

PowerLecture:

Chapter 41

Hominids, Hips, and Hunger

Section 41.0: Weblinks and InfoTrac

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Videos: CNN

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➤ Genetics, 2003, Vol. 1, *Fat Hormone* (2:33)

➤ A&P, 2004, Vol. 8, *Teen Obesity Surgery* (2:00)

Impacts, Issues: **Hominids, Hips, and Hunger**

➤ Adipose cells are fat-storing cells, an adaptation that helped our ancestors survive times of food scarcity

➤ Adipose cells produce leptin, a hormone which acts on the brain to control hunger

Impacts, Issues: **Hominids, Hips, and Hunger**

➤ Americans are among the fattest people in the world

● 60% of adults are overweight

● Obesity is overabundance of fat in adipose tissue

➤ Obese people do not have less leptin than normal, but leptin receptors may not work properly

➤ Gastric bypass – surgery to close off part of stomach and most of small intestine

Impacts, Issues: **Hominids, Hips, and Hunger**

➤ Cholecystokinin may promote appetite suppression

➤ Elderly tend to have low appetites that sometimes endanger health

➤ New drugs that block cholecystokinin may help elderly stay nourished

Impacts, Issues Video

Section 41.1: Weblinks and InfoTrac

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Fighting Fat

- Fat-storing cells are an adaptation for survival in lean times
- Once formed, fat cells are forever
- Dieting decreases amount of fat in cells
- Dieting triggers metabolic slowdown

Eating Disorders

- Anorexia nervosa
 - Potentially fatal eating disorder based on a flawed assessment of body weight
- Bulimia
 - Out-of-control “oxlike” appetite
 - Binge-purge can damage teeth, gut lining

Digestive System Tasks

- Break up, mix, and move food material
- Secrete enzymes into tube where digestion occurs
- Digest (break down) food particles into smaller molecules
- Absorb nutrients and fluids
- Eliminate wastes and residues

Two Types of Systems

- Incomplete digestive system
 - One-way, saclike digestive cavity
- Complete digestive system
 - A tube with an opening at each end

Two Types of Systems

Examples of digestive systems

Digestive Specialization

- Digestive system is often subdivided into functional regions
- Specialization reflects feeding behavior

Specialized Teeth

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

Antelope Stomach

- Multiple chambers allow rechewing and breakdown of cellulose

Antelope Stomach

Antelope stomach function

Human Digestive System

- A complete system with many specialized organs
- About 6.5 to 9 meters long if extended
- Lined with mucus-secreting epithelium
- Movement is one way, from mouth to anus

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➤ Anatomy and Physiology, 2002, Vol. 6, *Video Pill* (1:32)

Major Components

- Mouth (oral cavity)
- Pharynx (throat)
- Esophagus
- Gut
 - Stomach
 - Small intestine
 - Large intestine
 - Rectum
 - Anus

Human digestive system

Accessory Organs

- Salivary glands
 - Secrete saliva
- Liver
 - Secretes bile
- Gallbladder
 - Stores and concentrates bile
- Pancreas
 - Secretes digestive enzymes

Section 41.3: Weblinks and InfoTrac

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Human Teeth

- Normal adult number is 32

Human teeth

Saliva

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

Swallowing

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

Section 41.4: Weblinks and InfoTrac

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Structure of the Stomach

- J-shaped organ lies below the diaphragm

- Sphincters at both ends
- Outer serosa covers smooth muscle layers
- Inner layer of glandular epithelium faces lumen

Digestive Enzymes

Stomach Secretions

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

Mixing Chyme

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

Peristalsis

Protein Digestion in Stomach

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

Ulcer

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

Into the Small Intestine

- Movement into duodenum controlled by pyloric sphincter
- Only a small amount of chyme passes through sphincter at a given time
- Fat content of chyme affects the rate of stomach emptying

Intestinal Secretions

- 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

- Secreted into duodenum
- Pancreatic amylase
- Trypsin and chymotrypsin
- Carboxypeptidase
- Lipase
- Pancreatic nucleases

Fat Digestion

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

Hormones and Digestion

- Gastrin
- Secretin
- Cholecystokinin (CCK)
- GIP (glucose insulinotropic peptide)

Section 41.5: Weblinks and InfoTrac

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Walls of Small Intestine

- Projections into the intestinal lumen increase the surface area available for absorption

Structure of the small intestine

Absorption of Nutrients

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

Absorption

Mechanisms

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

Fat Absorption

Digestion and Absorption

Absorption

Into the Blood

- Glucose and amino acids enter blood vessels directly
- Triglycerides enter lymph vessels, which eventually drain into blood vessels

Section 41.6: Weblinks and InfoTrac

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- Biology, 2001, Vol. 5, *Screening for Colon Cancer* (1:54)

Large Intestine (Colon)

- Concentrates and stores feces
- Sodium ions are actively transported out of lumen and water follows
- Lining secretes mucus and bicarbonate

Structure of the large intestine

Bacteria in Colon

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

Movement through Colon

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

Defecation

- Distension of the last part of the colon triggers a reflex action
- Smooth muscle of anal sphincter relaxes
- Voluntary contraction of external sphincter can prevent defecation

Colon Malfunction

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

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Pathways of Organic Metabolism

Section 41.8: Weblinks and InfoTrac

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Videos: CNN

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- Biology, 2004, Vol. 8, *Fat Facts* (2:29)
- Genetics, 2004, Vol. 2, *Gene Therapy for Diabetes* (2:16)

Food Pyramid

Carbohydrates

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

Lipids

- Most fats can be synthesized
- Essential fatty acids must be obtained from food
- Fats should be about 30 percent of diet
- Excess saturated fats can raise cholesterol level and contribute to heart disease

Proteins

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

Dietary Essentials

- Vitamins
 - Essential organic substances
- Minerals
 - Essential inorganic substances

Food Pyramid

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Vitamins

Fat soluble

- Excess accumulates in tissue
- Vitamins A, D, E, K

Vitamins

Major Minerals

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

Section 41.10: Weblinks and InfoTrac

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Videos: CNN

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- Anatomy and Physiology, 2003, Vol. 7, *Obesity and Infertility* (2:16)

Obesity

- Increasing numbers of Americans are obese
- Obesity-related conditions

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

Body-Mass Index

- An indicator of obesity-related health index

$$\text{BMI} = \frac{\text{Weight (lbs)} \times 700}{\text{Height (inches)}^2}$$

- BMI greater than or equal to 27 indicates health risk

Body mass index

Caloric requirements

Maintaining Weight

- Caloric input must equal caloric use
- Calories burned depends upon
 - Activity level
 - Age
 - Height and build

Leptin

- Hormone that affects appetite and metabolic rate
- Product of the *Ob* gene
- Faulty *Ob* gene may contribute to some human obesity
- Effects of leptin on bone may complicate use of leptin to treat obesity

Chronology of leptin research

Ghrelin

- Newly discovered peptide hormone
- Secreted mainly by cells of the stomach lining
- Directly stimulates the appetite control center
- Makes you feel hungry