Alimentary canal basics

- Motility - propulsion and mixing
- Secretion of digestive enzymes, bile, mucus, water
- Chemical digestion
- Absorption

Constraints on endothermy

Digestive tract

Mucosa
- endocrine, exocrine fxns

Submucosa
- vessels, lymph

Muscles

Serosa

Esophagus

- Distinct in tetrapods
- Controlled mainly by involuntary muscle movements (peristalsis)
- Keratinization occurs in birds, herbivorous mammals
Esophagus modifications

- Some birds have a crop
  - Food storage (often seeds), “crop-milk”
  - Fermentation in hoatzin

Weak flight muscles

Stomach modifications

Bony fish

- Pyloric ceca – absorb nutrients, salt balance – some fish have many (100s)
- Inflatable diverticulum

Stomach

- Evolved with interval feeding (opposed to filter feeding)
- Gastric glands – HCl, pepsinogen
  - Chitinase – in some vertebrates
- Pyloric region, body region
  - Pyloric helps neutralize acid

Stomach modifications

Gizzard – birds, crocodiles, some fish

Birds also have proventriculus or “true” stomach

Alligator gizzard
Being herbivorous
Ingestion rate: carnivores vs. herbivores
Digesting cellulose
What animals can be herbivorous?

Herbivorous mammals
- Two styles of digesting plant fibers:
  - Foregut fermentors (ruminants) - Artiodactyla order
  - Hindgut fermenters – horses, elephants, rodents, rabbits, beaver, others
- Both strategies utilize anaerobic bacteria

Ruminant stomach

Abomasum - "True" stomach
**Ruminant stomach**
- Cellulose is broken down into small organic acids and absorbed
- Bacteria make vitamins, and use nitrogen to make proteins that the ruminant digests
- Transit time in a cow is 80 hours

**Small intestine**
Three regions in mammals:
- Duodenum - exocrine secretions, neutralization of pH
- Jejunenum – site of chemical digestion, absorption
- Ileum – finishes absorption
Villi

Stem cells constantly replace mucosa lining

Intestine specializations

- Spiral valve in Chondrichthyes, early bony fish – mucosa fold
- Lengthened w/ herbivory and endothermy

Large intestine

- Evolved in tetrapods - water resorbed
- Colon and rectum regions
- Ileocecal valve
  - Pushes valve open
  - Relaxes sphincter
  - Valve prevents contamination of the small intestine by bacteria

Large intestine specializations

- Herbivores – (non-ruminants) have an intestinal caecum, usually near beginning of colon. “Hindgut fermenters”
Comparing hindgut and foregut fermenters

- Digestion time
- Quality, quantity of food required
- Metabolic rate and size constraints

Coprophagy

- Hindgut fermenters will lose some nutrients to bacteria in their cecum
- Rabbits, guinea pigs are coprophagous (small hindgut fermenters)