Notes

Emma's lower heart rate Question: Why do fit athletes have lower heart rates?

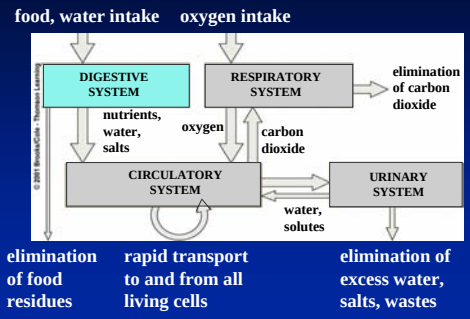
- Conditioned athletes build a stronger, more efficient heart with greater capacity. To maintain the required oxygen supply the heart does not need to pump as often to distribute the same amount of oxygen as a normal heart.

Liz's question about cholesterol and Sam's comment about avocados:

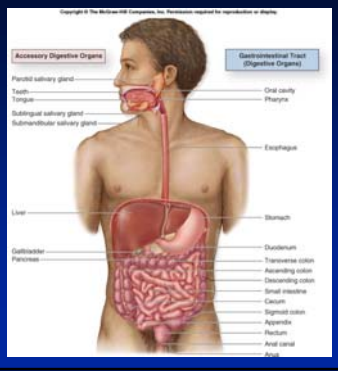
- Cholesterol in the diet comes exclusively from animal sources, particularly meats and dairy products. Eggs are probably the best-known source, containing a whopping 213 milligrams of cholesterol per yolk (more than two-thirds of the recommended daily allowance of cholesterol). In contrast, foods of plant origin contain no cholesterol, including avocados. In fact, there are several studies that have shown a steady diet of avocados actually reduces LDL cholesterol.

Functional Connections

Figure 37.2 from page 613 of your text



Digestion and Human Nutrition

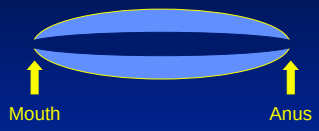


Types of Guts

Sac-like Gut

Single opening for ingesting food and excreting wastes.

Tube-like Gut



Complete gut with mouth and anus. Food travels one-way through the organism.

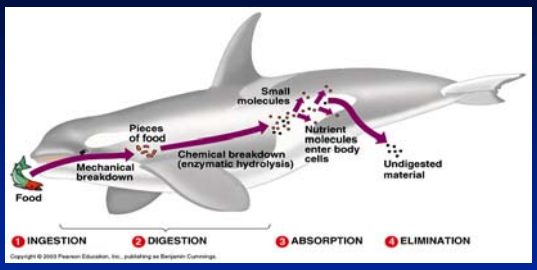
Two Types of Systems

1. Incomplete digestive system
   - One-way, saclike digestive cavity

2. Complete digestive system
   - A tube with an opening at each end

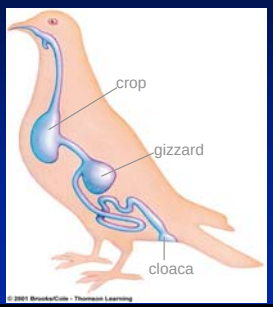
5 Tasks for a Digestive System

1. Mechanical processing and motility – break-up, mixing, and propelling food
2. Secretion – release of digestive enzymes
3. Digestion – breakdown of food into particles small enough (soluble) for absorption
4. Absorption – passage of digested nutrients and fluid across tube wall and into body fluids
5. Elimination – expulsion of undigested, unabsorbed residues from the end of gut



Digestive Specialization

1. Digestive system is often subdivided into functional regions
2. Specialization reflects feeding behavior



Digestive Tract Structures and Functions

1. Teeth (or gizzard) – physical breakdown.
2. Crop – storage
3. Stomach – chemical breakdown
4. Intestine – absorption and breakdown in small intestine; water absorption in large intestine.
5. Cecum/Rumen – fermentation
6. Rectum – water removal, storage
7. Various glands/organs for enzymes and secretions which aid digestion.

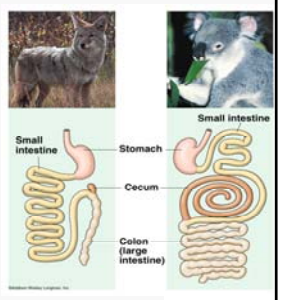
Digestive System Adaptations

Adaptations of vertebrate digestive systems reflect diet

Herbivores and omnivores
- longer alimentary canal compared to body size.
- more time to digest vegetation
- more surface area for uptake of nutrients

ceca - very long
- cellulose-digesting microbes

Carnivores
- short alimentary canal
- high [nutrient] in meat



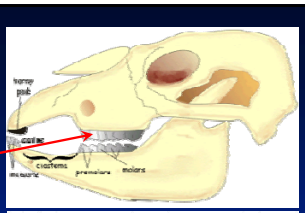
Herbivores, Omnivores, Carnivores

1. Carnivores have a high protein diet and eat meat. Herbivores eat plants. Omnivores eat both. Herbivores and omnivores have longer guts than carnivores. Vegetation has more time to be digested and there is a greater surface area for absorption. Herbivores have cellulose digesting organisms in their guts.
2. Teeth – Herbivores have large, flat teeth with lots of surface area for grinding plant tissue. Carnivores have sharp canines for grasping and tearing flesh. Carnivore molars are pointed.
3. Examples: Carnivores – cheetah, fox, bat, lion; Herbivores – sheep, deer, rabbit, gopher Omnivores – man, bear, rat, opossum

Dentition and Diet

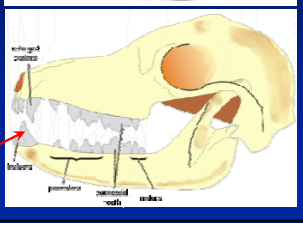
Herbivore (sheep)

flat molars



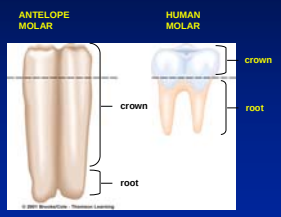
Carnivore (dog)

large canines



Specialized Teeth

1. Structure of teeth reflects feeding behavior
2. Antelope brush teeth against dirt as they eat; wear down crowns



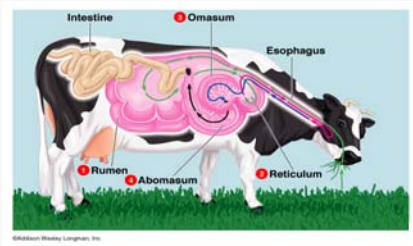
Foregut and Hindgut Fermentation

1. Ruminants (foregut fermenters) – hoofed, usually horned, herbivorous mammals with a stomach divided into 4 compartments. Examples: cattle, sheep, goats, deer, and giraffes. First two stomach compartments contain bacterial symbionts to breakdown cellulose. Food is regurgitated for additional chewing (cud). Food is swallowed a second time and moves to the third and fourth stomachs before passing to intestine.
2. Hindgut fermenters – bacterial symbionts in colon or cecum (after the stomach) breakdown cellulose. Examples: termites, elephants, horses, zebras, manatees, guinea pigs, rats, porcupines, beaver, rabbits, iguana, red howler monkey, koala, and some birds.

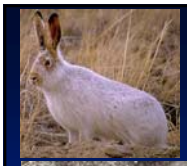
Digestive System Adaptations

Ruminant mammals have an elaborate system for cellulose digestion

- four-chambered stomach
- prokaryotes and protists in rumen and reticulum break down cellulose
- animal periodically regurgitates meal to soften the material(cud)



Coprophagy – eating feces



Two types of feces
soft & hard

Extract vitamin B

fresh cecal pellets

both types

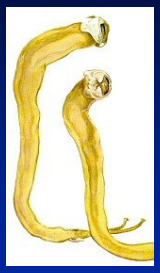
Termite Digestion of Cellulose

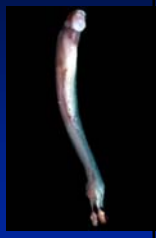
Trichonympha
unicellular protist
symbiont

termites

Silverfish digest wood with cellulase

Shipworms digest wood with cellulase





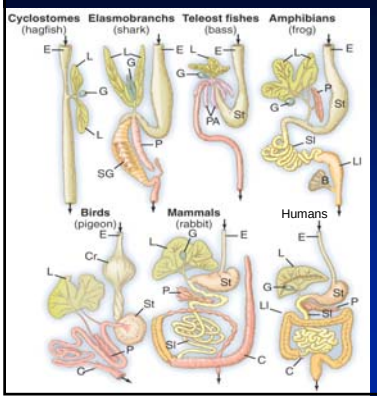
Teredo navalis shipworm (bivalve)

wood bored by shipworm

shipworm

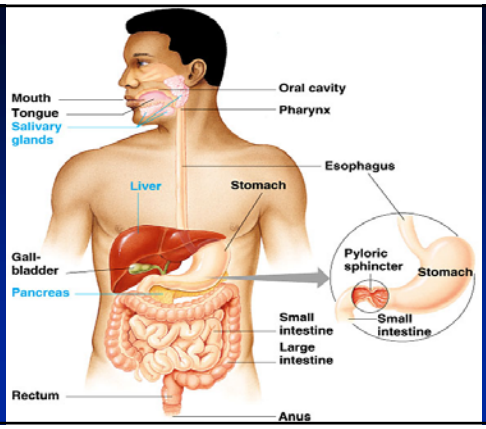
Longhorned beetles digest wood with cellulase

Vertebrate Digestive System:



Common Elements

B=Urinary Bladder
C=Cecum
Cr=Crop
E=Esophagus
G=Gall Bladder
L=Liver
LI=Large Intestine
P=Pancreas
PA=Pyloric Appendices
SG=Spiral Valve
SI=Small Intestine
St=Stomach



Human

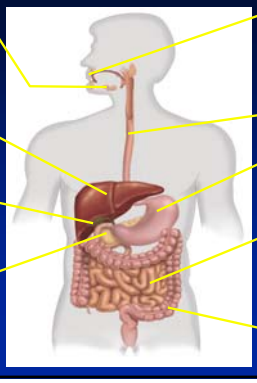
Accessory organs

Salivary glands Secretes enzymes that digest carbohydrates

Liver Secretes molecules required for digestion of fats

Gall bladder Stores secretions from liver; empties into small intestine

Pancreas Secretes enzymes and other materials into small intestine



Major components

1. Mouth Mechanical and chemical processing (chewing reduces size of food; saliva digests carbohydrates)

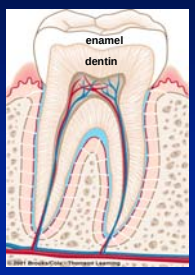
2. Esophagus Transports food

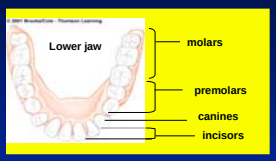
3. Stomach Mechanical and chemical processing (digestion of proteins)

4. Small intestine Chemical processing and absorption (digestion of proteins, fats, carbohydrates; absorption of nutrients and water)

5. Large intestine Water absorption and feces formation

Human Teeth





1. Normal adult number is 32

Tongue

1. Skeletal muscle
2. Functions in speech, positioning food, swallowing
3. Taste buds contain sensory receptors

Saliva

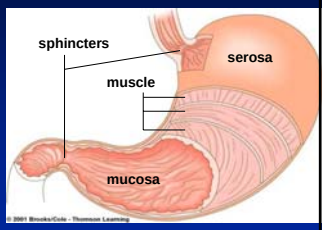
1. Produced by salivary glands at back of mouth and under tongue
2. Saliva includes
   - Salivary amylase (enzyme)
   - Bicarbonate (buffer)
   - Mucins (bind food into bolus)
   - Water

Swallowing

1. Complex reflex
2. Tongue forces food into pharynx
3. Epiglottis and vocal cords close off trachea; breathing temporarily ceases
4. Bolus moves into esophagus, then through esophageal sphincter into stomach

Structure of the Stomach

1. J-shaped organ lies below the diaphragm
2. Sphincters at both ends
3. Outer serosa covers smooth muscle layers
4. Inner layer of glandular epithelium faces lumen

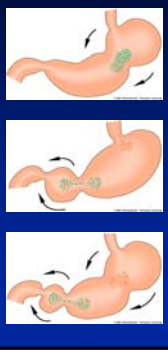


Stomach Secretions

1. Secreted into lumen (gastric fluid)
   - Hydrochloric acid (HCl)
   - Mucus (protective)
   - Pepsinogen (inactive form of a protein-digesting enzyme)
2. Stomach cells also secrete the hormone gastrin into the bloodstream

Mixing Chyme

1. A thick mixture of food and gastric fluid
2. High acidity kills many pathogens
3. Mixed and moved by waves of stomach contractions (peristalsis)



Protein Digestion in Stomach

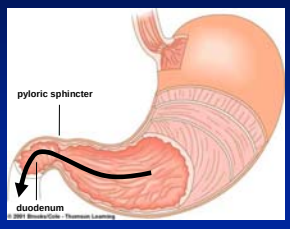
1. High acidity of gastric fluid denatures proteins and exposes peptide bonds
2. Pepsinogen secreted by stomach lining is activated to pepsin by HCl
3. Pepsin breaks proteins into fragments

Ulcer

1. An erosion of the wall of the stomach or small intestine
2. Can result from undersecretion of mucus and buffers, or oversecretion of pepsin
3. Most ulcers involve *Helicobacter pylori* bacteria and can be treated with antibiotics

Into the Small Intestine

1. Movement into duodenum controlled by pyloric sphincter
2. Duodenum receives secretions from pancreas, liver, and gallbladder; continues process of digestion



Intestinal Secretions

1. Wall of the duodenum secretes
   - Disaccharidases - digest disaccharides to monosaccharides
   - Peptidases - break protein fragments down to amino acids
   - Nucleases - digest nucleotides down to nucleic acids and monosaccharides

Pancreatic Enzymes

1. Secreted into duodenum
2. Pancreatic amylase
3. Trypsin and chymotrypsin
4. Carboxypeptidase
5. Lipase
6. Pancreatic nucleases

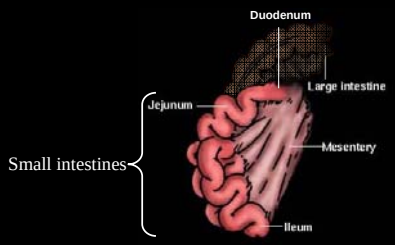
Fat Digestion

1. Liver produces bile
2. Bile is stored in gallbladder, then secreted into duodenum
3. Bile emulsifies fats; breaks them into small droplets
4. This gives enzymes a greater surface area to work on

Hormones and Digestion

1. **Gastrin**
   - Stimulation of gastric acid secretion.
2. **Cholecystokinin (CCK)**
   - the principle stimulus for delivery of pancreatic enzymes and bile into the small intestine.
3. **Secretin**
   - pH control

Small Intestines

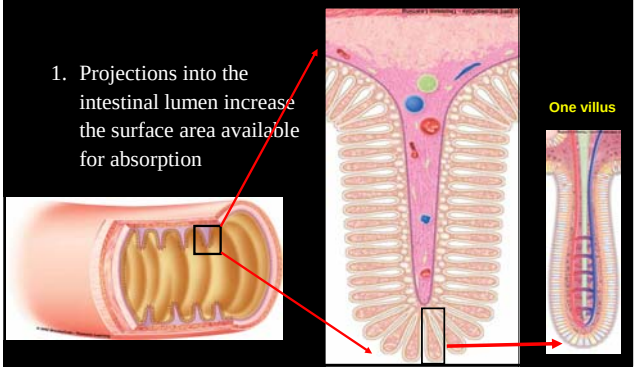


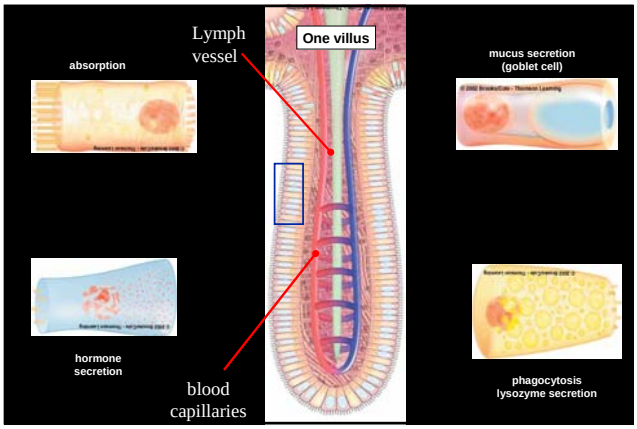
Jejunum
- absorption of carbohydrates and proteins.

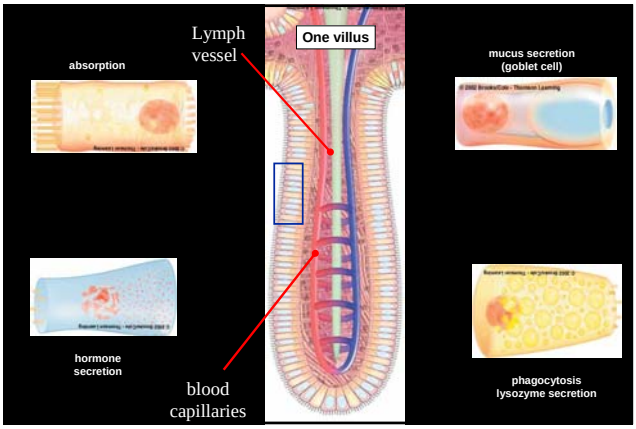
Ileum - larger channels
- absorption of fats, water, B12, bile salts.

Walls of Small Intestine - microvilli

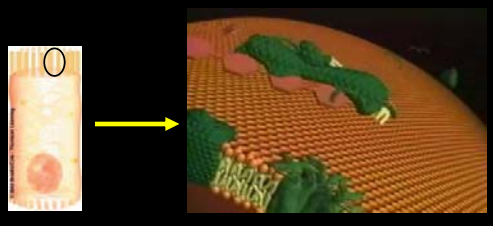
1. Projections into the intestinal lumen increase the surface area available for absorption







Animation of Absorption starting with absorption cell surface

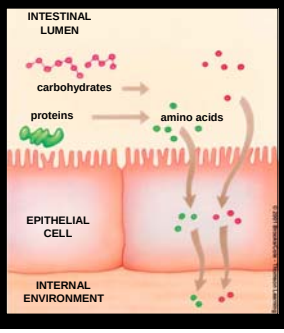


Absorption of Nutrients

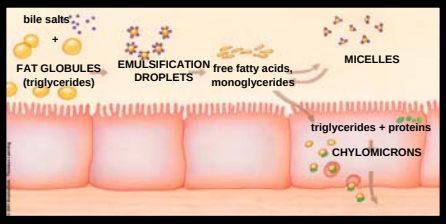
1. Passage of molecules into internal environment
2. Occurs mainly in jejunum and ileum of small intestine
3. Segmentation mixes the lumen contents against wall and enhances absorption

Absorption Mechanisms

1. Monosaccharides and amino acids are actively transported across plasma membrane of epithelial cells, then from cell into internal environment



Fat Absorption

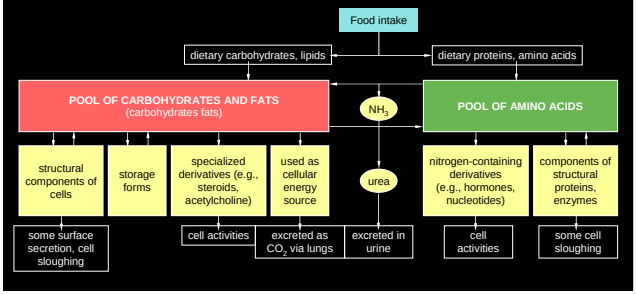


1. Bile salts and enzymed bind fat droplets – fatty acids.
2. Bile salts bind to fatty acids to form micelles, which create a gradient across cell membranes.
3. Micelles diffuse into cells. Chylomicrons leave epithelial cells by exocytosis and enter internal environment.

Into the Blood

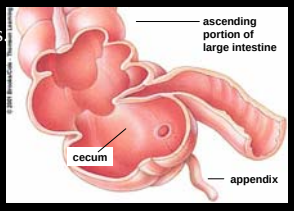
1. Glucose and amino acids enter blood vessels directly
2. Triglycerides enter lymph vessels, which eventually drain into blood vessels

Pathways of Organic Metabolism



Large Intestine (Colon)

1. Concentrates and stores feces.
2. Sodium ions are actively transported out of lumen and water follows.
3. Lining secretes mucus and bicarbonate to protect lumen lining and provide lubrication.



Bacteria in Colon

1. Slow movement of material through colon allows growth of bacteria.
2. Harmless--unless they escape into abdominal cavity.
3. Some produce vitamin K, which is absorbed through intestinal wall.

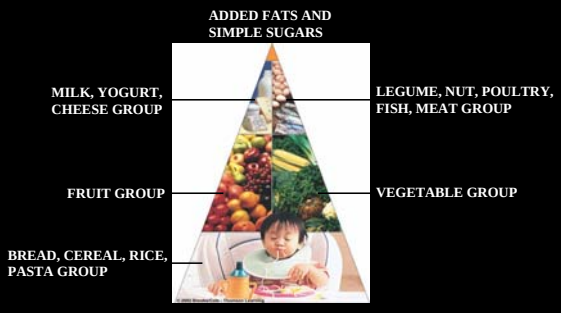
Movement through Colon

1. During a meal, gastrin and autonomic signals trigger contraction of ascending and transverse colon
2. Material moves along to make room for incoming food
3. Feces is stored in last part of colon

Colon Malfunction

1. Appendicitis
2. Constipation
3. Colon cancer
   - Symptoms include blood in feces
   - Can be caused by a genetic defect
   - Low-fiber diet is a predisposing factor

Food Pyramid



Carbohydrates

1. Body's main energy source.
2. Foods high in complex carbohydrates are usually high in fiber; promote colon health.
3. Simple sugars lack fiber, as well as minerals and vitamins of whole foods; intake should be minimized.

Lipids

1. Most fats can be synthesized from proteins and carbohydrates.
2. Essential fatty acid diets cannot; must be obtained from food.
3. Fats should be about 30 percent of diet.
4. Excess saturated fats can raise cholesterol level and contribute to heart disease.

Proteins

1. Body cannot build eight of the twenty amino acids.
2. These essential amino acids must be obtained from diet.
3. Animal proteins are complete; supply all essential amino acids.
4. Plant proteins are incomplete; must be combined.

Essential amino acids & vegetarians

The proteins found in milk, eggs, meat, fish, and cheese are the most complete sources of essential amino acids. Proteins are also found in foods from plants, but no one plant food has all of the essential amino acids in the correct amounts. To get all the essential amino acids the body needs for growth and good health, eat a variety of foods.

Sources of essential amino acids

1. ***Histidine**: Apples, pomogranates, alfalfa, beets, carrots, celery, cucumber, dandelion, endive, garlic, radish, spinach, turnip greens.
2. ***Arginine**: Alfalfa, beets, carrots, celery, cucumbers, green vegetables, leeks, lettuce, potatoes, radishes, parsnips, nutritional yeast.
3. **Valine**: Apples, almonds, pomegranates, beets, carrots, celery, dandelion greens, lettuce, okra, parsley, parsnips, squash, tomatoes, turnips, nutritional yeast.
4. **Tryptophan**: Alfalfa, brussel sprouts, carrots, celery, chives, dandelion greens, endive, fennel, snap beans, spinach, turnips, nutritional yeast.
5. **Threnoine**: Papayas, alfalfa sprouts, carrots, green leafy vegetables such as celery, collards, kale, and lettuce (especially iceberg), lima beans, laver (Nori -- a sea vegetable).
6. **Phenylalanine**: Apples, pineapples, beets, carrots, parsley, spinach, tomatoes, nutritional yeast.
7. **Methionine**: Apples, pineapples, Brazil nuts, filberts, brussels sprouts, cabbage, cauliflower, chives, dock (sorrel), garlic, horseradish, kale, watercress.
8. **Lysine**: Apples, apricots, grapes, papayas, pears, alfalfa, beets, carrots, celery, cucumber, dandelion greens, parsley, spinach, turnip greens.
9. **Leucine**: Avocados, papayas, olives, coconut, sunflower seeds.
10. **Isoleucine**: Avocados, papayas, olives, coconut, sunflower seeds.

* Essential for children

Dietary Essentials

1. Vitamins
   - Essential organic substances
2. Minerals
   - Essential inorganic substances

A balanced diet provides all of the essential vitamins and minerals.

Vitamin and mineral supplements are only required by strict vegetarians and people who are ill.

Vitamins
Essential organic substance

Fat soluble

1. Excess accumulates in tissue
2. Vitamins A, D, E, K

Fat insoluble

1. B vitamins
2. Pantothenic acid
3. Folate
4. Biotin
5. Vitamin C

- Vitamins and minerals are important for a vegan diet. If the lactovegetarian and the ovo-lactovegetarian diets are planned well, they will contain all the vitamins and minerals the body needs for good health. Vitamins and minerals that may be lacking in the vegan diet are vitamin B-12, vitamin D, riboflavin, calcium, zinc, and iron. Soybeans and soy bean milk and dark green leafy vegetables are good sources of calcium and iron, but spinach, chard, and beet greens should be eaten in smaller amounts because they contain oxalic acid. Oxalic acid may interfere with the absorption of calcium.
- Since vitamin B-12 is not found in plants, it is necessary for strict vegetarians to get it another way. Commercially prepared foods and meat substitutes are sometimes fortified with vitamin B-12. Check the special foods sections of the supermarket or health food store for these items. The health care provider may prescribe a vitamin B-12 supplement.

Major Minerals
Essential inorganic substances

Calcium	Magnesium
Chloride	Phosphorus
Copper	Potassium
Fluorine	Sodium
Iodine	Sulfur
Iron	Zinc

Obesity

1. Increasing numbers of Americans are obese
2. Obesity-related conditions

Type 2 diabetes	Breast cancer
Heart disease	Colon cancer
Hypertension	Gout
Gallstones	Osteoarthritis

Anorexia

All-American Diet

Heaviest Human

Carol Yager

(1960 - 1994)

1,600 lbs.

Heaviest Man

Jon Brower Minnoch
(1941-1983)
1400 lbs.

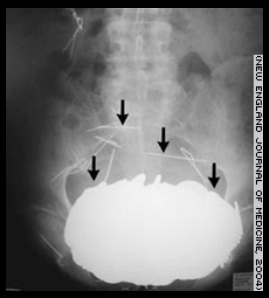
He lost 1,000 lbs after a 16 month hospital stay and a 1,200 calorie/day diet. After his release form the hospital he gained 200 lbs in 7 days. He died at 800lbs.

Another sad story

Francis John Lang
(1934-?)
1187 lbs.

X-Ray of Human Stomach

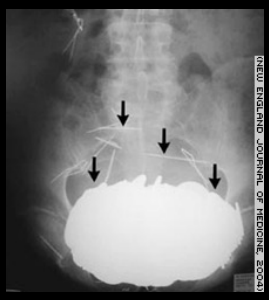
What's in here?



X-Ray of Human Stomach

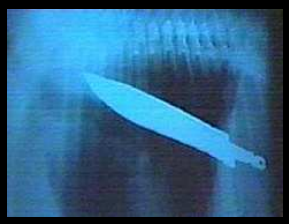
What's in here?

$650 worth of coins, assorted necklaces and needles.



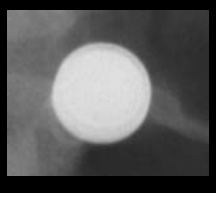
X-Ray of Dog Stomach

Dog ate a knife



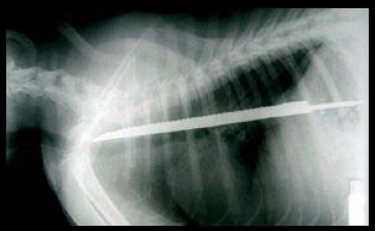
X-Ray coin

Girl ate coin



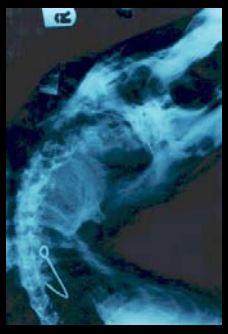
X-Ray of Dog Stomach

Dog ate a knife II



X-Ray of Dog Stomach

Crocodile swallowed fish hook or fish with a hook.



X-Ray of Dog Stomach

Woman swallowed fork