

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.

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Design of Digestive Systems

Intracellular:

paramecium with phagocytosis

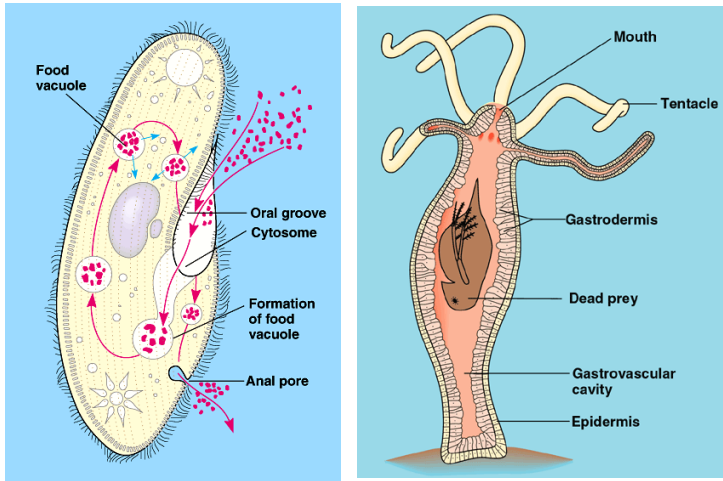
Extracellular in bag:

hydra with tentacles, mouth, and gastrovascular cavity

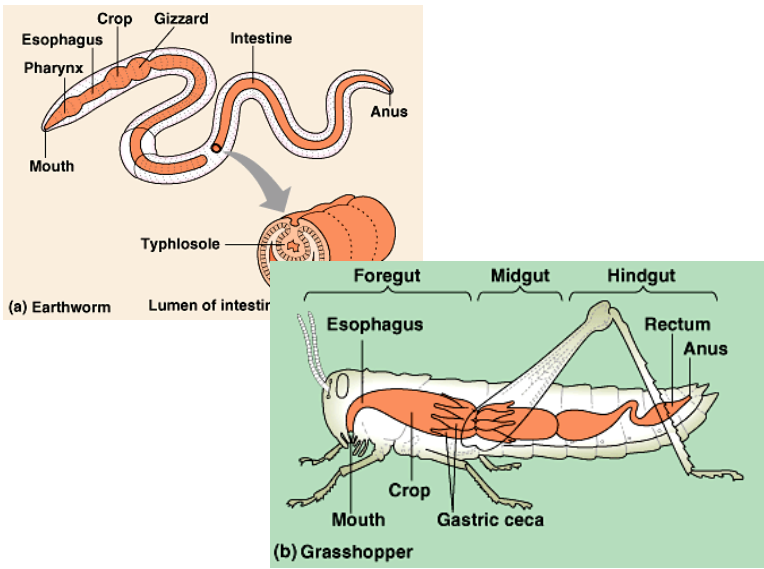
Extracellular in tube (alimentary canal):

earthworm, insect, bird, mammal

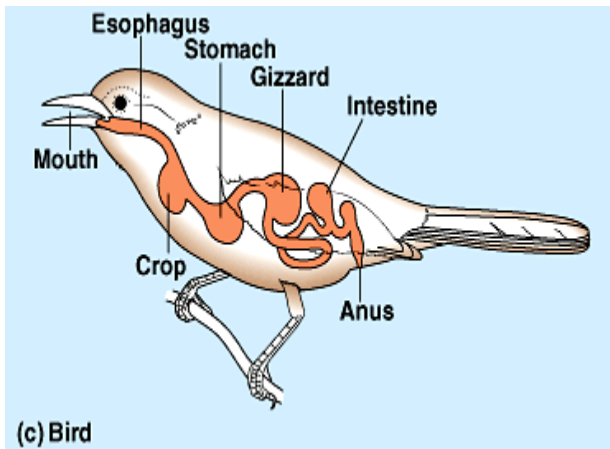
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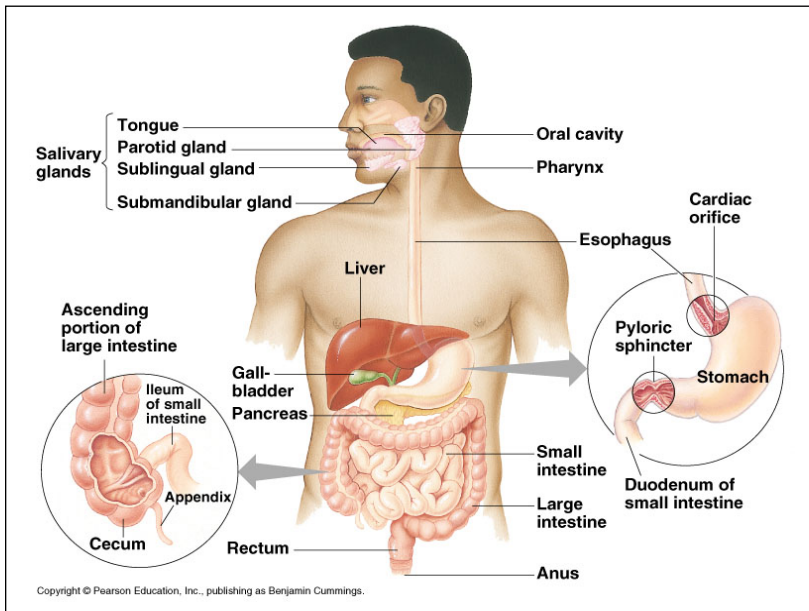
Mammalian Digestive Tract

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

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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**)

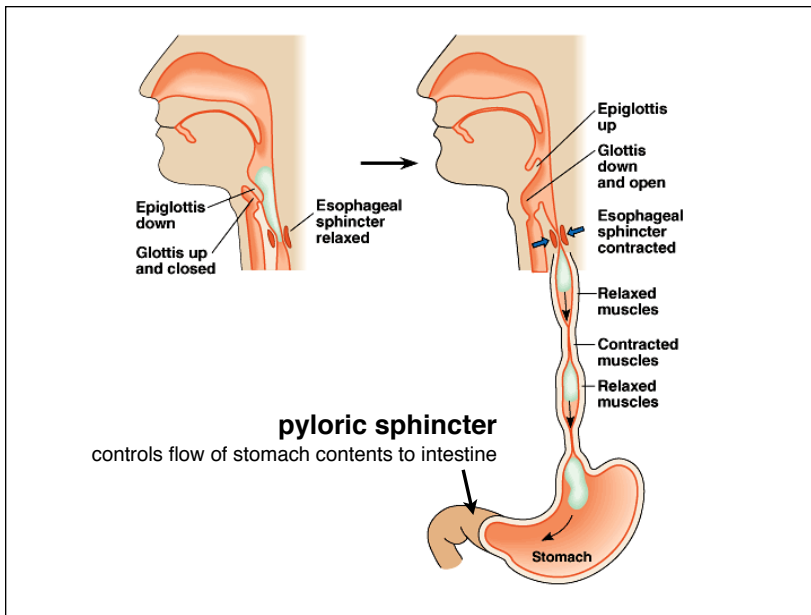
e.g. pyloric sphincter between stomach and intestine

Peristalsis Video Links

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

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

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Functional Parts of Digestive System

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

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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

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Behavioral Responses to Taste are innate:



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sucrose citric acid quinine



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

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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

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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

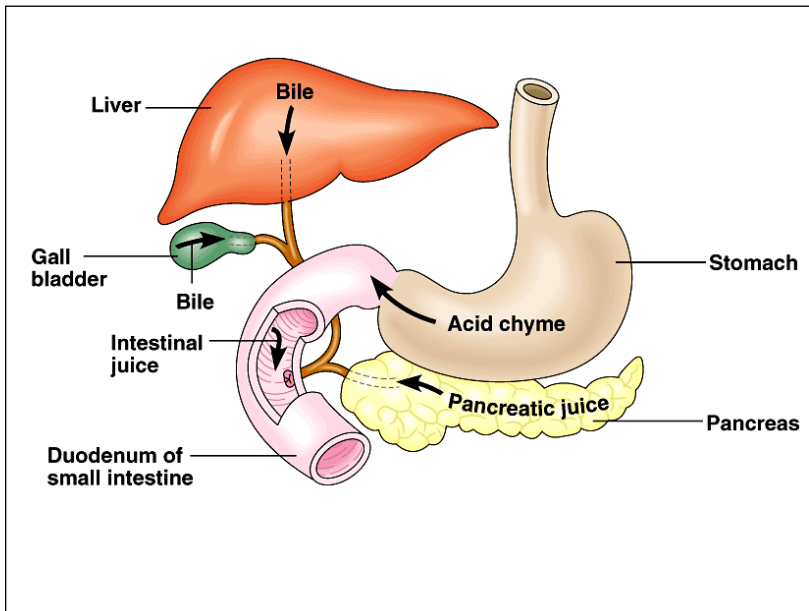
duodenum -> peptidases, saccharases

Enzymes secreted by **glands** into alimentary canal

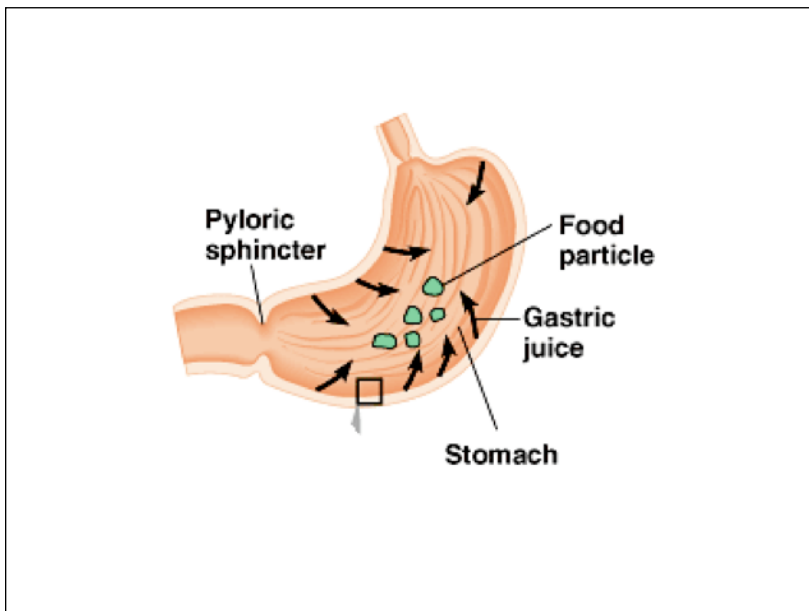
salivary glands -> mouth (polysaccharides)

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

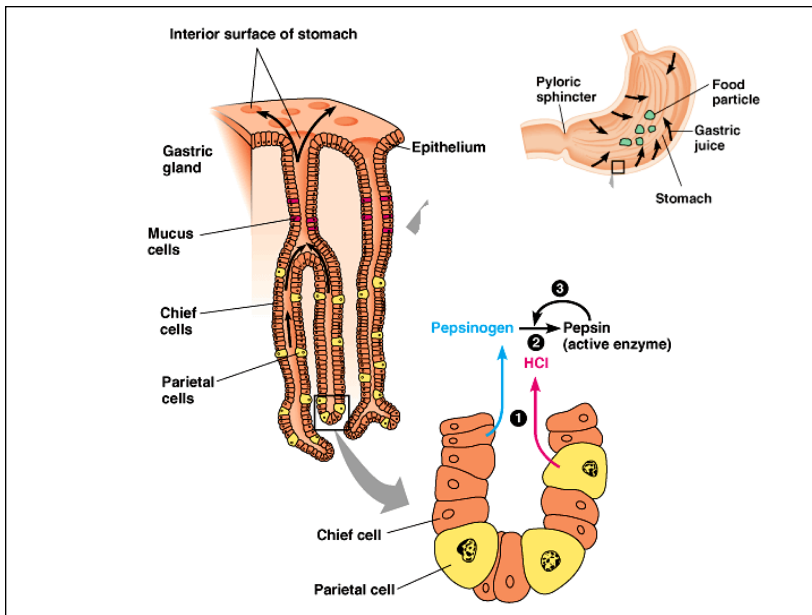
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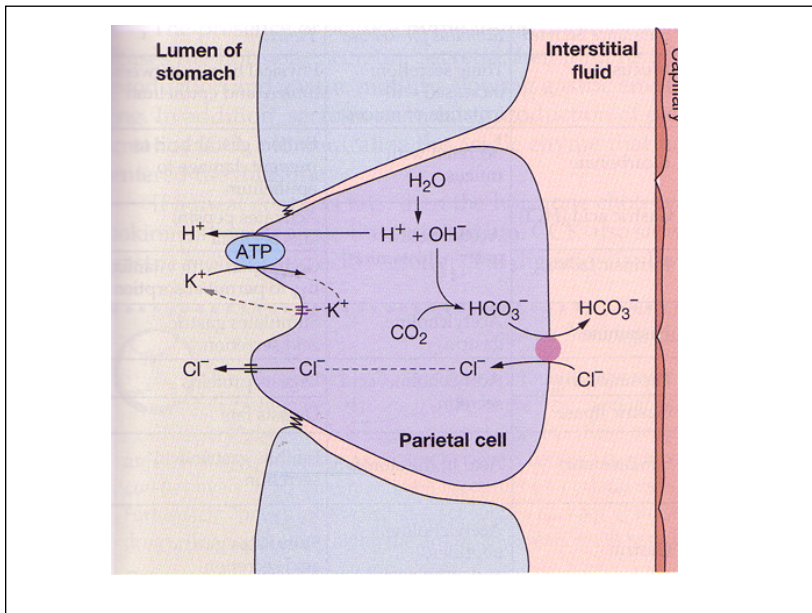
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Dr. William Beaumont and Alexis St. Martin

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

The complex block contains a portrait of William Beaumont, a diagram of the stomach showing the location of the gastric fistula, and a small text box with the following information:

ALBION, O.
 Dr. William
 "The
 Mackinaw
 shot of
 Beaumont
 and
 St. Martin
 in 1825
 is
 the
 first
 case
 of
 a
 gastric
 fistula."

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Absorption from the Lumen

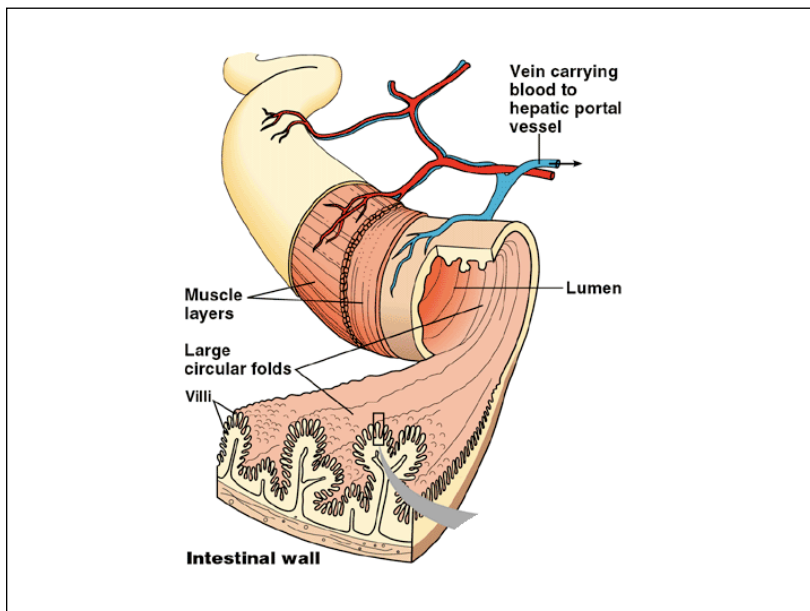
Nutrients from small intestine, **water** from large intestine.

Surface area is vastly increased by villi and microvilli

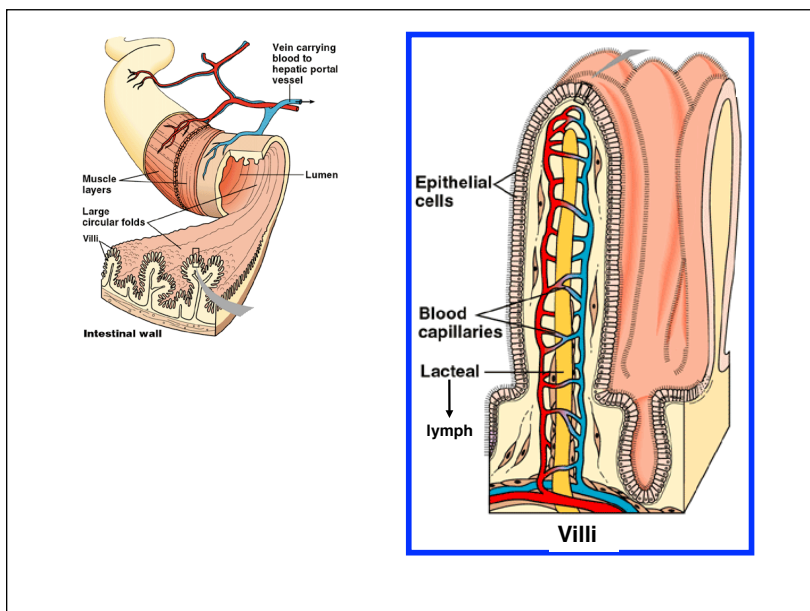
Combination of bulkflow, diffusion, and transport gets compounds from lumen into cells, **blood** and **lymphatic** vessels.

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

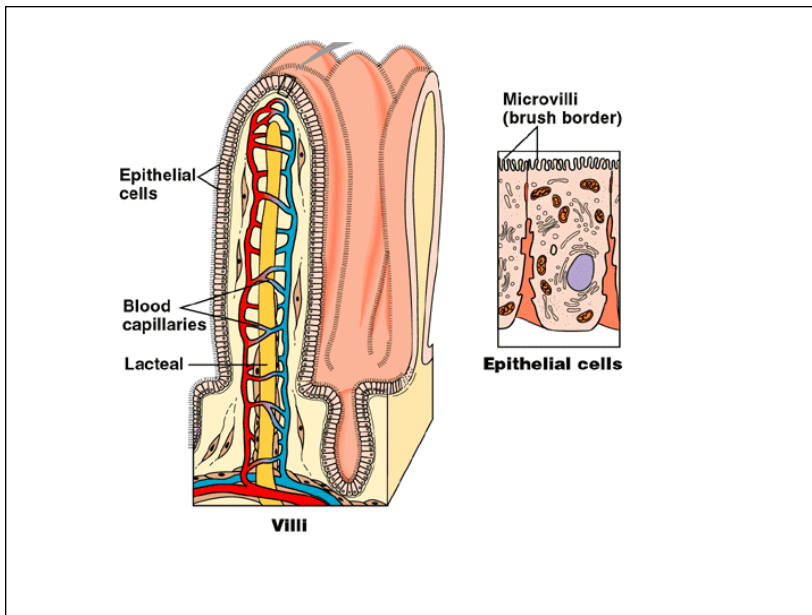
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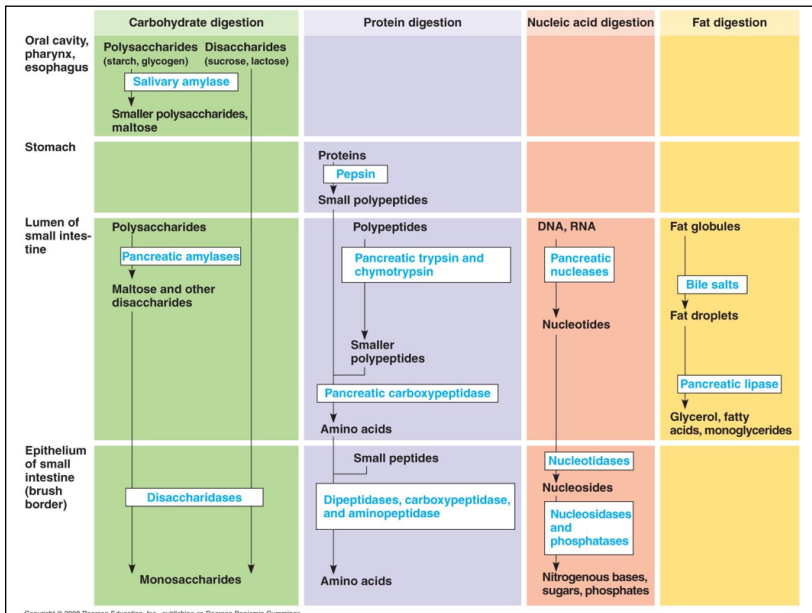
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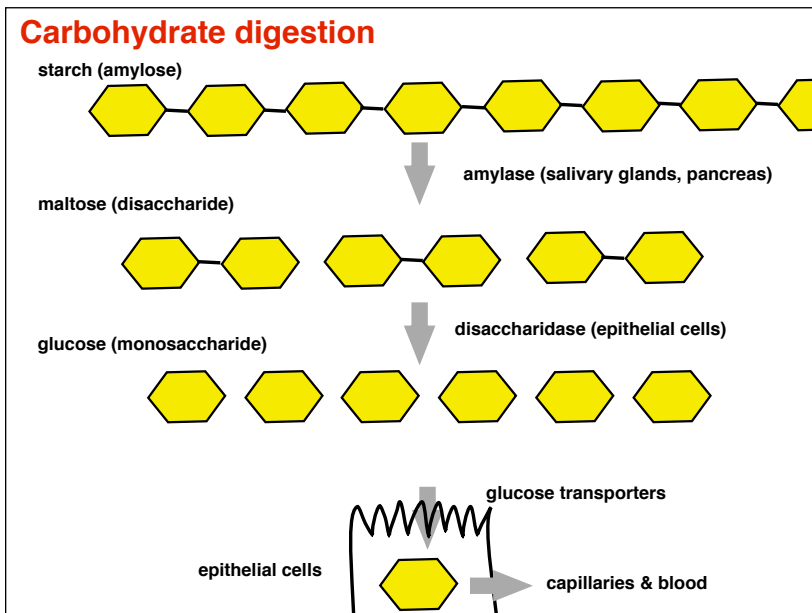
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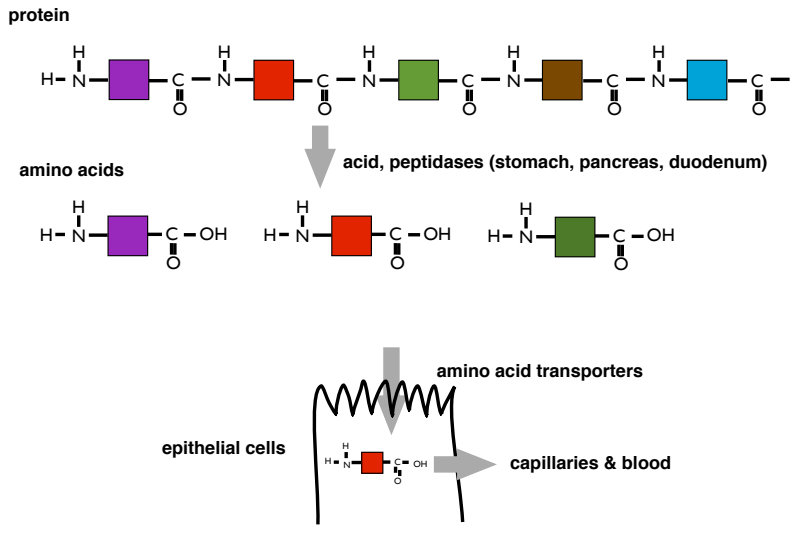


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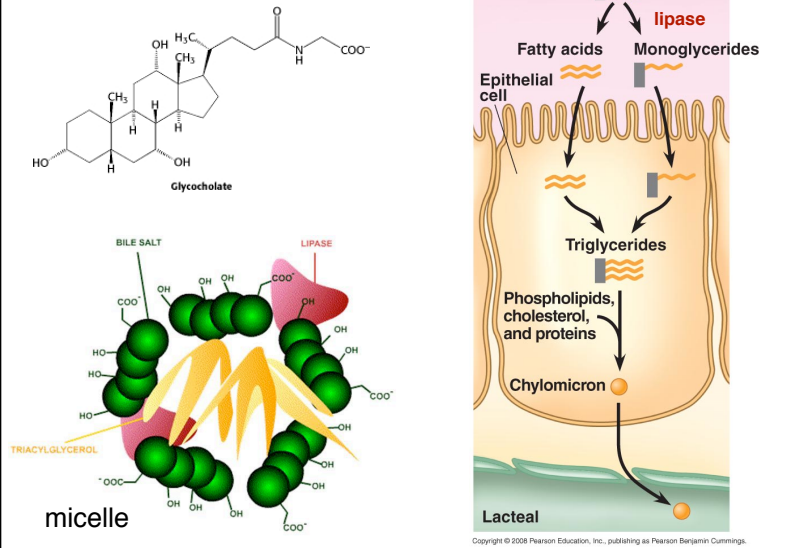
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Protein digestion



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Bile & Lipases



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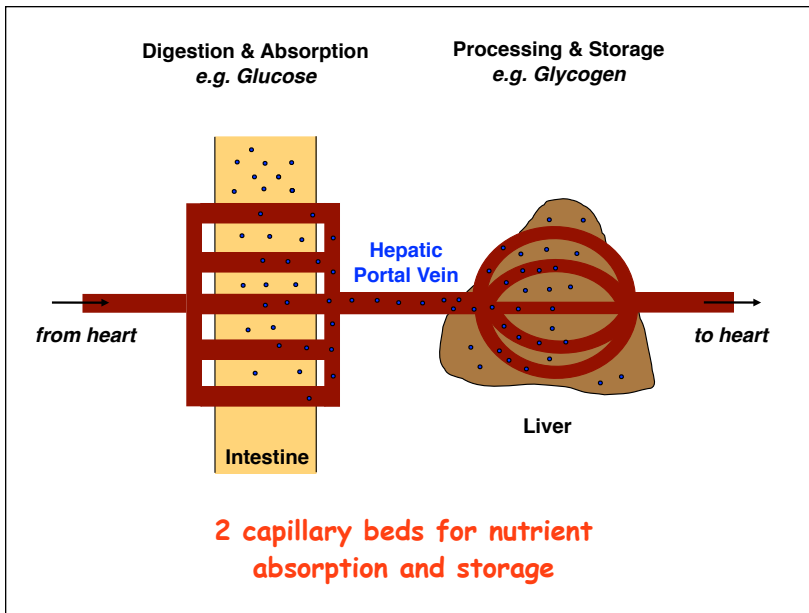
Hepatic Portal Vein:

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.

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Adaptations of Digestive System

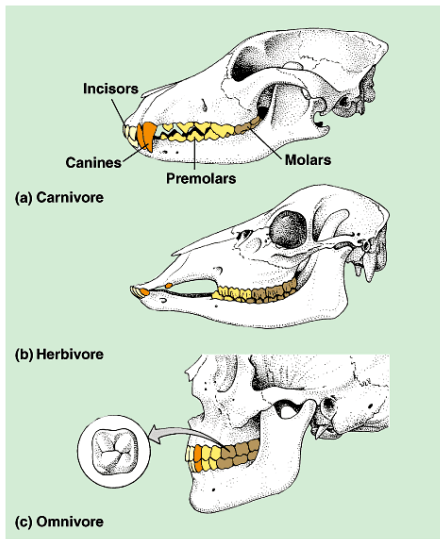
1. **Teeth and skull for acquiring different foods**
2. **Intestines for absorption needs from different foods**

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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**

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Teeth of Herbivores

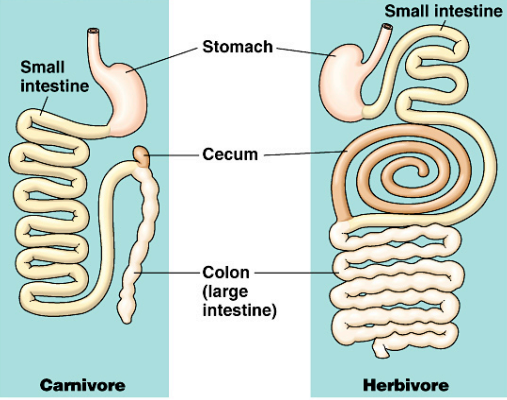
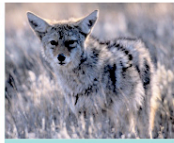
1. Long incisors for biting/tearing off long leafy food
2. Broad flat molars for grinding up tough cell walls of plants
3. Eyes on side of skull for 360° vision

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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

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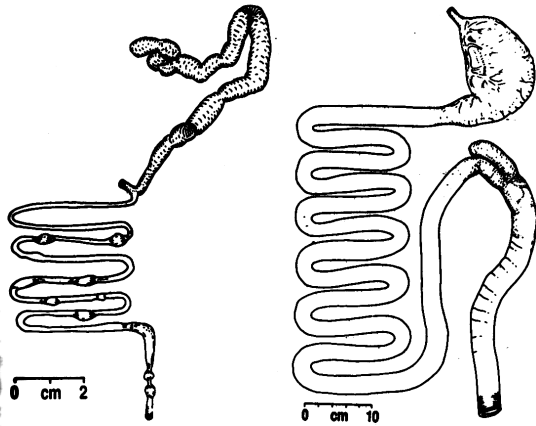
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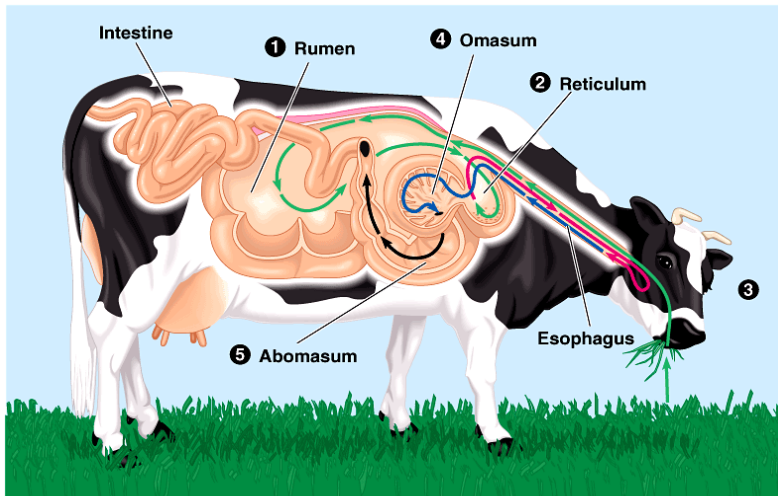
Short GI tract of Carnivores

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

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



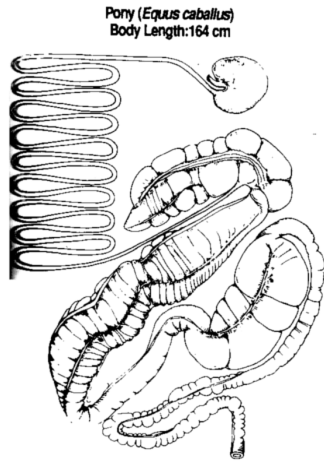
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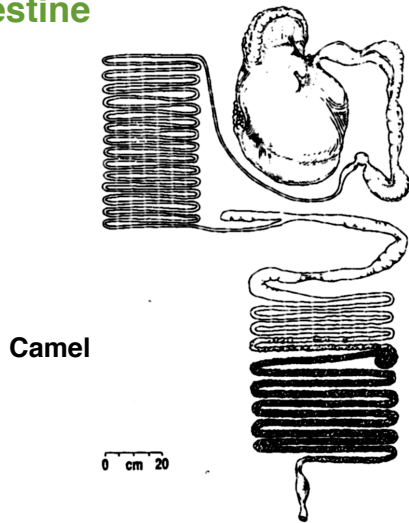
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Horse:
Non-ruminant Herbivore with big Cecum



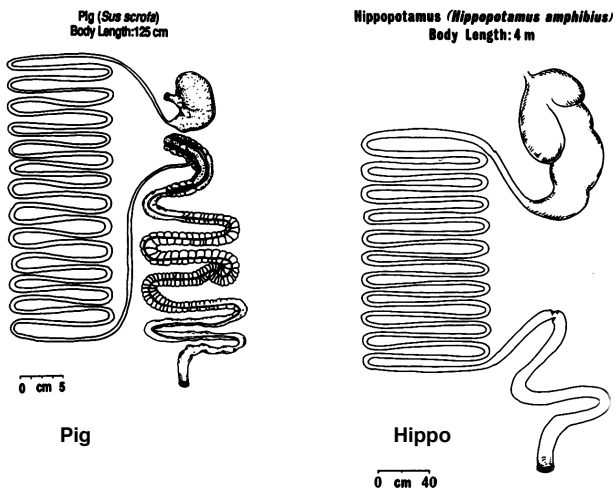
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Desert Herbivore: big stomach, long large intestine



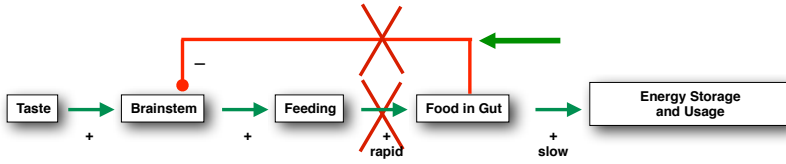
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Hippo: opposite of desert animal, so almost no large intestine



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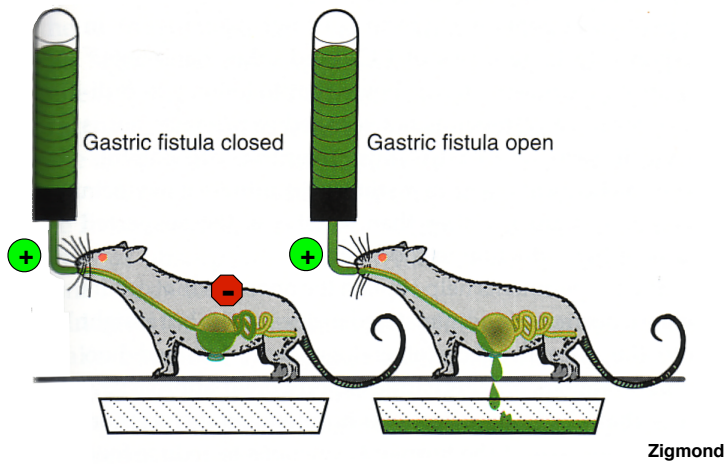
Short-term controls of Food Intake



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

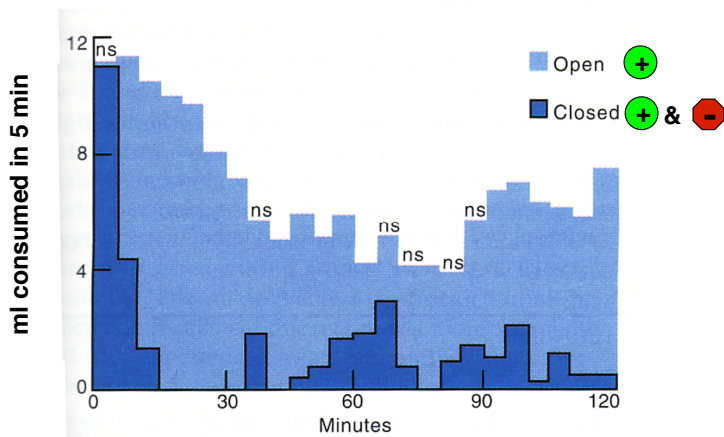
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Sham-Feeding dissociates positive from negative controls of feeding



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Sham-Feeding dissociates positive from negative controls of feeding



Zigmond

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