cells, mixed with cholesterol and coated with protein forming a small globules called **chylomicron**, which then transported to lacteal by exocytosis. Lymphatic vessels deliver chylomicron-containing lymph to large veins that return blood to the heart

-Epithelial cells absorb fatty acids and monoglycerides and recombine them into triglycerides. These fats are coated with phospholipids, cholesterol, and proteins to form water-soluble **chylomicrons**

-All the capillaries drain nutrients away from the villi to **hepatic portal vein** ( blood vessel leads directly to the liver), many metabolisim processes occur in the liver, after that blood travels to the heart which pump the blood and the nutrients to all parts of the body.

-The liver regulates nutrient distribution, interconverts many organic molecules, and detoxifies many organic molecules



### 7. The large intestine

-The **colon** of the large intestine is connected to the small intestine in a T-shape junction

-One of the T arms is the **cecum**, which aids in the fermentation of plant material and connects where the small and large intestines meet

-The other arm is the long colon (1.5 m)

-The human cecum has an extension called the appendix, which plays a very minor role in immunity.

-The major function of the colon is to reabsorb the water and fluids from the lumen remaining from the small intestine (most of the water is reabsorbed in the small intestine with the nutrients).

-90% of water is reabsorbed by both small intestine and colon.

-Colon has a large number of harmless bacteria called the **normal flora** like Escherichia coli, and these bacteria live on unabsorbed organic material, and they produce gases and some of them produce vitamins such as folic acid, vitamin K and vitamin B.

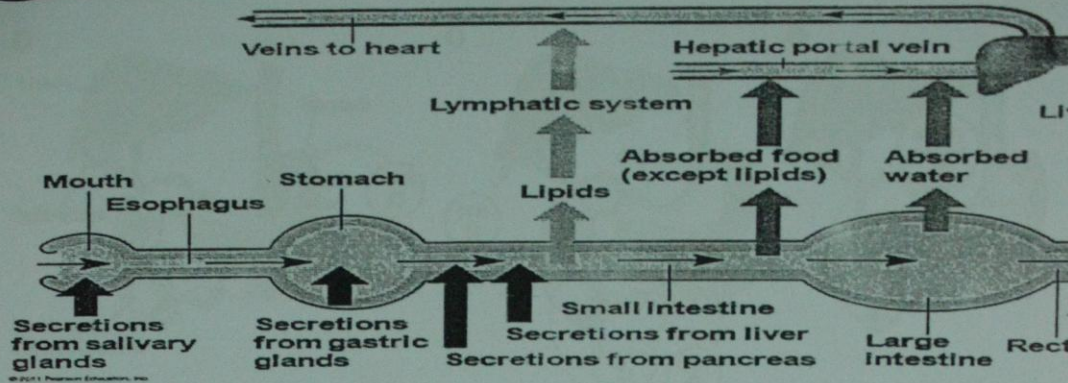
-The terminal portion of the colon called the rectum, where feces (mass of bacteria, cellulose, and undigested material) are stored until can be eliminated from the body through the anus in 12-24 hours.

- Feces become more solid as they move through the colon.

-Between the rectum and the anus are two sphincters one involuntary and the other voluntary.

-If the lining of the colon is irritated by virus or bacteria, less water than normal may be reabsorbed, it will result in **diarrhea**

-**Constipation:** when peristalsis move the feces along the colon too slowly, an excess water is reabsorbed



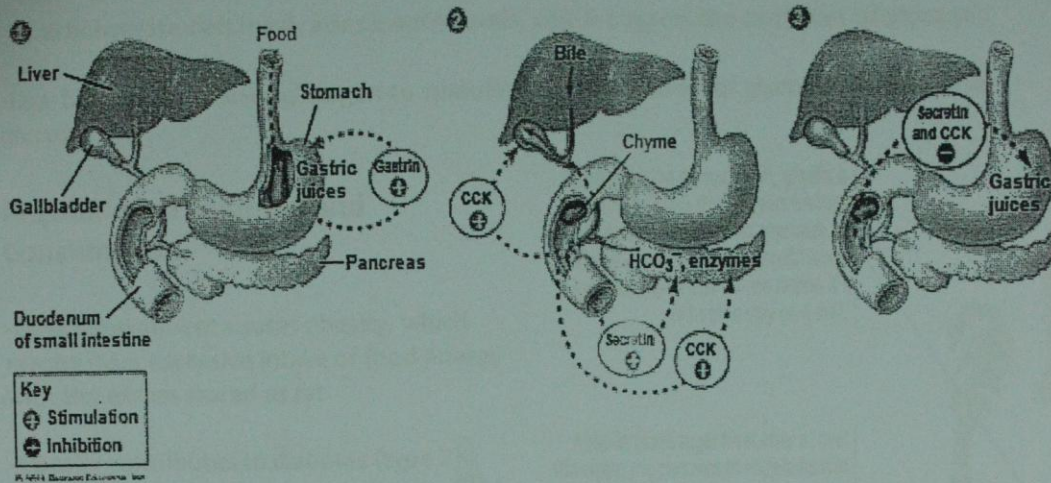
## Regulation of Digestion

- Each step in the digestive system is activated as needed
- The enteric division of the nervous system helps to regulate the digestive process
- The endocrine system also regulates digestion through the release and transport of hormones

## Hormones Help Regulate Digestion

Hormones released by the wall of stomach and duodenum help ensure that digestive secretion are present only when needed.

1. When see, smell, or taste food, brain stimulates the stomach to release gastric juice.
2. Some substances in the food stimulate stomach cells to release hormone called gastrin, which stimulate further secretion of the gastric juice.
3. If the pH of the stomach is too low (very acidic), acid will inhibit secretion of gastrin
4. Other group of hormones called **enterogastrones**, secreted by the duodenum wall such as:
  - a. **Secretin** : acidic chyme stimulates the duodenal wall to secrete this hormone its function is to stimulate pancreas to produce bicarbonate to neutralize the acids.
  - b. **Cholecystokinin (CCK)**: secreted in response to presence of amino acids or fatty acids, it stimulates gallbladder to secrete bile salts for fat digestion and pancreas to secrete enzymes for protein digestion.

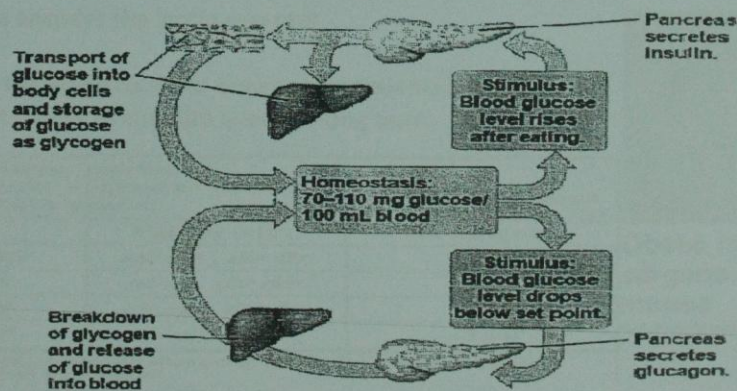


## Regulation of Energy Storage

- The body stores energy-rich molecules that are not needed right away for metabolism
- In humans, energy is stored first in the liver and muscle cells in the polymer glycogen
- Excess energy is stored in adipose tissue, the most space-efficient storage tissue

## Glucose Homeostasis

- Oxidation of glucose generates ATP to fuel cellular processes
- The hormones insulin and glucagon regulate the breakdown of glycogen into glucose
- The liver is the site for glucose homeostasis



- A carbohydrate-rich meal raises insulin levels, which triggers the synthesis of glycogen
- Low blood sugar causes glucagon to stimulate the breakdown of glycogen and release glucose

### Regulation of Appetite and Consumption

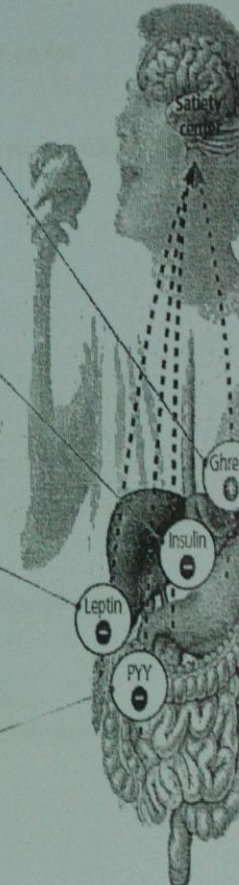
- Over nourishment causes obesity, which results from excessive intake of food energy with the excess stored as fat
- Obesity contributes to diabetes (type 2), cancer of the colon and breasts, heart attacks, and strokes
- Researchers have discovered several of the mechanisms that help regulate body weight
- Hormones regulate long-term and short-term appetite by affecting a "satiety center" in the brain
- Studies on mice revealed that the hormone leptin plays an important role in regulating obesity
- Leptin is produced by adipose tissue and can help to suppress appetite
- The *ob* gene codes for the hormone leptin.
- The *db* gene encodes the leptin receptor.
- Leptin and the leptin receptor are key components of the circuitry that regulates appetite over the long term.

Secreted by the stomach wall, ghrelin is one of the signals that triggers feelings of hunger as mealtimes approach. In dieters who lose weight, ghrelin levels increase, which may be one reason it's so hard to stay on a diet.

A rise in blood sugar level after a meal stimulates the pancreas to secrete insulin (see Figure 41.20). In addition to its other functions, insulin suppresses appetite by acting on the brain.

Produced by adipose (fat) tissue, leptin suppresses appetite. When the amount of body fat decreases, leptin levels fall, and appetite increases.

The hormone PYY, secreted by the small intestine after meals, acts as an appetite suppressant that counters the appetite stimulant ghrelin.



Obese mouse with mutant *ob* gene (left) next to wild-type mouse

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#### RESULTS

Genotype pairing (red type indicates mutant genes)		Average change in body mass (g) of subject
Subject	Paired with	
<i>ob<sup>+</sup> ob<sup>+</sup>, db<sup>+</sup> db<sup>+</sup></i>	<i>ob<sup>+</sup> ob<sup>+</sup>, db<sup>+</sup> db<sup>+</sup></i>	8.3
<i>ob ob, db<sup>+</sup> db<sup>+</sup></i>	<i>ob ob, db<sup>+</sup> db<sup>+</sup></i>	38.7
<i>ob ob, db<sup>+</sup> db<sup>+</sup></i>	<i>ob<sup>+</sup> ob<sup>+</sup>, db<sup>+</sup> db<sup>+</sup></i>	8.2
<i>ob ob, db<sup>+</sup> db<sup>+</sup></i>	<i>ob<sup>+</sup> ob<sup>+</sup>, db db</i>	-14.9*

Due to pronounced weight loss and weakening, subjects in this pairing were weighed after less than eight weeks.

### Obesity and Evolution

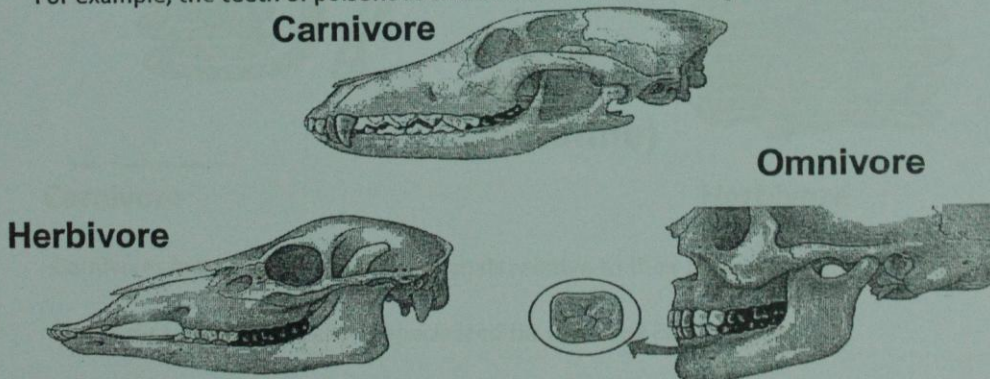
- A species of birds called petrels become obese as chicks; in order to consume enough protein from high-fat food, chicks need to consume more calories than they burn
- The problem of maintaining weight partly stems from our evolutionary past, when fat hoarding was a means of survival
- Individuals who were more likely to eat fatty food and store energy as adipose tissue may have been more likely to survive famines

### Evolutionary adaptations of vertebrate digestive systems correlate with diet

- Digestive systems of vertebrates are variations on a common plan
- However, there are intriguing adaptations, often related to diet

### Dental Adaptations

- Dentition, an animal's assortment of teeth, is one example of structural variation reflecting diet
- The success of mammals is due in part to their dentition, which is specialized for different diets
- Nonmammalian vertebrates have less specialized teeth, though exceptions exist  
 For example, the teeth of poisonous snakes are modified as fangs for injecting venom



- Carnivores: Large, pointed incisors and canines that can be used to kill prey and rip or cut away pieces of flesh. The jagged premolars and molars crush and shred food.

-Herbivores: Premolars and molars with broad, ridged surfaces that grind tough plant material. The incisors and canines: biting off pieces of vegetation.

-As omnivores, humans are adapted to eating both plants and meat.

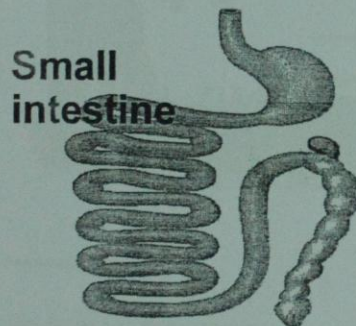
-Adults have 32 teeth.

-From front to back along either side of the mouth are four blade-like incisors for biting, a pair of pointed canines for tearing, four premolars for grinding, and six molars for crushing

### Stomach and Intestinal Adaptations

-Many carnivores have large, expandable stomachs

-Herbivores and omnivores generally have longer alimentary canals than carnivores, reflecting the longer time needed to digest vegetation



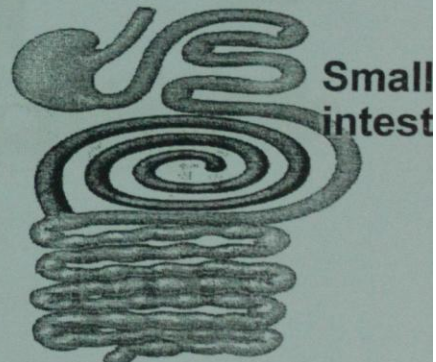
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**Carnivore**

**Stomach**

**Cecum**

**Colon  
(large  
intestine)**



**Herbivore**

-Carnivores have shorter alimentary canals relative to their body size than do herbivores.

-The koala's alimentary canal is specialized for digesting Eucalyptus leaves.

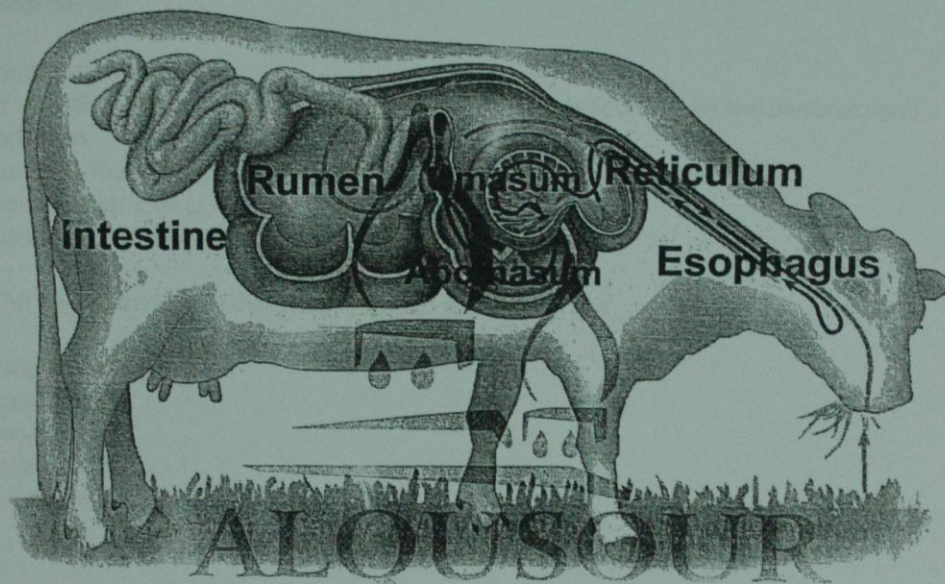
-Extensive chewing chops the leaves into tiny pieces, increasing exposure to digestive juices.

-In the long cecum and the upper portion of the colon, symbiotic bacteria convert the shredded leaves to a more nutritious diet.

### Mutualistic Adaptations

-Many herbivores have fermentation chambers, where mutualistic microorganisms digest cellulose

-The most elaborate adaptations for an herbivorous diet have evolved in the animals called ruminants



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-Boluses enter the rumen.

-Some boluses also enter the reticulum. In both the rumen and the reticulum, prokaryotes and protists digest the cellulose & secrete fatty acids.

-The cow periodically regurgitates and rechews the cud, which further breaks down the fibers, making them more accessible to further microbial action.

-Omasum: The cow then reswallows the cud, which moves to the omasum, where water is removed.

-Abomasum: The cud, containing great numbers of microorganisms, finally passes to the abomasum for digestion by the cow's own enzymes





### Sample Questions

1. In vertebrates, food is moved along the length of the digestive system by \_\_\_\_\_.
  - a. active transport across cell membrane
  - b. peristalsis
  - c. diffusion and osmosis
  - d. sequential contraction of bands of skeletal muscles
2. Acid chyme \_\_\_\_\_.
  - a. contains digested fat
  - b. is a mush made from boluses and hydrolytic enzymes secreted by the pancreas and duodenum
  - c. contains food and gastric juice and moves through the pyloric sphincter
  - d. causes gastric ulcers
  - e. passes into the large intestine, where water is removed
3. The largest variety of digestive enzymes function in the \_\_\_\_\_.
  - a. large intestine
  - b. oral cavity
  - c. stomach
  - d. gallbladder
  - e. small intestine



## بيدية القصور

ودروس مساندة واستشارات متخصصة لطلاب الجامعات  
في التخصصات الطبية والهندسية والعلمية

### Questions Answers

Question	Answer
1	b. peristalsis
2	c. contains food and gastric juice and moves through the pyloric sphincter
3	e. small intestine



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