

1

Digestive Systems

Functions:

detect, acquire, store, digest, absorb

animals have different adaptations of various components of digestion for their particular diets

All systems carry out same functions, so all require detection & acquisition mechanisms, lumen for storage and digestion, and surface area for absorption into circulation.

2

Design of Digestive Systems

Intracellular:

paramecium with phagocytosis

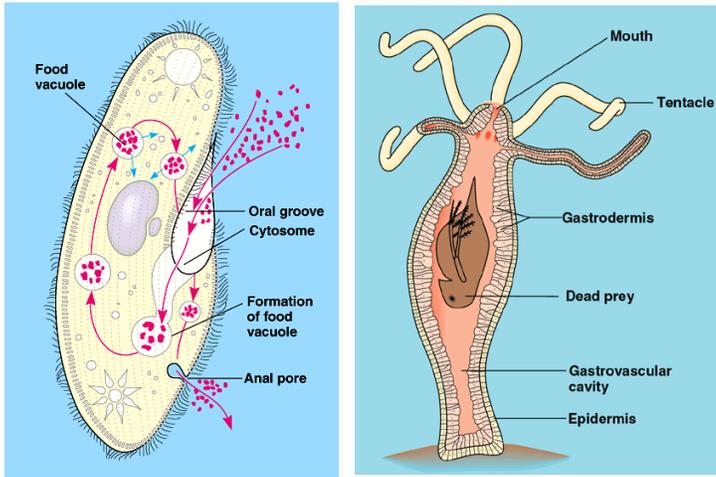
Extracellular in bag:

hydra with tentacles, mouth, and gastrovascular cavity

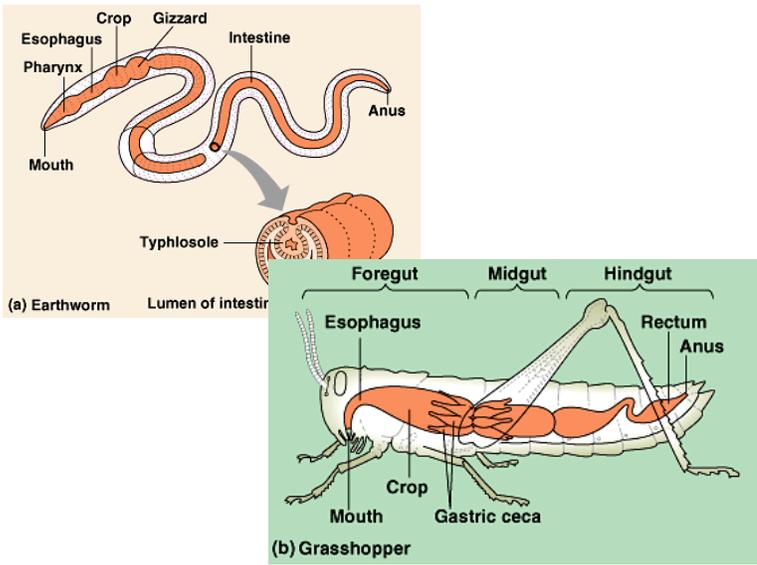
Extracellular in tube (alimentary canal):

earthworm, insect, bird, mammal

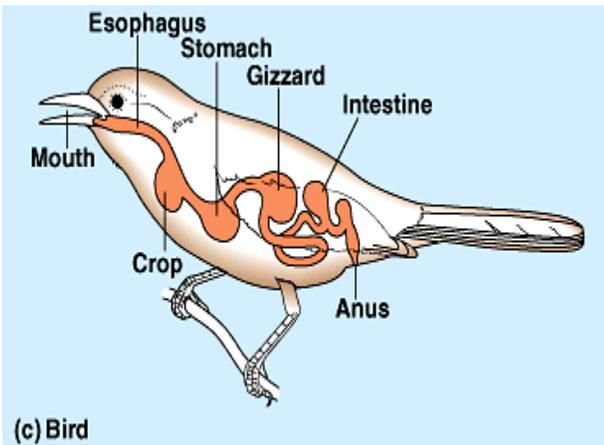
3



4



5



6

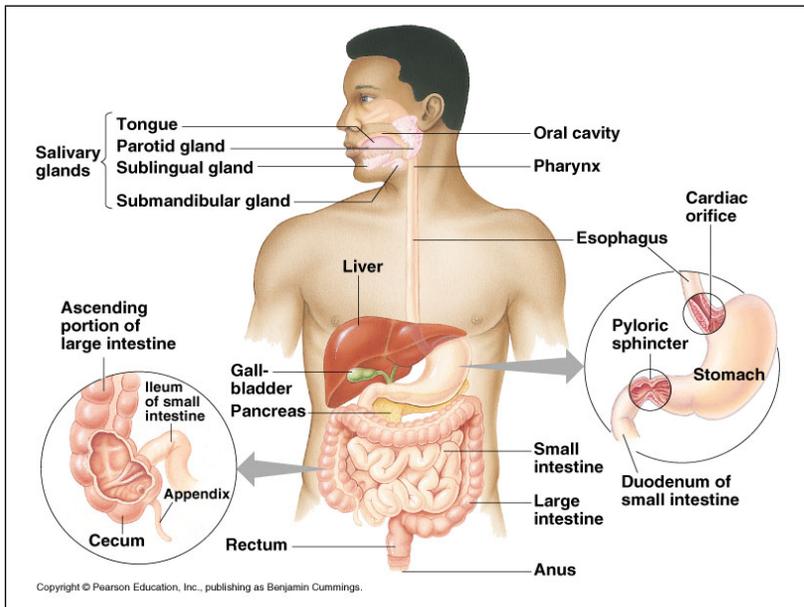
Mammalian Digestive Tract

alimentary canal, gastrointestinal (GI) tract, gut (+ mouth)

oral cavity
pharynx
esophagus
stomach
small intestine
 duodenum
 jejunum
 ileum
cecum/appendix
large intestine
rectum
anus

associated glands:
salivary glands
pancreas
liver
gall bladder

7



8

Peristalsis & Sphincters

Alimentary canal is a muscular tube

Food transported as bolus by wave-like muscular contractions (**peristalsis**)

Transport is regulated and one way due to muscular constrictions (**sphincters**)

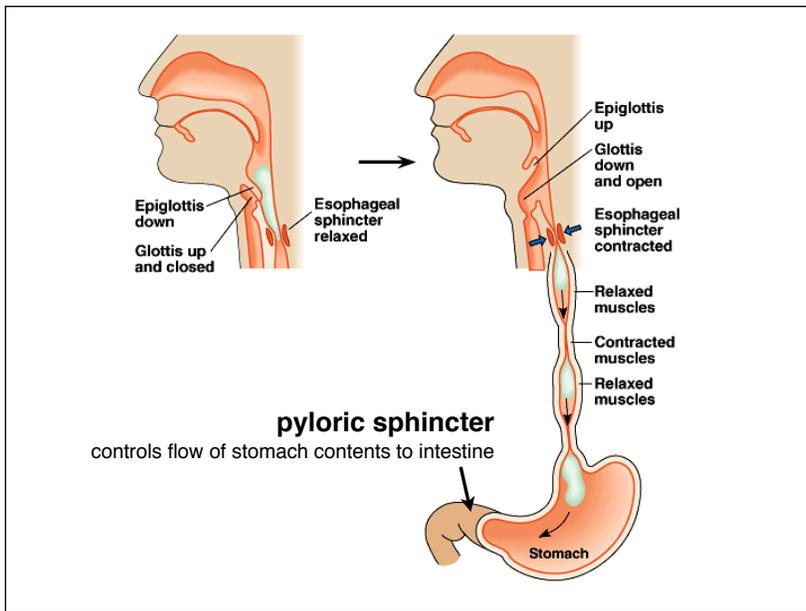
e.g. pyloric sphincter between stomach and intestine

Peristalsis Video Links

<http://www.youtube.com/watch?v=o18UycWRsaA>

<http://www.youtube.com/watch?v=ZNdkOT0C7rE>

9



10

Functional Parts of Digestive System

- Detection**
- Acquisition**
- Storage**
- Grinding**
- Chemical & Enzymatic Digestion**
- Absorption from Lumen**
- Transport to Liver**

11

Detection of food:
taste, odor receptors on feet, skin, tongue, nose

Acquisition:
mouth parts, beak, teeth, lips

Storage:
expandable stomach, pyloric sphincter to regulate flow to intestine

Grinding:
muscular jaws with teeth in vertebrates
gastric mill in crustaceans, crop & gizzard in birds
muscular stomach for churning

12

Behavioral Responses to Taste are innate:



13

sucrose citric acid quinine



Newborns receiving tastants within minutes of birth:
sucrose elicits mouth smacking, swallowing, smiles
quinine elicits spitting, grimaces, crying

14

Detection of food:

taste, odor receptors on feet, skin, tongue, nose

Acquisition:

mouth parts, beak, teeth, lips

Storage:

expandable stomach, pyloric sphincter to regulate flow to intestine

Grinding:

muscular jaws with teeth in vertebrates
gastric mill in crustaceans, crop & gizzard in birds
muscular stomach for churning

15

Chemical & enzymatic digestion:

Chemicals secreted into gut:

stomach lining -> **acid** (proteins)

(*proton transport into stomach, HCO_3^- into blood*)

liver, gall bladder -> **bile** in duodenum

(*detergent that emulsifies fats*)

Enzymes secreted from **lining** of alimentary canal:

stomach -> pepsin

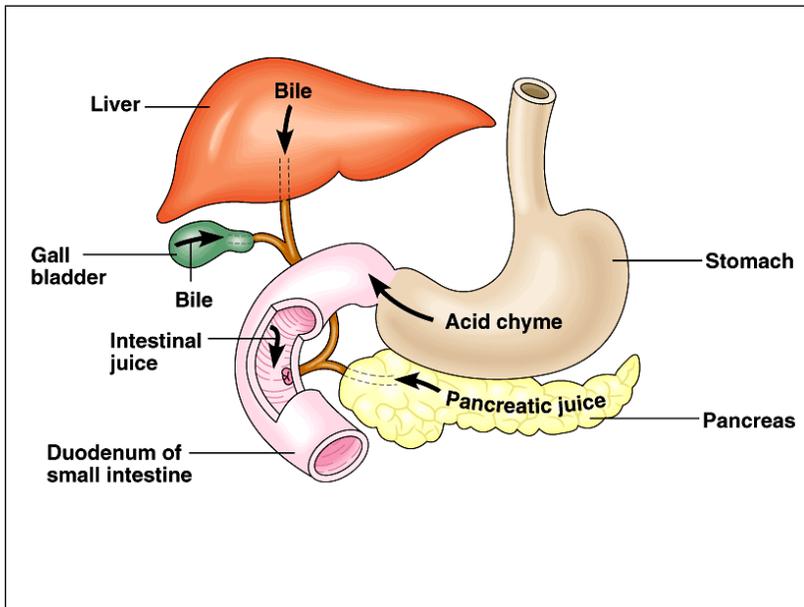
duodenum -> peptidases, saccharases

Enzymes secreted by **glands** into alimentary canal

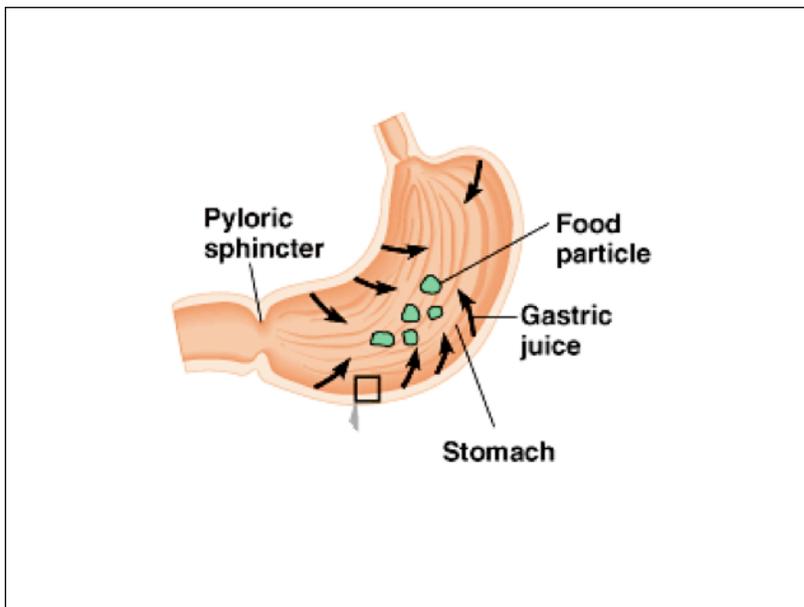
salivary glands -> mouth (polysaccharides)

pancreas -> duodenum (polysaccharides, proteins, nucleic acids)

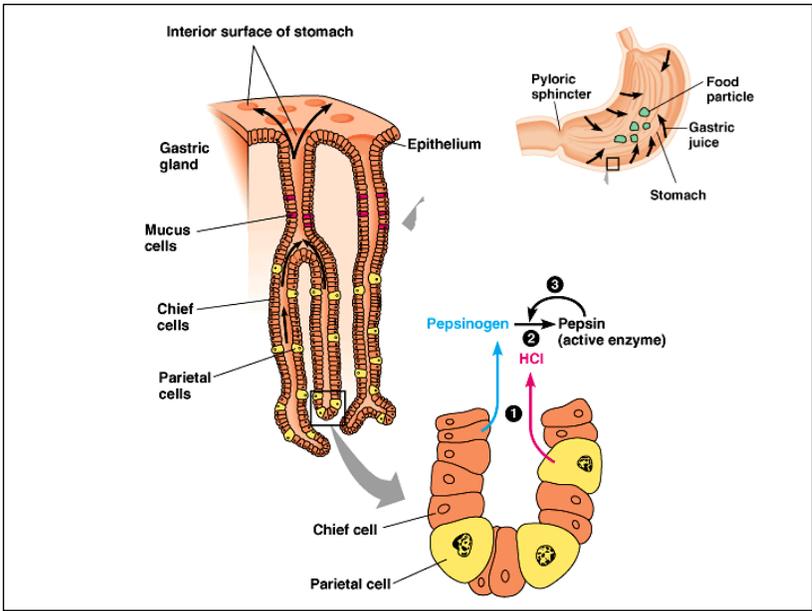
16



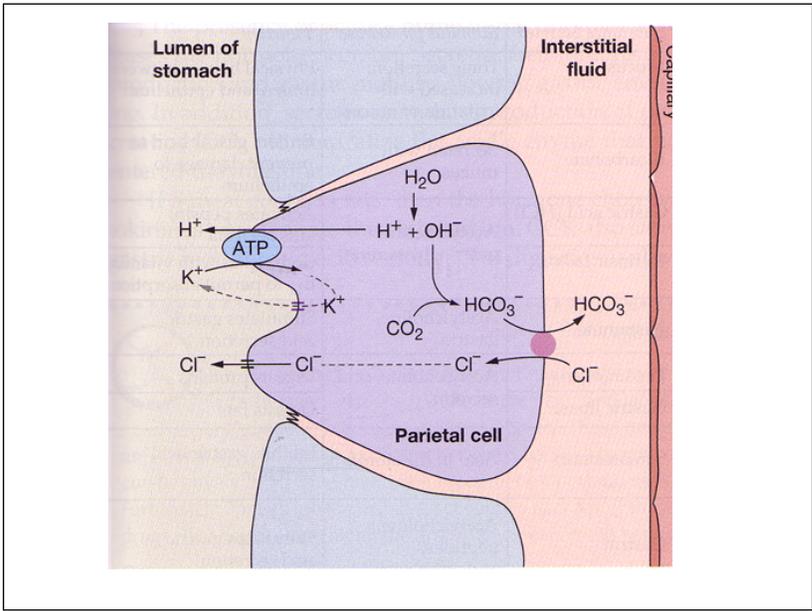
17



18



19



20

Dr. William Beaumont and Alexis St. Martin

1825 - Mackinaw Island, Michigan
 Gunshot wound -> gastric fistula
 Used by Beaumont to demonstrate gastric digestion by acid

The image includes a portrait of William Beaumont and a diagram of the stomach showing the location of the gastric fistula. The diagram is labeled 'Alexis St. Martin' and 'Dr. William Beaumont'.

21

Absorption from the Lumen

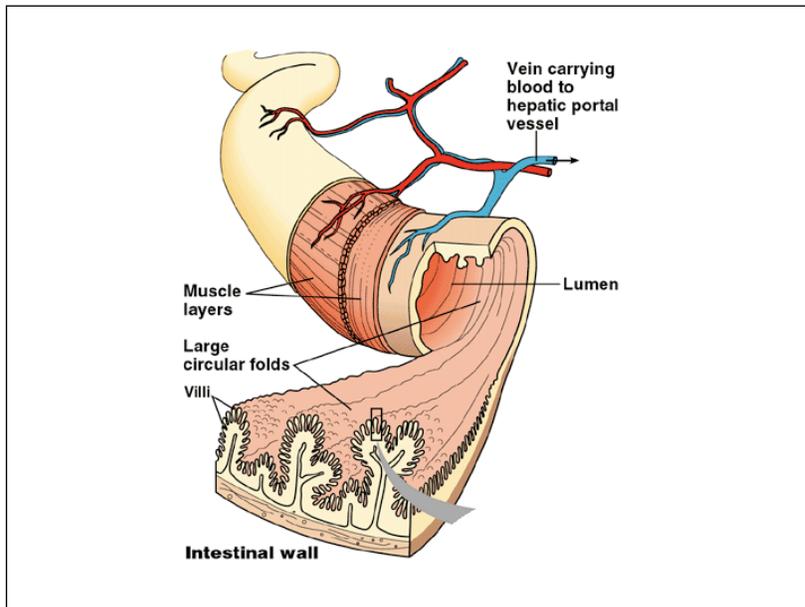
Nutrients from small intestine, water from large intestine.

Surface area is vastly increased by villi and microvilli

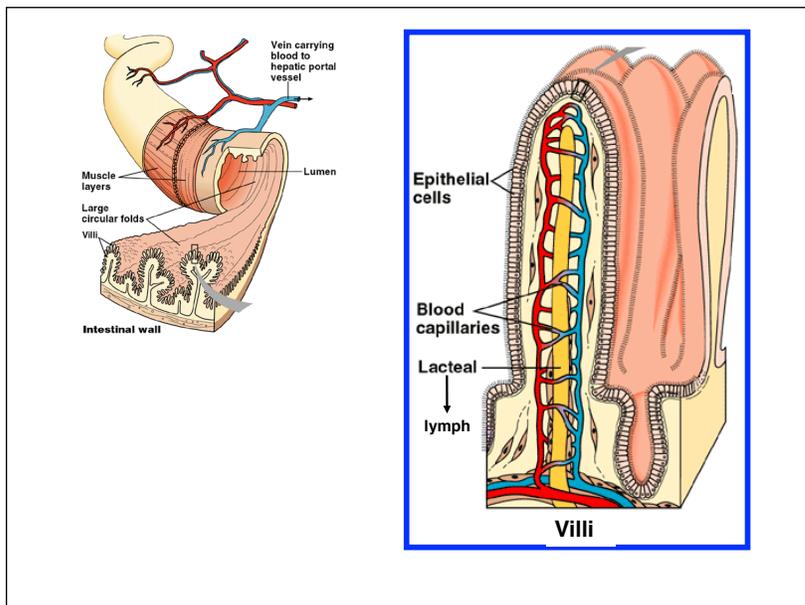
Combination of bulkflow, diffusion, and transport gets compounds from lumen into cells, blood and lymphatic vessels.

Fats -> **lymphatics** -> great veins

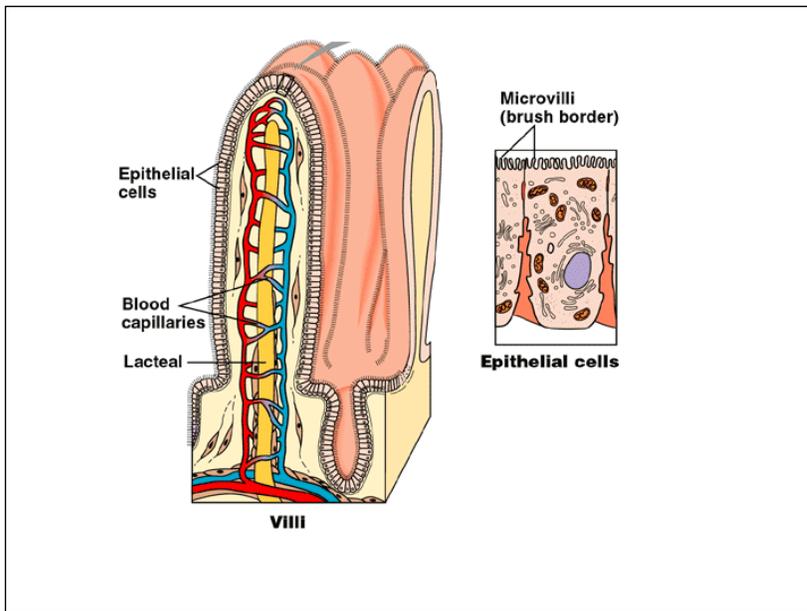
22



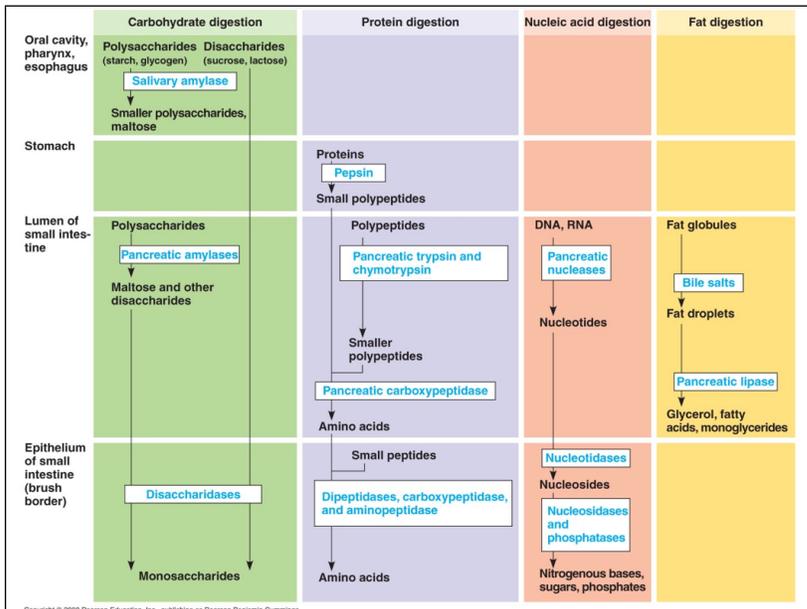
23



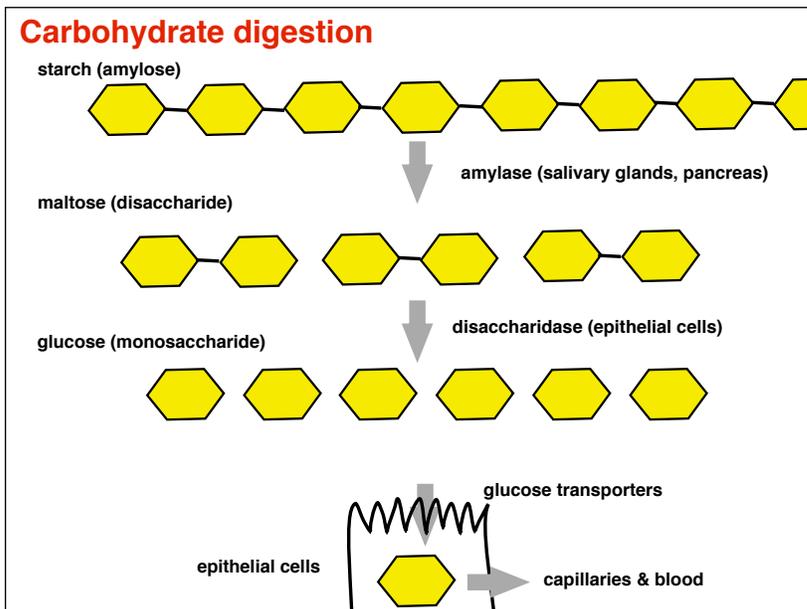
24



25

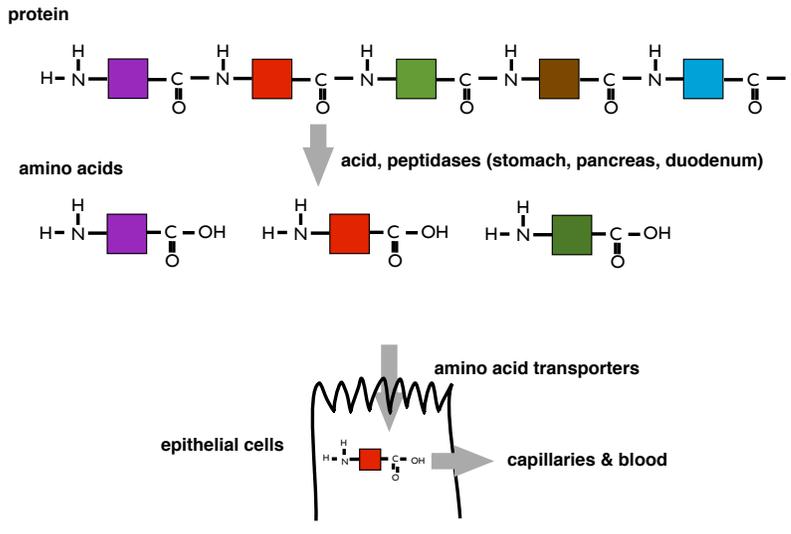


26



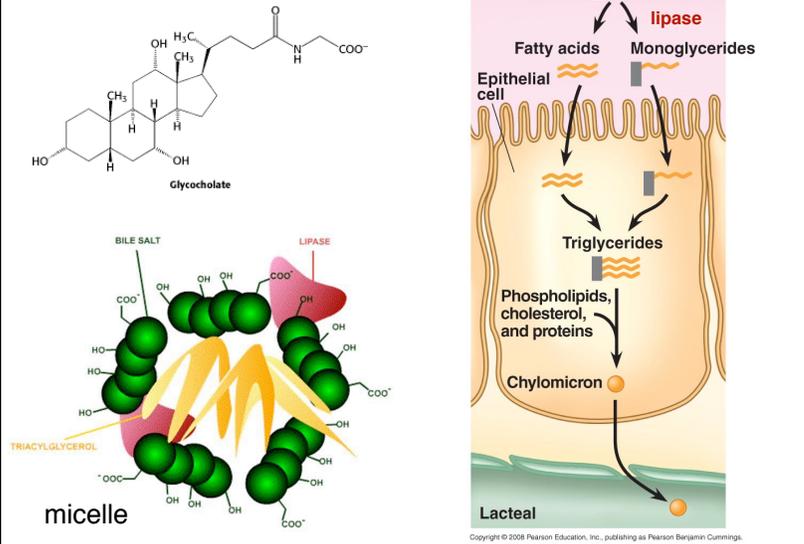
27

Protein digestion



28

Bile & Lipases



29

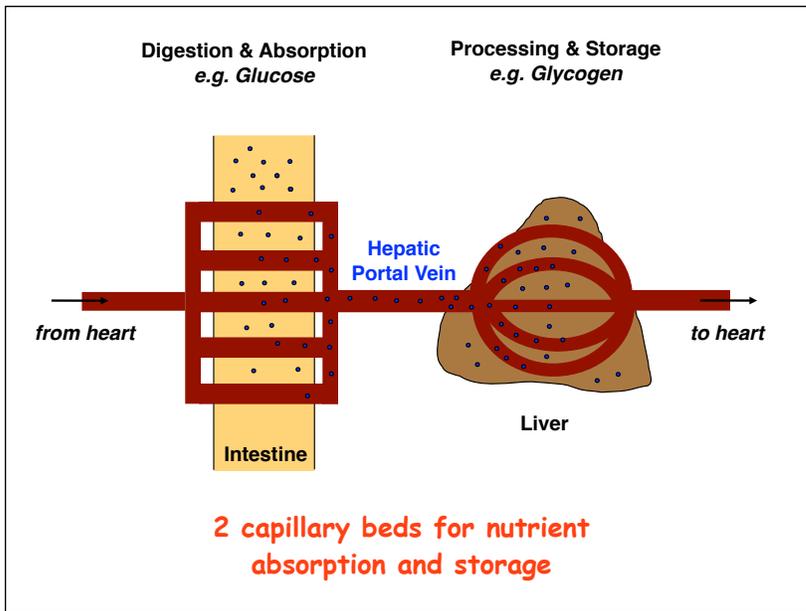
Hepatic Portal Vein:

Blood from capillaries of small intestine drain into **hepatic portal vein**

Hepatic Portal Vein carries nutrients to capillaries of liver for storage & processing

and then back to vena cava and heart.

30



31

Adaptations of Digestive System

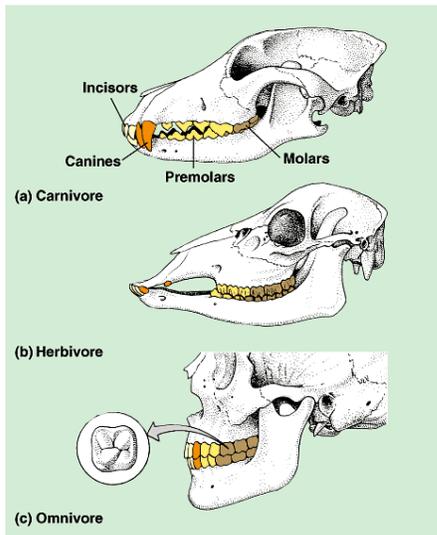
1. **Teeth and skull for acquiring different foods**
2. **Intestines for absorption needs from different foods**

32

Teeth of Carnivore

1. **Large front canines, pointed front and side teeth for tearing**
2. **No flat molars, because no plant cell walls to grind**
3. **Eyes on front of skull for hunting**

33



34

Teeth of Herbivores

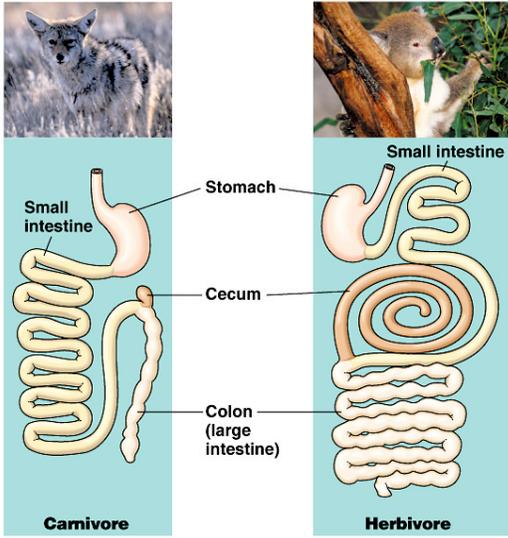
1. Long incisors for biting/tearing off long leafy food
2. Broad flat molars for grinding up tough cell walls of plants
3. Eyes on side of skull for 360° vision

35

Gastrointestinal Tract Adaptations

1. Carnivore intestines are short for easily digestible meat.
2. Herbivores have long intestine for maximum digestion, absorption
3. Many herbivores have fermentation chambers for bacteria to digest cellulose
Ruminants -> rumens (multi chamber stomach)
Others -> cecums (enlargement of "appendix")
4. Desert animals have enlarged large intestine for water absorption

36



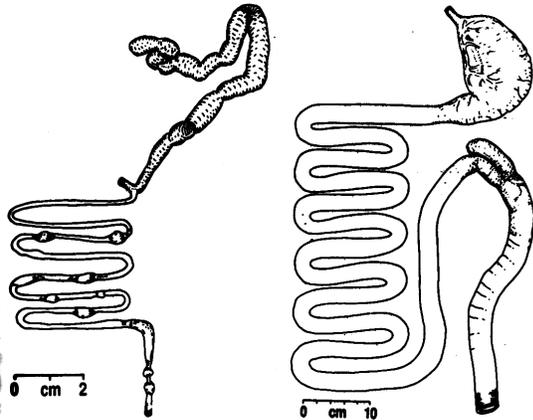
Copyright © Pearson Education, Inc., publishing as Benjamin Cummings.

37

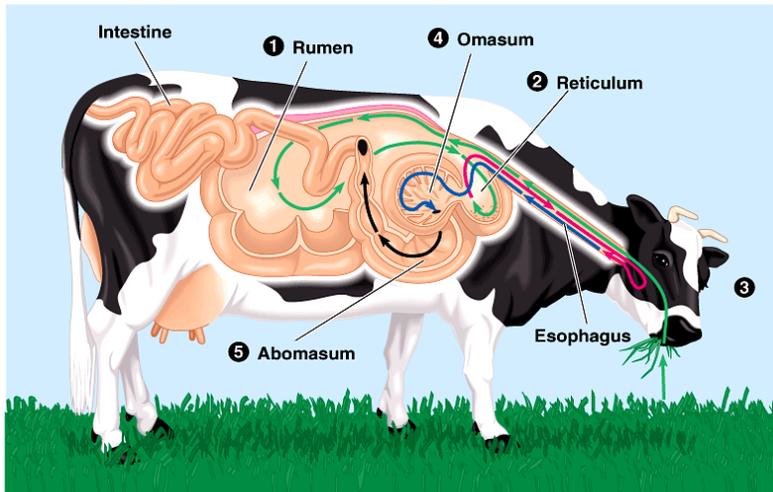
Short GI tract of Carnivores

Vampire Bat (*Desmodus rufus*)
Body Length: 7.5 cm

Dog (*Canis familiaris*)
Body Length: 90 cm



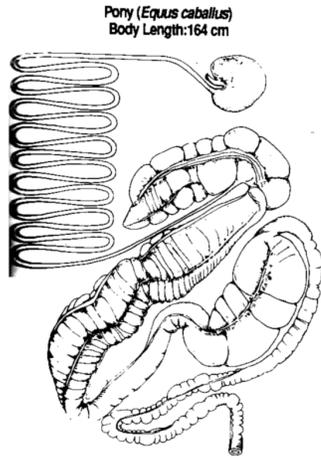
38



Copyright © Pearson Education, Inc., publishing as Benjamin Cummings.

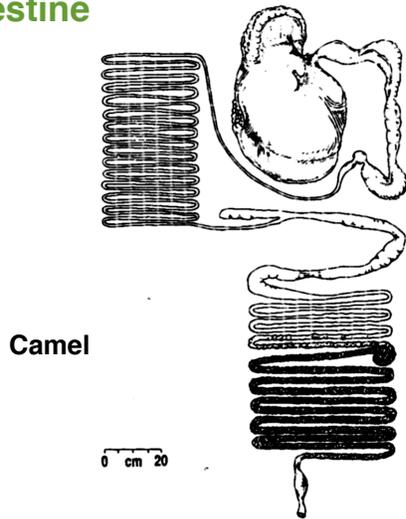
39

Horse:
Non-ruminant Herbivore with big Cecum



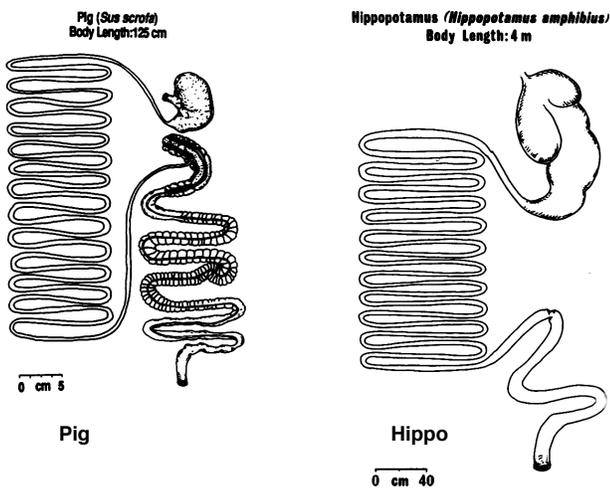
40

Desert Herbivore: big stomach, long large intestine



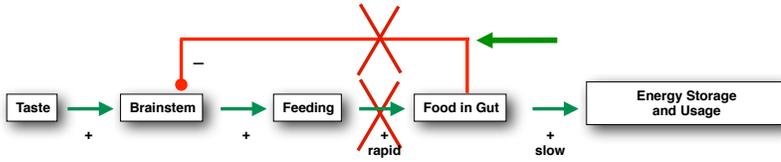
41

Hippo: opposite of desert animal, so almost no large intestine



42

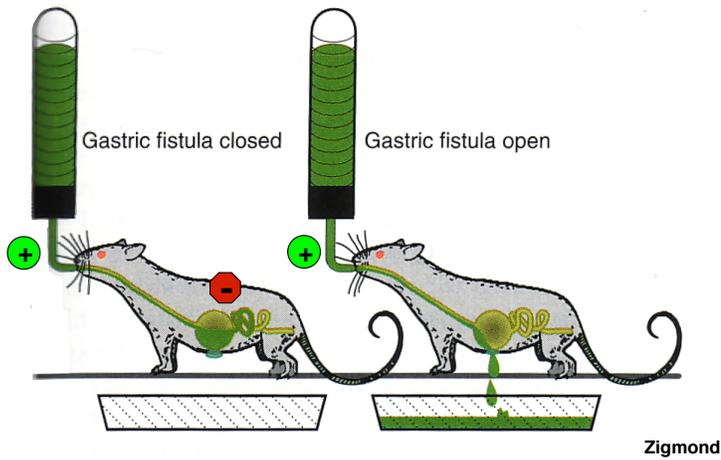
Short-term controls of Food Intake



Meal Size is mediated by:
 taste
 postingestive effect of food
 GI signals
 brainstem

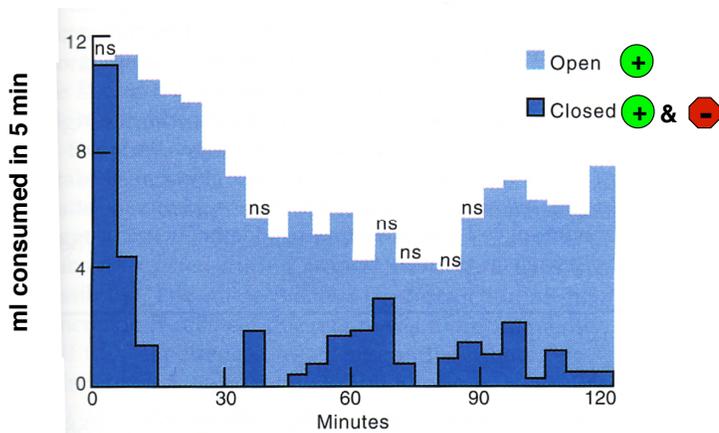
43

Sham-Feeding dissociates positive from negative controls of feeding



44

Sham-Feeding dissociates positive from negative controls of feeding



45