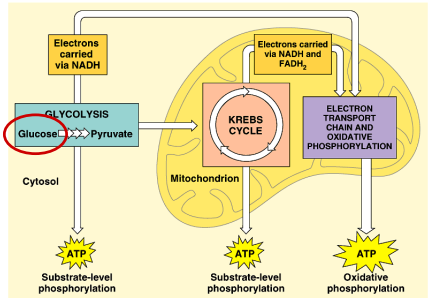
Cellular Respiration
Other Metabolites & Measuring Respiration

Cellular respiration



Beyond glucose: Other carbohydrates

- Glycolysis accepts a wide range of carbohydrates fuels

polysaccharides → → → glucose
hydrolysis

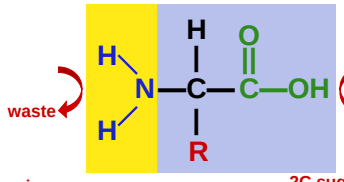
- ex. starch, glycogen

other 6C sugars → → → glucose
modified

- ex. galactose, fructose

Beyond glucose: Proteins

proteins → → → → → amino acids
hydrolysis



waste

glycolysis
Krebs cycle

amino group = waste product excreted as ammonia, urea, or uric acid

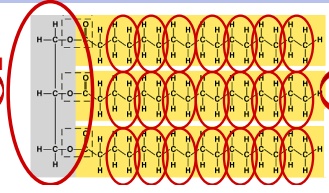
2C sugar = carbon skeleton = enters glycolysis or Krebs cycle at different stages

Beyond glucose: Fats

fats → → → → → glycerol + fatty acids
hydrolysis

glycerol (3C) → → G3P → → glycolysis

fatty acids → 2C acetyl groups → acetyl coA → Krebs cycle



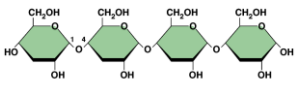
3C glycerol enters glycolysis as G3P

2C fatty acids enter Krebs cycle as acetyl CoA

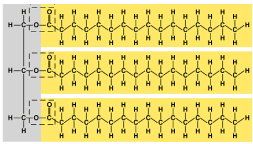
Carbohydrates vs. Fats

- Fat generates 2x ATP vs. carbohydrate
  - more C in gram of fat
    - more energy releasing bonds
  - more O in gram of carbohydrate
    - so it's already partly oxidized
    - less energy to release

carbohydrate

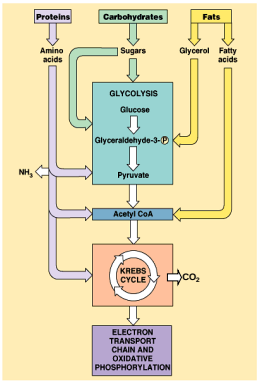


fat



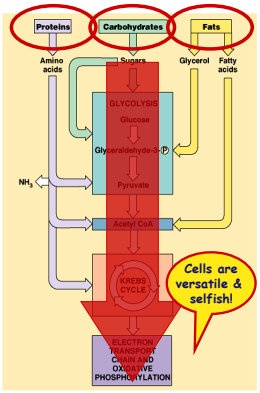
Metabolism

- Coordination of chemical processes across whole organism
  - digestion
    - catabolism when organism needs energy or needs raw materials
  - synthesis
    - anabolism when organism has enough energy & a supply of raw materials
  - by regulating enzymes
    - feedback mechanisms
    - raw materials stimulate production
    - products inhibit further production



Metabolism

- Digestion
  - digestion of carbohydrates, fats & proteins
    - all catabolized through same pathways
    - enter at different points
  - cell extracts energy from every source



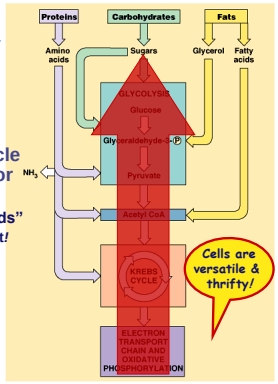
Metabolism

- Synthesis
  - enough energy?
    build stuff!
  - cell uses points in glycolysis & Krebs cycle as links to pathways for synthesis
    - run pathways "backwards"
      - have extra fuel, build fat!

pyruvate → → glucose

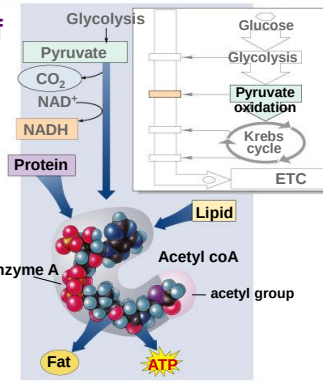
Krebs cycle intermediaries → → amino acids

acetyl CoA → → fatty acids



Central Role of Acetyl CoA

- Acetyl CoA is central to both energy production & biomolecule synthesis
- Depending on organism's need
  - build ATP
    - immediate use
  - build fat
    - stored energy



Energy of Substrates

- As already mentioned, molecules with greater energy density have greater reducing power (make more NADH)
- Values:
  - Carbs: 15.8 kJ/g
  - Proteins: 17 kJ/g
  - Lipids: 39.4 kJ/g

Respiratory Quotient

- The Respiratory Quotient or RQ value is a measure of the ratio of carbon dioxide produced and oxygen consumed by an organism per unit time

$$RQ = \frac{\text{volume of carbon dioxide produced}}{\text{volume of oxygen consumed}} \text{ per unit time}$$

The respiratory quotient is a ratio and therefore has NO UNITS

The respiratory quotient is a valuable measurement as it provides us with information regarding the nature of the substrate being used by an organism for respiration

Example:

The simplified equation for the aerobic respiration of glucose is:

$C_6H_{12}0_6 + 6O_2 = 6CO_2 + 6H_2O$

In this reaction, SIX CARBON DIOXIDE MOLECULES are produced and SIX OXYGEN MOLECULES are consumed

The RQ for this reaction is
$6\ CO_2/6\ O_2 = 1$

Example 2….

The RQ value varies with the nature of the substrate being used for respiration

The following equation represents the complete oxidation of the fatty acid, OLEIC ACID, when used as the substrate for respiration

The simplified equation for the aerobic respiration of oleic acid is:

$2C_{18}H_{34}0_2 + 51\ O_2 = 36\ CO_2 + 34\ H_2O$

In this reaction, THIRTY SIX CARBON DIOXIDE MOLECULES are produced and FIFTY ONE OXYGEN MOLECULES are consumed

The RQ for this reaction is
$36\ CO_2/51\ O_2 = 0.7$

Respirometer

- The device used to collect gas and measure respiration is cleverly called a respirometer.
- http://www.youtube.com/watch?v=r9o_VdToClE