**Module 3**

**Chapter 5 – Microbial Metabolism**

**Catabolic and Anabolic Reactions**

* Metabolism – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Two general types of metabolic reactions:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Recall from Chapter 2:
  + Energy can be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when \_\_\_\_\_\_\_\_\_\_\_\_\_ bonds \_\_\_\_\_\_\_
  + Energy can be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when \_\_\_\_\_\_\_\_\_\_\_\_\_ bonds \_\_\_\_\_\_\_
* Catabolism –
  + Purpose is to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Anabolism –
  + Requires \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to form bonds
  + Purpose is to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Catabolic reactions are “coupled with” anabolic reactions
  + Coupled by \_\_\_\_\_\_\_\_\_
* A metabolic pathway is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of chemical \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a cell
* Metabolic reactions are controlled by proteins – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Enzymes**

* Enzymes are biological catalysts
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for a \_\_\_\_\_\_\_\_\_\_\_\_ chemical reaction
* Specificity is due to \_\_\_\_\_\_\_\_\_\_\_\_\_ of enzyme
  + Proteins (enzymes) have characteristic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Structure is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* If enzyme \_\_\_\_\_\_\_\_\_\_\_\_\_, enzyme doesn’t \_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Enzymes act on one or more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bind at \_\_\_\_\_\_\_\_\_\_
* Each enzyme is specific
* Names of enzymes end in “\_\_\_\_\_\_\_\_\_\_\_\_”
  + Sucr*ase*, catal*ase*, DNA polymer*ase*

*Enzyme components*

* Many enzymes are made entirely of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Some consist of 2 components
  + Apoprotein:
  + Cofactor:
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: organic cofactor
* Holoenzyme:

*Enzyme Mechanism*

* The general sequence of events in an enzymatic reaction
  + Substrate(s) binds to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - This is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + The substrate(s) is transformed
  + Transformed molecule(s), the \_\_\_\_\_\_\_\_\_\_\_\_\_\_, released from enzyme
    - No longer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Enzyme only \_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_\_
  + Enzyme is free to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Sequence continues until enzyme is \_\_\_\_\_\_\_\_\_\_\_\_, or enzyme \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Factors influencing enzymatic activity*

* Enzymes require \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to function
* Hostile environments can cause proteins to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Temperature
  + In general, chemical reactions speed up as temp \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + For enzymes, too \_\_\_\_\_\_\_\_\_\_ temperature causes \_\_\_\_\_\_\_\_\_\_\_
* pH
  + pH is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + All enzymes have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pH
  + \_\_\_\_\_\_\_\_\_\_\_ from preferred pH will \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Inhibitors
  + Certain chemicals that bind to enzymes
* Two classes of inhibitors:
  + Competitive inhibitors – bind \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - *\_\_\_\_\_\_\_\_\_\_\_\_\_\_* with substrate for the \_\_\_\_\_\_\_\_\_\_\_\_\_ of the enzyme
    - \_\_\_\_\_\_\_\_\_ drugs inhibit \_\_\_\_\_\_\_\_\_\_\_\_\_ (an essential \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) synthesis via competitive inhibition
    - \_\_\_\_\_\_\_\_\_ drugs were the first effective antibacterial drugs
  + Noncompetitive inhibitors – bind \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Aka \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ inhibition
    - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ prevents replication of HIV via noncompetitive inhibition

*Feedback inhibition*

* Control of enzymatic activity by use of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Energy Production**

* Energy is stored in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Recall, covalent bonds form by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Energy is stored in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ covalent bonds
* Catabolism involves stripping “high energy” \_\_\_\_\_\_\_\_\_\_ from molecules and concentrate them in the bonds of ATP
* Reactions that involve removing and adding electrons are called “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” reactions

**Oxidation-Reduction reactions**

* Oxidation:
* Reduction:
* \_\_\_\_\_\_\_\_\_\_ reaction: an oxidation reaction \_\_\_\_\_\_\_\_\_ with a \_\_\_\_\_\_\_\_\_\_ reaction
* Catabolism is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of highly \_\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules

**The Generation of ATP**

* Energy released by redox reactions “trapped” by \_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_ is generated by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_
  + Addition of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Requires energy
* 3 types of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to generate \_\_\_\_\_\_\_

Substrate-level phosphorylation

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a PO4- to \_\_\_\_\_\_\_ generates \_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ process
* \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_

Oxidative phosphorylation

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from organic molecule (\_\_\_\_\_\_\_\_\_\_\_\_\_\_) used to generate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) gradient
  + Gradient used to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ production

Photophosphorylation

* Occurs only in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells
* \_\_\_\_\_\_\_ transfers energy to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ electrons
  + \_\_\_\_\_\_\_\_\_ get excited
* Excited \_\_\_\_\_\_\_\_\_\_\_\_ used to generate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gradient, drive \_\_\_\_\_\_\_\_ production
  + Similar to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ phosphorylation, using \_\_\_\_\_\_\_\_ instead of \_\_\_\_\_\_\_ to build dam

**Metabolic pathways of energy production**

* Catabolism involves series of controlled reactions
  + Releasing energy in one reaction generates too much heat
  + Energy cannot be harnessed efficiently
* Catabolism involves a series of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reactions
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extracted to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Sequence of reactions called a \_\_\_\_\_\_\_\_\_\_\_
* Every reaction in a pathway is performed by \_\_\_\_\_\_\_\_\_\_\_

**Carbohydrate catabolism**

* Carbohydrates are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of energy
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is most common energy source
* Glucose is broken down via two general processes:
  + Cellular respiration
  + Fermentation

**Cellular Respiration**

* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** (catabolism) of glucose
  + Waste products are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Most of the \_\_\_\_\_\_\_\_\_\_\_\_\_ is produced via \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ phosphorylation
* Two types of respiration
  + **\_\_\_\_\_\_\_\_\_\_\_\_\_** Respiration – with \_\_\_\_\_\_\_\_\_\_\_\_\_
  + **\_\_\_\_\_\_\_\_\_\_\_\_\_** Respiration – without \_\_\_\_\_\_\_\_\_\_\_\_\_
* Multiple pathways involved

*Glycolysis*

* The \_\_\_\_\_\_\_\_\_\_ of glucose molecule (6 Carbons) to 2 pyruvic acid molecules (3 C)
* Main end-products
  + 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ via \_\_\_\_\_\_\_\_\_\_
* Electron Carriers
  + \_\_\_\_\_\_\_\_ (empty electron carrier) removes electrons from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
    - Becomes \_\_\_\_\_\_\_\_\_\_\_\_\_ (full electron carrier)
  + \_\_\_\_\_\_\_\_\_\_ takes electrons to their final destination

*The pathway*

* Requires 2 \_\_\_\_\_\_\_ to get started
* \_\_\_\_\_\_\_\_\_ is \_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_
* Overall \_\_\_\_\_\_\_\_\_ produced by glycolysis

Glycolysis \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ require oxygen

*Alternatives to glycolysis*

* Pentose-phosphate pathway
  + Uses \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + Operates \_\_\_\_\_\_\_\_\_\_\_\_ with glycolysis
* Entner-Doudoroff pathway
  + Produces \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_
  + Does \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ glycolysis

*Intermediate Step*

* Pyruvic acid (from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) is \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_ is produced
* \_\_\_\_\_\_\_\_ waste

*The Krebs Cycle*

* Aka \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or citric acid cycle
* A series of 8 reaction steps
* Completely catabolizes organic molecule to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Main products are \_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_, 1 ATP
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ carriers
* Final end-product is same as starting reactant; a cycle

*The pathway*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ enters Krebs cycle
* Generates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* 1 ATP produced by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_ generated as waste

*The Electron Transport Chain*

* A series of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pass electrons to ETC
  + Become \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Return to glycolysis, Krebs cycle
* Energy released from \_\_\_\_\_\_\_\_\_\_\_\_\_ used to drive \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from inside cell to \_\_\_\_\_\_\_\_\_\_\_\_ cell
  + Produced \_\_\_\_\_\_\_\_ concentration gradient – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Electrons end up on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ -
* ETC generates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gradient
* \_\_\_ gradient favors \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into cell
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diffuse across membrane freely
* \_\_\_\_\_\_\_ re-enters cell via \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Through transporter called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ captures energy in gradient
  + Produces \_\_\_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Summary of Respiration**

* Aerobic respiration: the final electron acceptor in ETC is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Organism is an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Oxygen is converted to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_
* Anaerobic respiration: the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the ETC is \_\_\_\_\_\_\_\_\_
  + Usually an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Yields \_\_\_\_\_\_\_\_\_\_\_\_ than aerobic respiration because only part of the Krebs cycle operates under \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ conditions
* \_\_\_\_\_\_\_\_\_\_\_\_\_ sources can be used
  + Eg, can oxidize lipids, \_\_\_\_\_\_\_\_\_\_\_\_\_
* Polymers broken down by enzymes
* Smaller subunits enter catabolism at various points of glycolysis, Krebs cycle

**Fermentation**

* Scientific definition:
  + Releases energy from \_\_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_ molecules (food)
  + Does \_\_\_\_\_\_\_\_\_\_\_\_\_ oxygen
  + Does not use the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Uses an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as the final electron acceptor
* ATP generated only via \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_ converted into organic molecule end-product 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Main purpose is to regenerate \_\_\_\_\_\_\_\_\_\_ (from \_\_\_\_\_\_\_\_\_\_\_) for \_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_ can participate in \_\_\_\_\_\_\_\_\_\_\_\_ again
* Produces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of energy - \_\_\_\_\_\_\_\_\_\_\_\_ left in end-product

*The Pathway*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ produces \_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ glucose during glycolysis
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ produced during glycolysis
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pyruvic acid; regenerates \_\_\_\_\_\_\_\_\_\_\_\_
* Lactic Acid fermentation produces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Ethanol fermentation produces \_\_\_\_\_\_\_\_\_\_\_\_\_

**Chemotherapy**

* \_\_\_\_\_\_\_\_\_\_\_ 🡪 highly toxic
  + Inhibit Cytochrome c Oxidase, enzyme in \_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ ETC
  + Cell cannot \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Cell cannot \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Cell \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ not affected by cyanide

**Photosynthesis**

* Photo: conversion of \_\_\_\_\_\_\_\_\_\_ energy into \_\_\_\_\_\_\_\_\_\_\_ energy (\_\_\_\_\_)
  + **\_\_\_\_\_\_\_\_\_\_\_\_-dependent (light) reactions**
* Synthesis:
  + **Carbon \_\_\_\_\_\_\_\_\_\_\_\_\_**: fixing carbon into \_\_\_\_\_\_\_\_\_\_ molecules
* Light energy is absorbed by \_\_\_\_\_\_\_\_\_\_\_\_\_
  + In \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of chloroplasts in eukaryotes
  + In \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of prokaryotes
* Light energizes or “\_\_\_\_\_\_\_\_\_\_” \_\_\_\_\_\_\_\_\_\_\_ in \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Excited electrons are passed on to \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + ATP is generated
* Occurs in two ways:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

*Cyclic photophosphorylation*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ electrons
* \_\_\_\_\_\_\_\_\_\_\_\_ passed on to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* ATP generated by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Electrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Noncyclic photophosphorylation*

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ electrons
* \_\_\_\_\_\_\_\_\_\_\_\_ passed on to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* ATP generated by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + - Electrons placed on \_\_\_\_\_\_\_\_\_\_\_\_ 🡪 forms \_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Electrons in chlorophyll replaced by electrons from \_\_\_\_\_\_\_\_\_\_\_\_\_ 🡪 \_\_\_\_\_\_\_\_ produced as waste

*Light-independent (Dark) reactions*

* + Aka The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cycle
  + Uses ATP, NADPH produced by noncyclic photophosphorylation to “\_\_\_\_\_\_\_\_” \_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_ from \_\_\_\_\_\_\_\_\_\_
  + Process requires lots of \_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ produced

**Metabolic diversity among organisms**

* Organisms classified according to \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Specifically, look at basic requirements to sustain life
* Two classifications based on \_\_\_\_\_\_\_\_\_\_\_ sources
  + Phototrophs –
  + Chemotrophs –
* Two classifications based on \_\_\_\_\_\_\_\_\_\_\_ sources
  + Autotrophs –
    - Aka \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Heterotrophs –
    - Aka \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Classification can be combined

* Photoautotroph
* Photoheterotroph
* Chemoautotrophs
* Chemoheterotrophs

**Chemoheterotrophs**

* Heterotrophs classified according to their source of organic molecule
  + Saprophytes –
  + Parasites –
* Metabolic diversity of great interest
  + Can cause problems, provide potential solutions
    - Rubber degrading bacteria can destroy gaskets in machinery
    - BUT, can be used to degrade discarded tires
    - *Rhodococcus erythropolis* can cause disease in humans, animals
    - BUT, can remove sulfur from petroleum