

MEDAVIE

HealthEd

ÉduSanté



# METABOLISM AND DIGESTION

Advanced Care Paramedicine

Module: 09

Section: 01b

- Metabolism
  - Includes all the chemical reactions in the body, including the utilization of nutrients
- Nutrition
  - The acquisition, assimilation and utilization of nutrients

- Mechanical
  - Mastication
  - Deglutition
  - Peristalsis and Segmentation

- Gastric Motility
  - Food stored in stomach is mixed with gastric juices to form chyme
  - Ejected into duodenum
  - Controlled by hormonal and nervous systems
    - Fats and nutrients stimulate the release of gastric inhibitory peptide (GIP) into blood
    - When this reaches the wall of stomach inhibits peristalsis
    - Nervous system (via vagus) inhibit peristalsis due to acid presence or distention

- Intestine Motility
  - Segmentation
    - mixes chyme with secretions from pancreas, liver and mucosa
  - Peristalsis
    - Regulated by intrinsic stretch reflexes
    - May also be stimulated by cholecystokinin-pancreozymin (CCK) secreted by the mucosa when chyme is present

- Chemical Digestion
  - All changes in chemical composition
  - Uses Digestive Enzymes to catalyze reactions

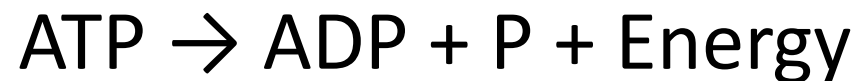
- Two types
  - Anabolism
  - Catabolism

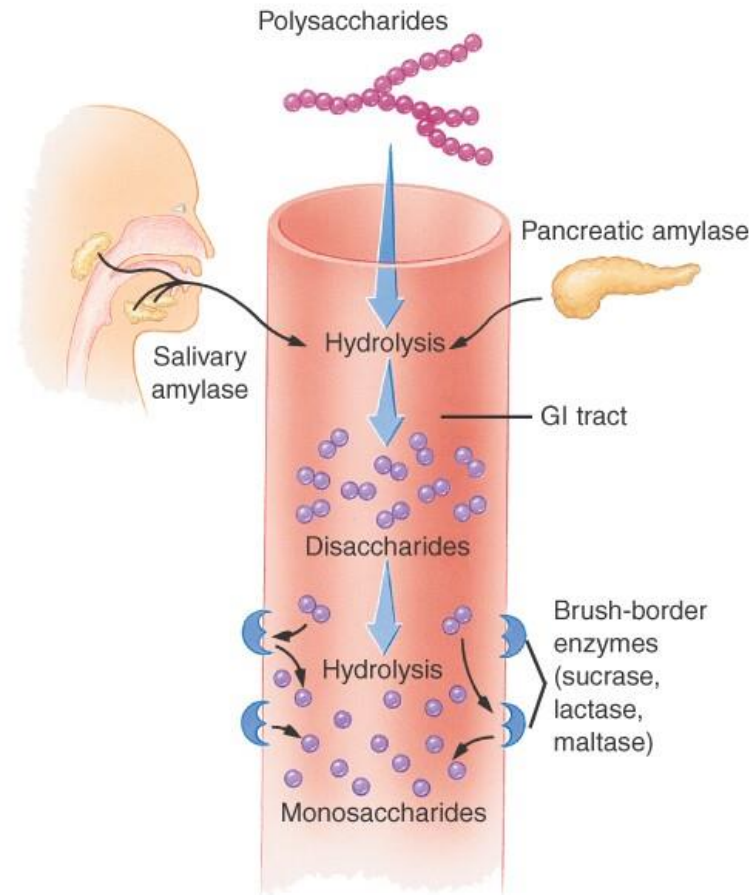
- Anabolism
  - Synthesis small molecules to form bigger molecules
  - Small molecules react to produce water and a larger molecule
  - Requires energy
  - These reactions represent dehydration synthesis

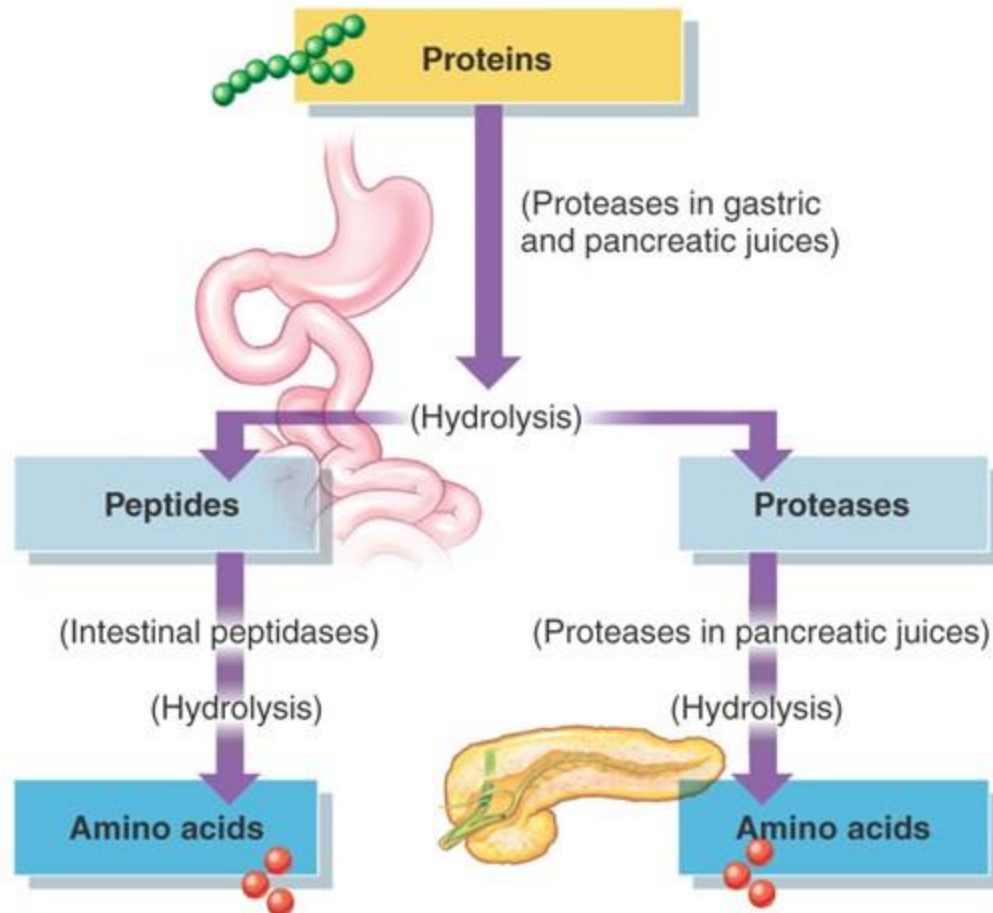


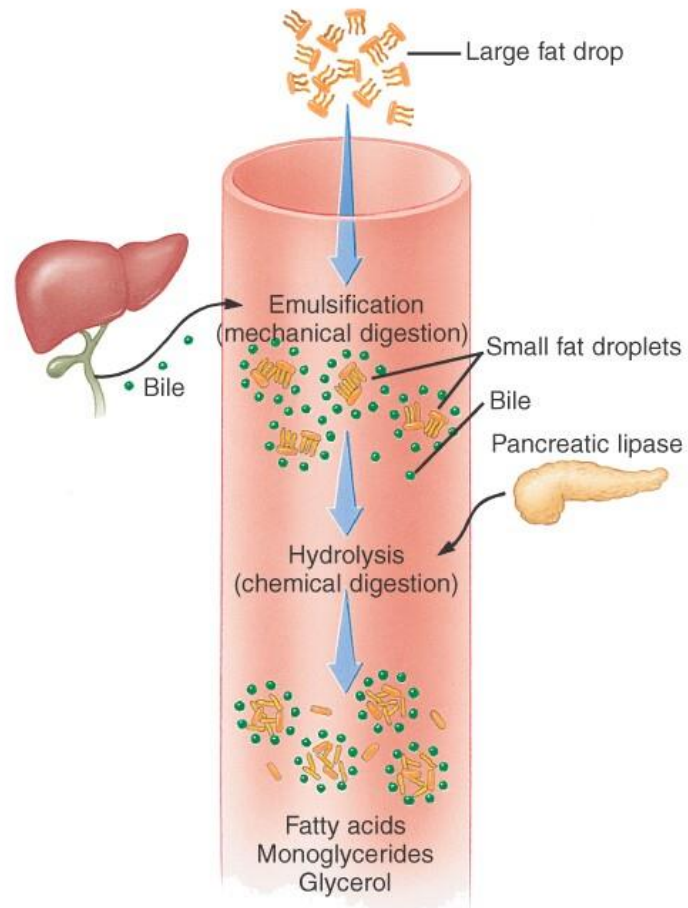
- Catabolism
  - Break down of large molecules into smaller molecules
  - Water is used to split the larger molecule into two parts (hydrolysis)
  - Releases energy

- Nutrients are “burned” in the cell as it is used during cellular respiration
- These reactions release energy
- Some is stored as ATP
- Remainder given off as heat





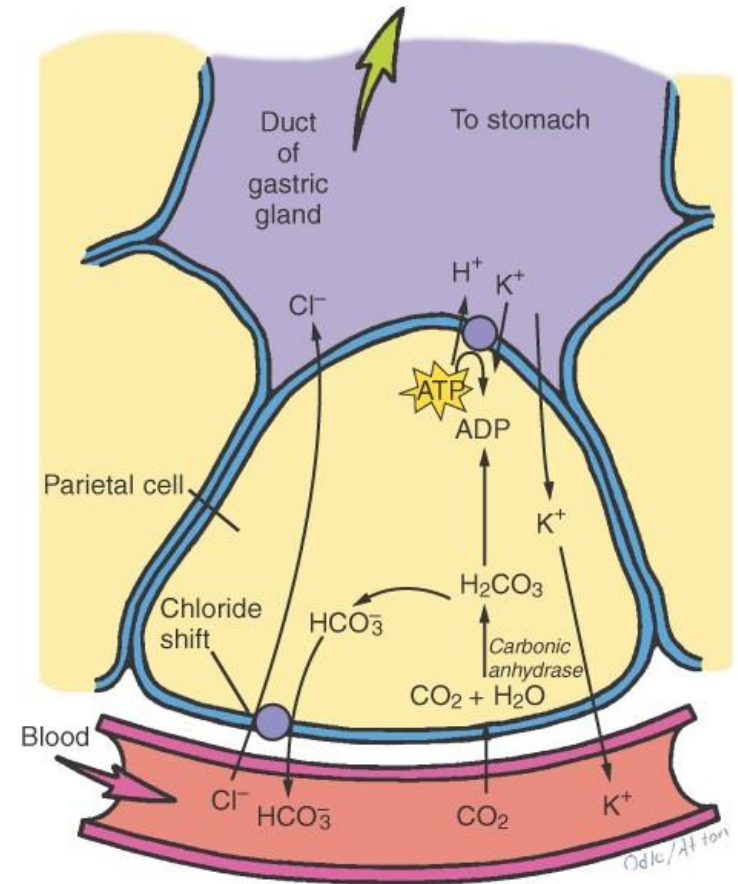




- Components of food that resist digestion
- Eliminated as feces

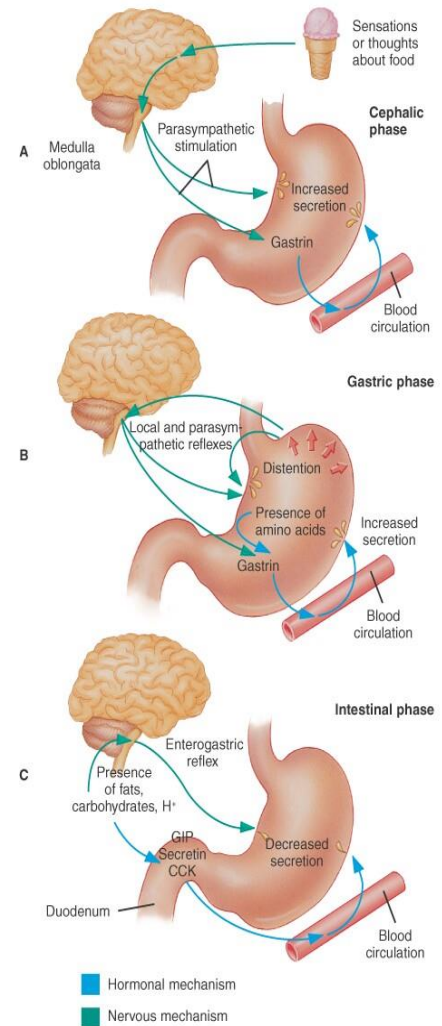
- Saliva
  - Secreted by salivary glands
  - Mostly water
  - Contains
    - Amylase      Carbohydrate digestive enzyme
    - Lipase        Lipid digestive enzyme
    - $\text{NaHCO}_3$     Helps produce alkaline environment for amylase
  - Helps mechanically digest food

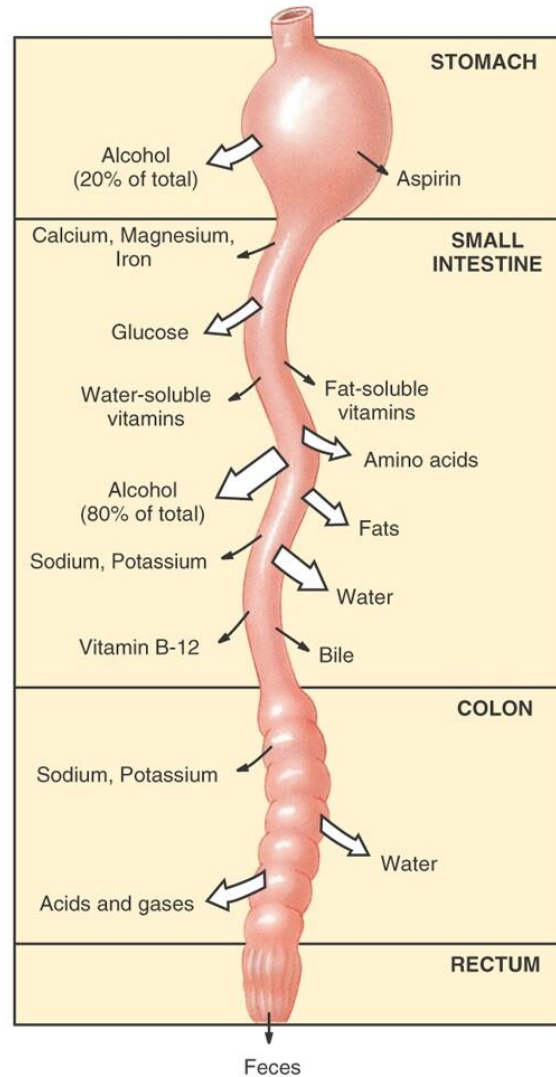
- Gastric Juice
  - Chief Cells
    - Secrete enzymes of gastric juice (Pepsinogen)
    - Inactive form of pepsin (breakdown most proteins), activate by HCl
  - Parietal Cells
    - HCl
      - » Kills bacteria and give acidic environment for enzymes
    - Intrinsic Factor
      - » Aids in B12 absorption



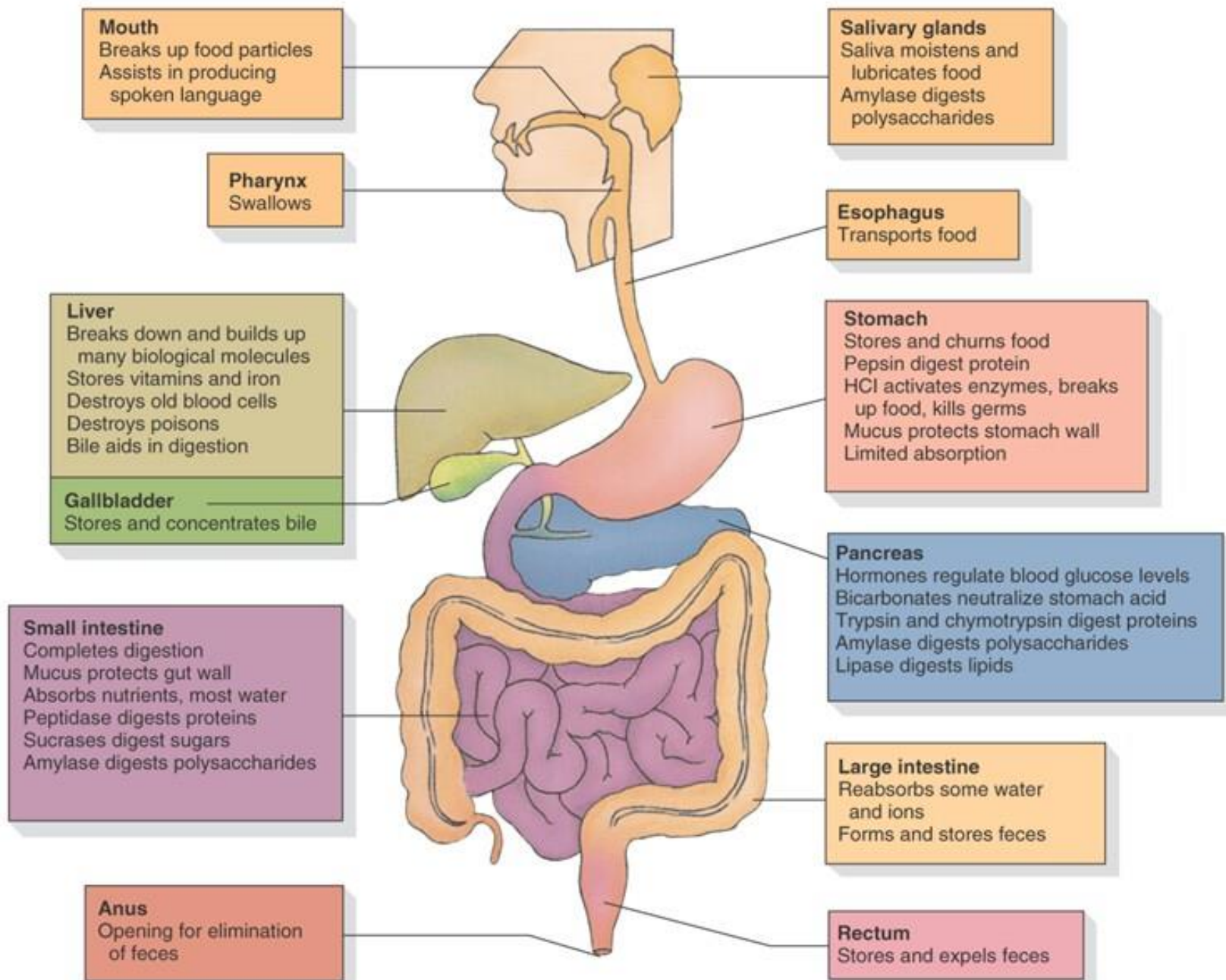


- Cephalic
  - Thinking of food produces vagal stimulation and produces secretions
- Gastric
  - Food enters stomach
  - More secretions (2/3)
- Intestinal
  - Chyme passes into duodenum
  - Secretions cease

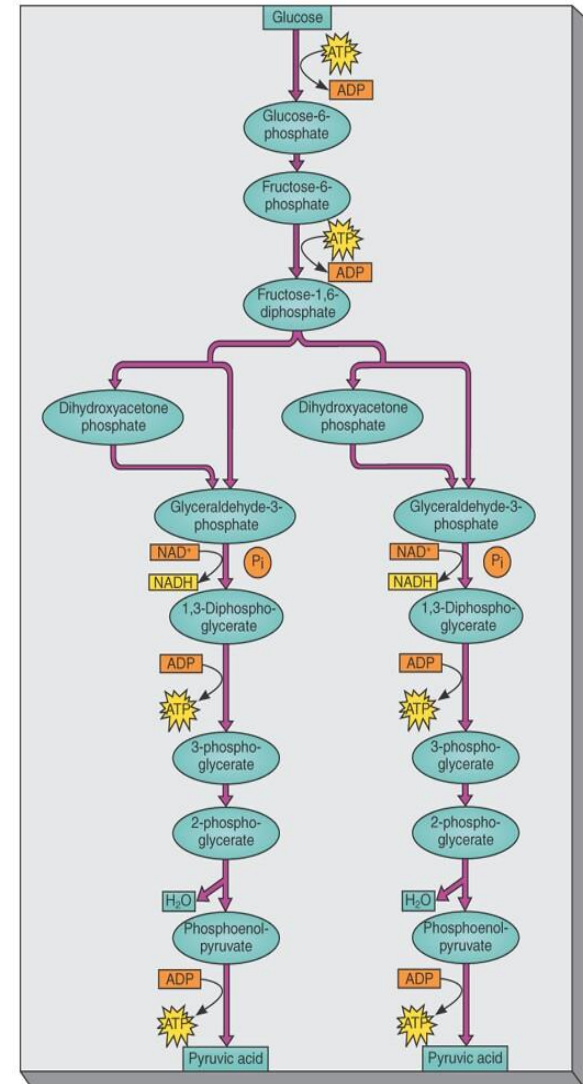




- Expulsion of feces from digestive tract (defecation)
- Reflex of stimulation of receptors in rectal mucosa

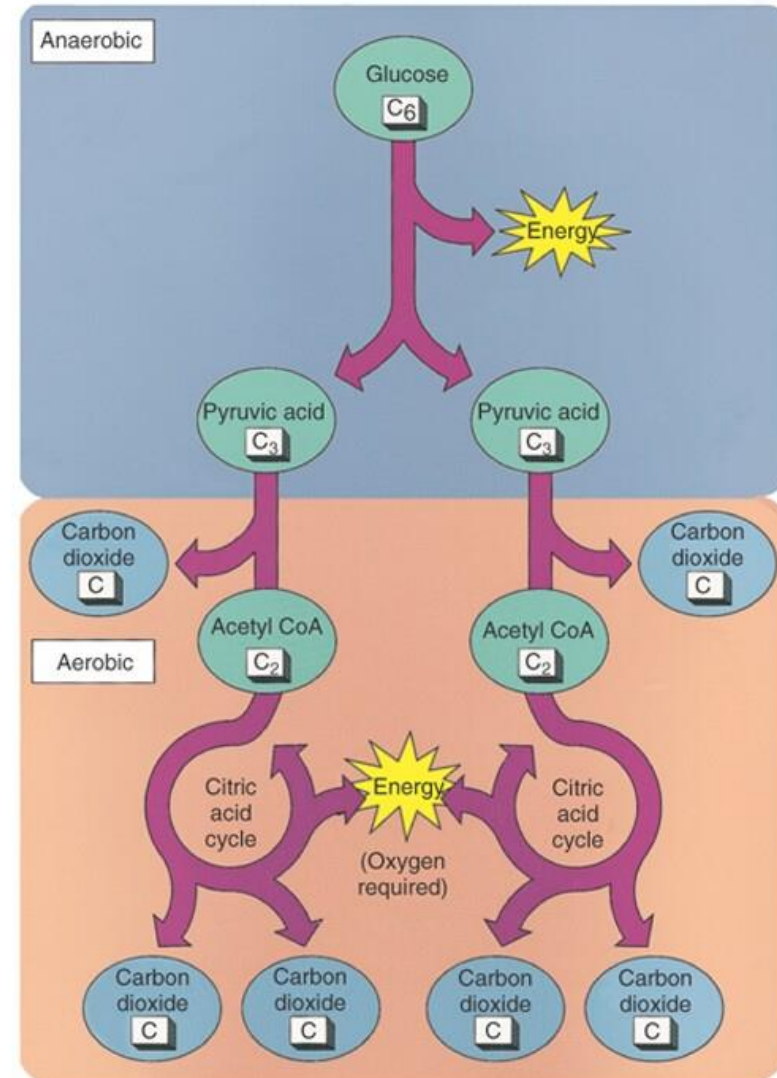


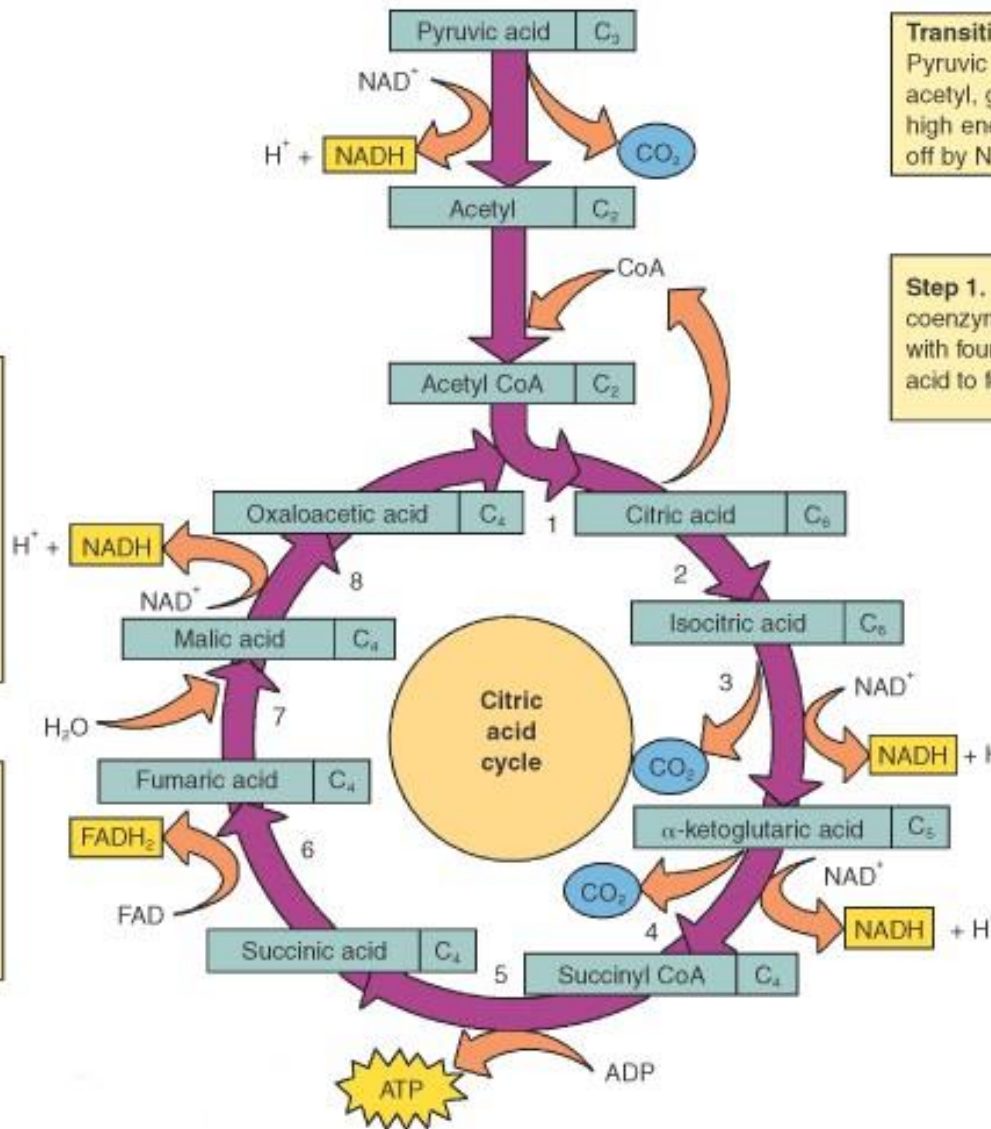
- Glycolysis (first reaction)
  - Occurs in the cytoplasm
  - Is anaerobic (provides cells with energy in a low oxygen environment)
    - Splits glucose into 2 pyruvic acid molecules
    - This requires 2 ATP to get started but yields 4 ATP
    - Most appears as heat
  - Prepares glucose for second step (Citric Acid Cycle)





- If no  $O_2$  is present PA is converted to Lactic acid
- If  $O_2$  then aerobic metabolism takes place in mitochondria producing Acetyl-CoA
- In the mitochondria the Acetyl-CoA enters a series of reactions called the citric acid cycle (Krebs cycle)
- High energy yields enter electron transport system





**Transition reaction.**  
Pyruvic acid is converted to acetyl, giving off CO<sub>2</sub> and high energy electrons carried off by NADH.

**Step 1.** Acetyl, carried by coenzyme A (CoA), combines with four-carbon oxaloacetic acid to form citric acid.

**Step 2-3.** Six-carbon substrate converted to five-carbon substrate, giving off CO<sub>2</sub> and high energy electrons carried off by NADH.

**Step 4.** Five-carbon substrate is converted to a four-carbon substrate, giving off another CO<sub>2</sub> and electrons carried off by NADH.

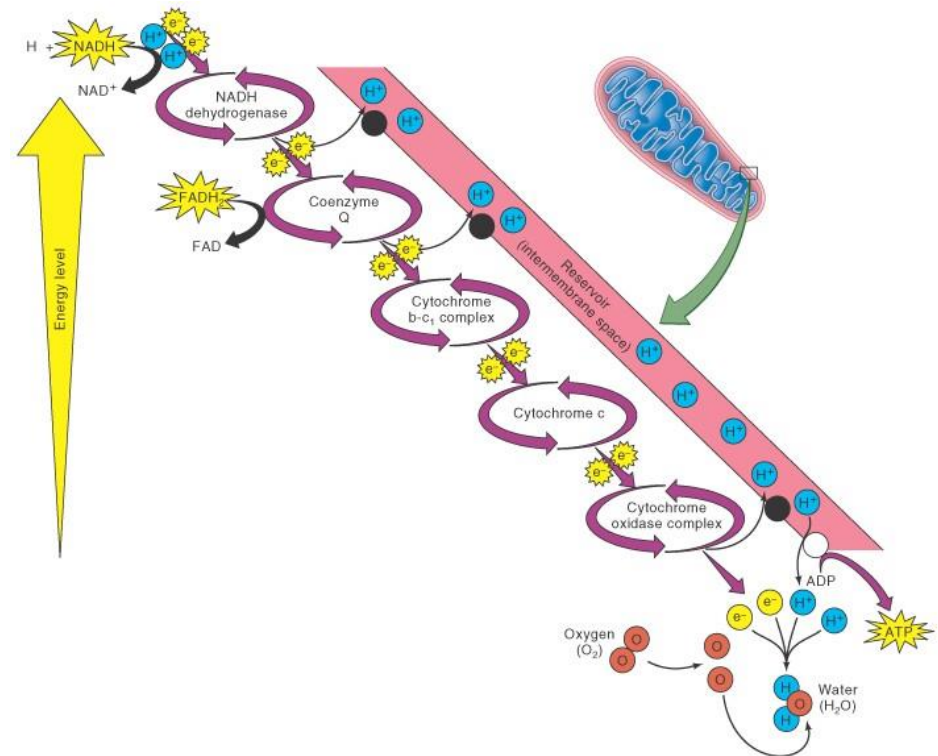
**Step 5.** Chemical energy is transferred out of the cycle to ATP.

**Step 7-8.** Additional electrons leave the cycle, carried by NADH. Oxaloacetic acid, the end product, can be recycled when CoA brings another acetyl group.

**Step 6.** High-energy electrons are carried away from the cycle by FADH<sub>2</sub>.

# Electron Transport System

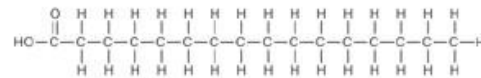
- Energy electrons enter chain of carrier molecules in the mitochondria
- As they move down the chain they release small bursts of energy
- This yields 36 to 38 ATP





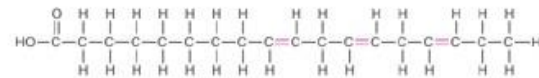
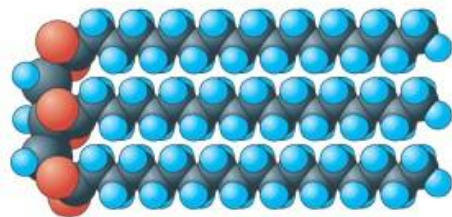
- If excessive glucose than liver converts and stores (glycogenesis)
- If not enough liver breaks glycogen down (glycogenolysis)
- If no glucose present then liver uses proteins, glycerol or fats (gluconeogenesis)

- Compounds of Fats, oil and related substances
  - Triglycerides (glycerol and 3 fatty acids)
  - Phospholipids
  - Cholesterol
- Classed as Saturated or Unsaturated
  - Saturated have all available bonds filled with Hydrogen atoms



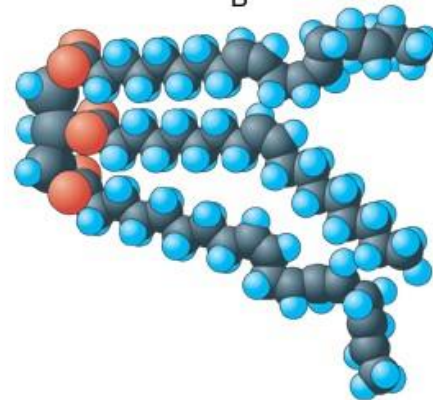
Palmitic acid (saturated)

A



Linolenic acid (unsaturated)

B

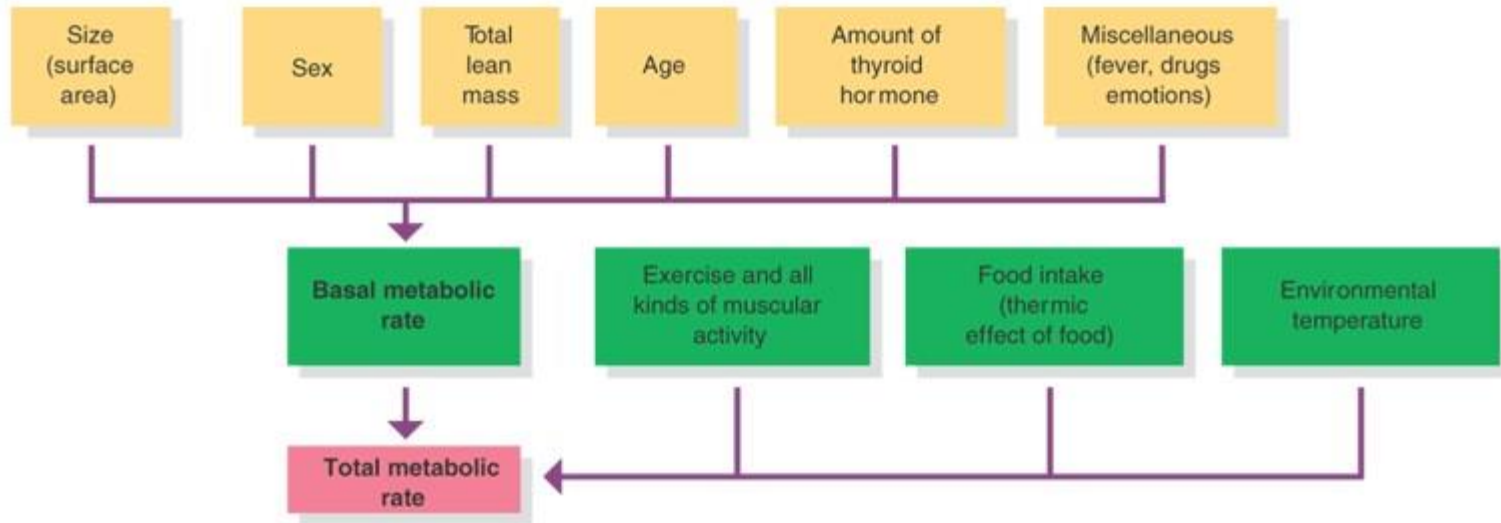


- Transported in blood as
  - Chylomicrons
    - Small fat droplets comprised of triglycerides, cholesterol and phospholipids
    - Absorbed into adipose tissue
  - Lipoproteins
    - Made in liver
    - Blood then contains VLDL, LDL and HDL
  - Fatty acids
    - Carried by albumin

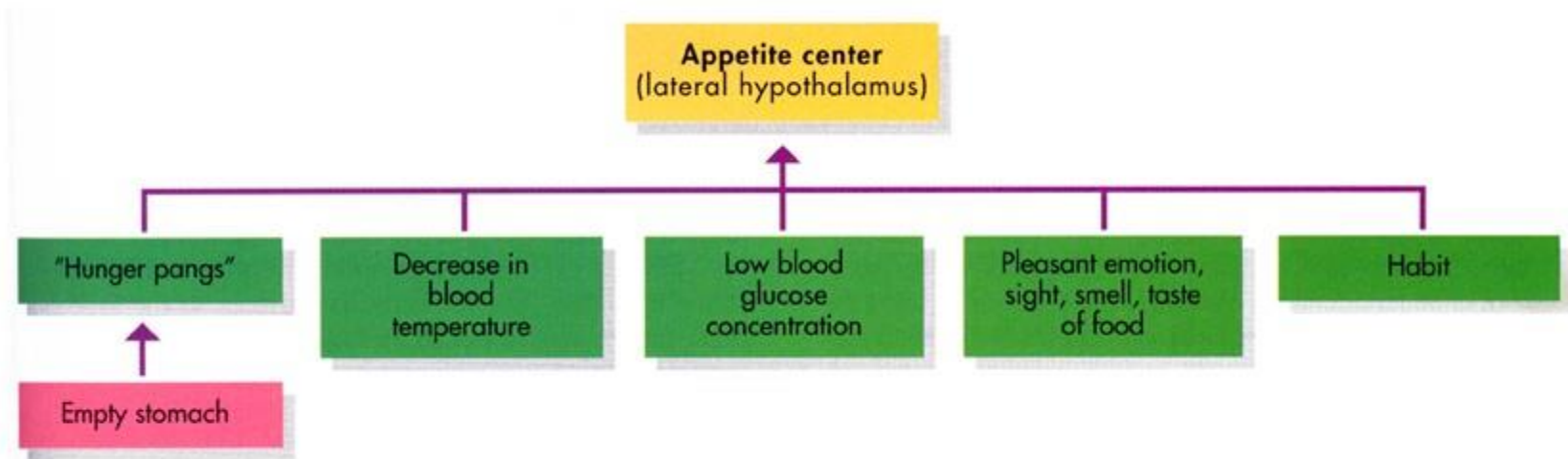
- Energy derived from food is measured in kcal or C
- 1 C is the amount of energy required to raise 1 kg of water 1°C
- Energy is used in 3 ways:
  - Basal metabolism
  - Physical activity
  - Thermogenesis

- Basal metabolism
  - The basilar metabolic rate (BMR) is the energy required to maintain the body functioning at a minimal level
  - May be influenced by
    - Size (more muscle – more metabolism)
    - Sex (males are higher)
    - Age (decreases)
    - Hormones (may increase)
    - Fever (increase)
    - Drugs (Caffeine....increase)
    - Emotions (increase)

- Amount of energy used or expended by the body in a given time (kcal/hr)



# Regulation of Food Intake



- Physical Activity
  - Muscular contractions require energy
  - Accounts for only 25% of use
  - May increase with increased activity
  - Can be controlled voluntarily
- Thermogenesis
  - Energy used to digesting food
  - Accounts for only 10% of usage



- Maintenance of the core temp is essential for enzyme function
- Average temp 37.6 °C
- Temp at the body surface is called the shell temperature and is typically 37°C (heat loss area)
- Shell Temp is lower than core temp

## Heat Production

- Produced by catabolism of nutrients
  - 40% is used for biological activities
  - Remainder is heat energy
- Changes in temp signal body to maintain homeostasis

- What happens when you are in a:
  - Hot environment?
  - Cold environment?
- Is temperature regulation negative or positive feedback?