**Cellular Respiration**

**Other Metabolites & Measuring Respiration**

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**Beyond glucose: Other carbohydrates**

- Glycolysis accepts a wide range of carbohydrates fuels
  
  **polysaccharides → → → glucose**
  
  - ex. starch, glycogen
  
  **other 6C sugars → → → glucose**
  
  - ex. galactose, fructose

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**Beyond glucose: Proteins**

- Proteins undergo hydrolysis to form amino acids
  
  - amino group = waste product excreted as ammonia, urea, or uric acid
  
  - 2C sugar = carbon skeleton enters glycolysis or Krebs cycle at different stages

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**Beyond glucose: Fats**

- Fats undergo hydrolysis to form glycerol + fatty acids
  
  **glycerol (3C) → → G3P → → glycolysis**
  
  **fatty acids → 2C acetyl → acetyl → Krebs groups → coA → Krebs cycle**

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**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
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

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

- 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

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

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

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

\[ \text{RQ} = \frac{\text{volume of carbon dioxide produced}}{\text{volume of oxygen consumed}} \]

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:

\[ \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 = 6\text{CO}_2 + 6\text{H}_2\text{O} \]

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

The RQ for this reaction is 
\[ 6\text{ CO}_2/6\text{ O}_2 = 1 \]

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:

\[ 2\text{C}_{18}\text{H}_{34}\text{O}_2 + 51\text{O}_2 = 36\text{CO}_2 + 34\text{H}_2\text{O} \]

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

The RQ for this reaction is
\[ 36\text{ CO}_2/51\text{ O}_2 = 0.7 \]

Respirometer

- The device used to collect gas and measure respiration is cleverly called a respirometer.
- [http://www.youtube.com/watch?v=r9o_VdToCIE](http://www.youtube.com/watch?v=r9o_VdToCIE)