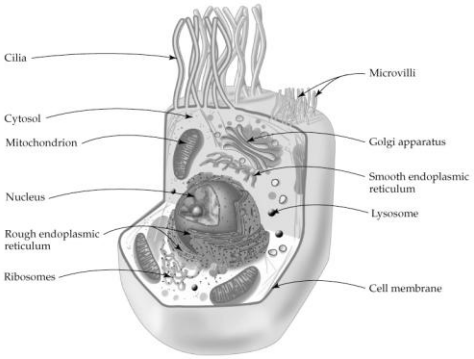
The Flow of Energy

I. Energy for Cells



A. *ATP (Adenosine Tri Phosphate)* is the source of free energy (Energy available to do work) for reactions in the cell

1. **All reactions in the cell require energy**
2. **Two types of reactions in a cell**
   a. ***Endorgonic* – those that require energy**
   b. ***Exorgonic* – those that give off energy**
3. **Free energy is needed to move a muscle, active transport, protein synthesis etc.**
4. **In cells most of the free energy needed to carry on cell activities come from ATP, A-P-P-P**

B. Releasing energy from ATP happens when the bond between the phosphates is broken

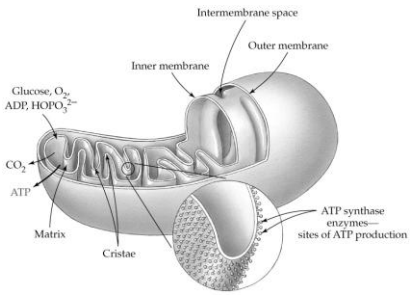
1. **The breaking down of ATP is a hydrolysis reaction**
   a. **ATP + H_2O → ADP + P_i + Free Energy (P_i is a free inorganic phosphate)**
   b. ***ADP is Adenosine di Phosphate***

C. Where does ADP P_i get the energy to become ATP again?

1. **Cellular respiration is the process that returns the energy to form ATP**
2. **During respiration energy from energy rich molecules such as glucose are used to change ADP + P_i into ATP**

D. Respiration with 0_2 – *Aerobic respiration*

1. **Aerobic respiration starts in cytoplasm and finishes in mitochondria**
2. **Aerobic Respiration Summarized**
   a. **$C_6H_{12}O_6 + 6O_2 + 38ADP + 38\ P_i$ → $6CO_2 + 6H_2O + 38$ ATP**
      1) **Two ATP are used in the cycle to get the process going**
      2) **That leaves a net gain of 36 ATP**

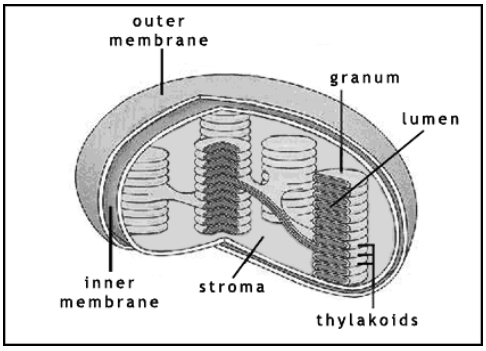


   b. **A glucose molecule is to much energy for the cell to use all at once**
   c. **Cellular respiration packages energy into useable sized energy packets (ATP)**
   d. **The ATP then is used again to do the cells work**
   e. **When the energy is released from the ATP to do work an ADP + P_i is what is left over**
   f. **In order for ADP + P_i to become ATP again cellular respiration must take place**

g. This is called the ATP, ADP + P_i Cycle
h. The 100 dollar bill example on page 148
i. Meat packing example

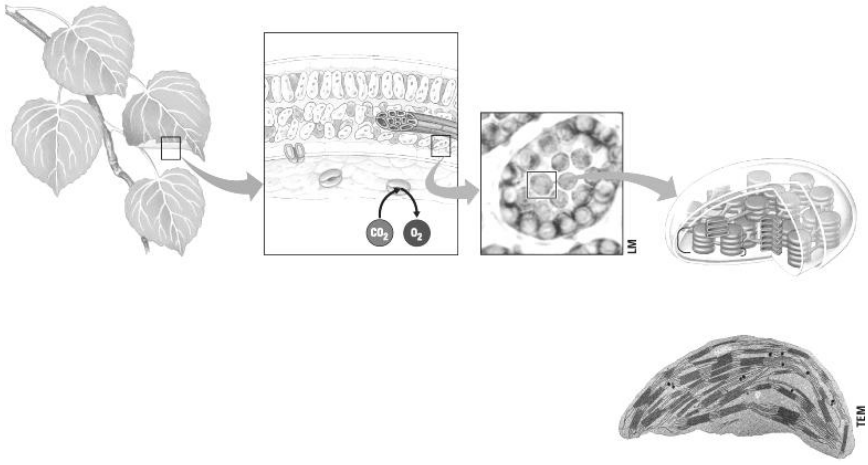
3. Anaerobic respiration – respiration that takes place in the absence of O_2
a. Called Fermentation
1) Lactic Acid Fermentation
a) $C_6H_{12}O_6$ + 4 ADP + 4 P_i → $2CH_3CHOHCOOH$ + 4ATP
b) 2ATP are used to start the process leaving a net gain of 2 ATP
c) Lactic Acid is what cause muscle soreness
2) Alcoholic Fermentation
a) $C_6H_{12}O_6$ + 4 ADP + 4 P_i → 2 C_2H_5OH + CO_2 + 4 ATP
b) 2 ATP are invested, giving a net gain of 2 ATP

II. Photosynthesis – Light used to put CO_2 + H_2O together to form sugar
A. Light – radiant energy
1. Human eye sees from 400 – 700 nm wavelength
2. What we see is called the visible spectrum
a. Red orange yellow green blue violet
3. Color – the reflection of light
B. Chlorophyll – green pigment in plants responsible for the energy absorption for photosynthesis



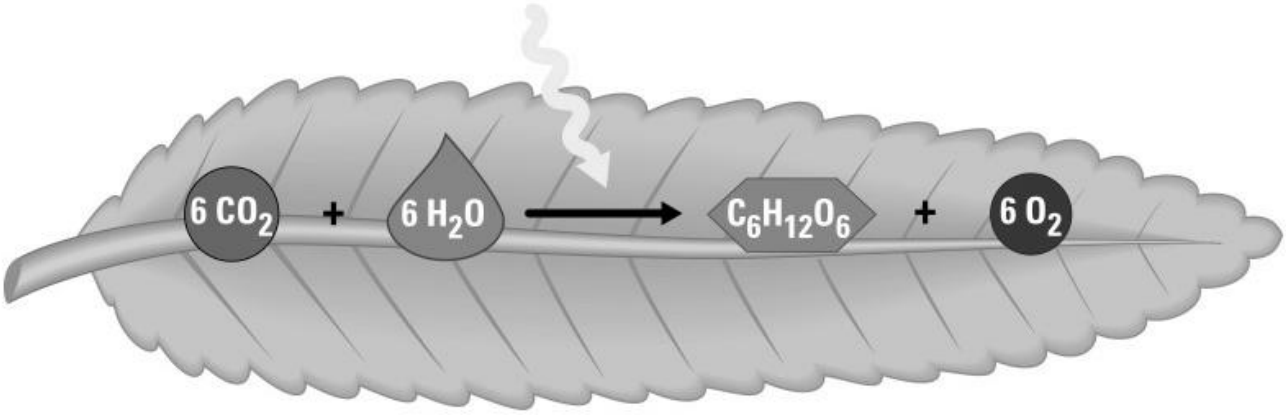
1. Chlorophyll reflects green and yellow parts of the spectrum and absorbs the other wavelengths
2. Chlorophyll *a* is the kind of chlorophyll in green plants
3. Other light absorbing pigments
a. Chlorophyll b
b. Carotenoids

C. Photosynthesis overview
1. Photosynthesis is an endorgonic and the energy needed for this reaction comes from light energy
2. Photosynthesis summarized
a. $6CO_2$ + $6H_2O$ + Chlorophyll and light energy → $C_6H_{12}O_6$ + $6O_2$



D. Part I of photosynthesis, Light Reactions – Light changed to chemical Energy

1. **Chloroplasts contain inner membranes called thylakoid membranes**
2. **There are two parts to the Light Reactions**
   a. **First is the trapping of light**
      1) **The thylakoid membranes in stacks are called grana**
      2) **Light reactions occur on thylakoid membranes**
         a) **Light is absorbed by chlorophyll**
         b) **Electrons in chlorophyll absorb energy causing them to become excited and leave the molecule**
         c) **The excited electron is used to change ADP + P_i to ATP making energy from light available to do biological work**



   b. **Part II of the light reaction is the splitting water**
      1) **Light energy splits H_2O in to H^+, electrons and O_2**
         a) **Electrons from splitting the water are used to replace electrons lost in the chlorophyll**

b) O_2 is given off as a bi-product

2) H^+ Ions attach to coenzyme NADPH to be used later in photosynthesis

E. Part II, The Calvin cycle – synthesizing of sugars takes place in the stroma

1. CO_2, H_2, and O_2 in stroma are put together with the help of the ATP and coenzyme NADPH to form simple sugars usually 3 carbon sugars that combine to form different Starches

III. **It is important to think of photosynthesis and respiration together, not as separate cycles. They are interdependent processes p. 160**