Physiology of Digestive System

By

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3rd Year/ Lecture 3b

Nutrition and Metabolism

- nutrition - the starting point and the basis for all human form and function
  - the source of fuel that provides the energy for all biological work
  - the source of raw materials for replacement of worn-out biomolecules and cells
- metabolism – the chemical changes that lie at the foundation of form and function

Body Weight and Energy Balance

- weight – determined by the body's energy balance
  - if energy intake and output are equal, body weight is stable
  - gain weight if intake exceeds output
  - lose weight if output exceeds intake
  - seems to have a stable, homeostatic set point
    - varies from person to person
    - combination of heredity and environmental influences
      - 30% to 50% hereditary
      - rest environmental factors such as eating and exercise habits

Appetite

- control of appetite and body weight includes a still-growing list of peptide hormones and regulatory pathways that control short- and long-term appetite
  - gut-brain peptides – act as chemical signals from the gastrointestinal tract to the brain
- short-term regulators of appetite
  - mechanisms work over periods of minutes to hours
  - makes one feel hungry and begin eating
  - makes one feel satiated and end a meal

Gut-Brain Peptides - Appetite

- short term - effects last minutes to hours
  - Ghrelin
    - secreted from parietal cells in fundus of empty stomach
    - produces sensation of hunger
    - stimulates the hypothalamus to secrete growth hormone-releasing hormone
      - primes the body to take best advantage of the nutrients about to be absorbed
    - ghrelin secretion ceases within an hour of eating
    - signal that begins a meal
  - Peptide YY (PYY)
    - secreted by enteroendocrine cells of ileum and colon
    - sense that food has arrived in the stomach
    - secrete PYY long before chyme reaches the ileum in amounts proportionate to calories consumed
    - primary effect is to signal satiety and terminate eating
    - signal that ends a meal
  - Cholecystokinin (CCK)
    - secreted by enteroendocrine cells in duodenum and jejunum
    - stimulates the secretion of bile and pancreatic enzymes
    - stimulates the brain and sensory fibers of the vagus nerve suppressing appetite

Gut-Brain Peptides - Appetite

- long term – governs one's average rate of caloric intake and energy expenditure over periods of weeks to years
- these two peptides inform the brain of how much adipose tissue the body has and activates mechanisms for adding or reducing fat
  - Leptin
    - secreted by adipocytes throughout the body
    - level proportionate to one's own fat stores
    - informs brain on how much body fat we have
    - obese people are more likely to have a receptor defect rather than hormone deficiency
  - Insulin
    - secreted by pancreatic beta cells
    - stimulates glucose and amino acid uptake
    - promotes glycogen and fat synthesis
    - has receptors in the brain and functions like leptin as an index of
    - body fat stores
    - weaker effect on appetite than leptin

Appetite Regulation by Hypothalamus

- arcuate nucleus of hypothalamus has receptors for all five chemical signals just described
  - has two neural networks involved in hunger
  - one group secretes neuropeptide Y (NPY), a potent appetite stimulant
    - Gherlin stimulates neuropeptide Y secretion
    - Insulin, PYY and leptin inhibit it
  - other group secretes melanocortin which inhibits eating
    - Leptin stimulates melanocortin secretion
    - inhibits secretion of appetite stimulants – endocannabinoids
      - named for their resemblance to the tetrahydrocannabinol (THC) of marijuana

Appetite Regulation

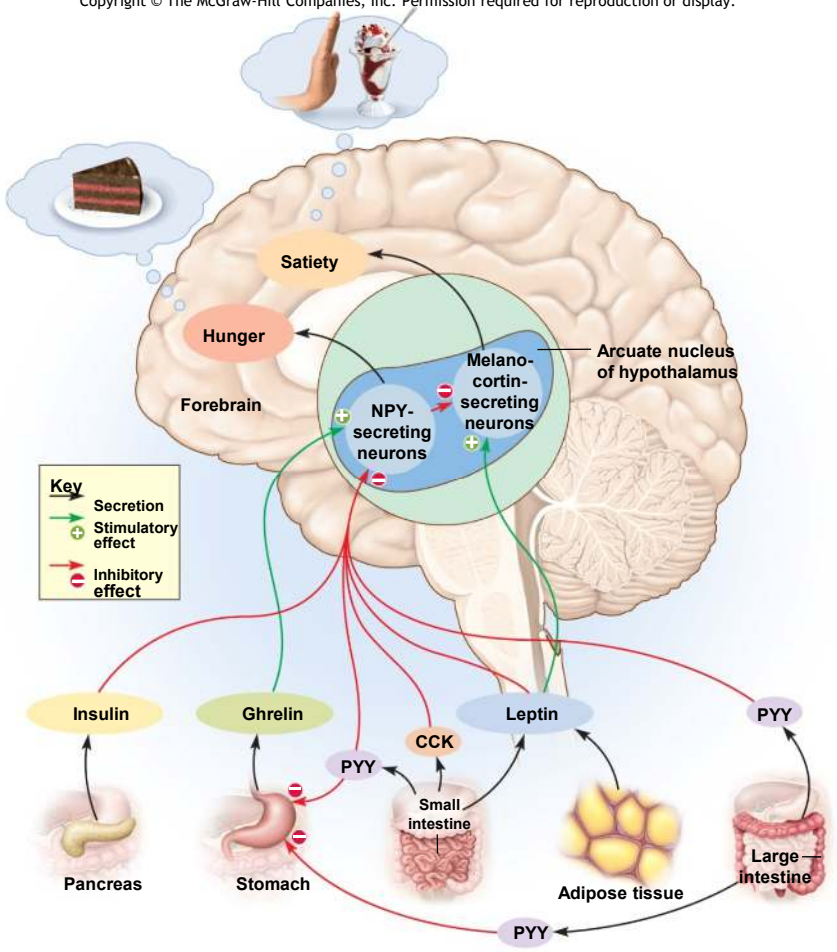

Figure 26.1

Obesity

- obesity - weight more than 20% above recommended norm for one's age, sex, and height
  - in United States
    - 30% obese
    - 35% overweight
- Body Mass Index (BMI) – indication of overweight or obese
  - BMI = W/H^2 (W = weight in kg, and H = height in meters)
    - 20 – 25 is optimal for most people
    - over 27 – overweight
    - above 30 – obese
- shortens life expectancy
  - increased risk of atherosclerosis, hypertension, diabetes mellitus, joint pain, kidney stones and gallstones, cancer of uterus, breast and prostate, and sleep apnea
- causes are diverse and unknown
  - heredity, overfeeding in infancy, and problems with appetite and weight-regulating mechanisms are suspected

Other Factors in Appetite Regulation

- hunger is stimulated partly by gastric peristalsis
  - mild hunger contractions begin soon after stomach is empty
  - increase in intensity over a period of hours
  - do not affect the amount of food consumed
- appetite is briefly satisfied by:
  - chewing and swallowing
  - stomach filling
  - lasting satiation depends upon nutrients entering blood
- neurotransmitters stimulate desire for different types of food
  - norepinephrine – carbohydrates
  - galanin – fats
  - endorphins – protein