Cellular Respiration- Equation	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_20$ and energy -The energy is released from the chemical bonds in the complex organic molecules -The catabolic process of releasing energy from food -Food: stored energy in chemical bonds- used to generate ATP -ATP: Useable energy for cell work
Redox Reactions	-The release of energy is dependent on the transfer of e- during rxns -e- transfers are called redox rxns because one substance is always oxidized and one substance is always reduced by the transfer -These rxns are usually paired or linked together -Many of the rxns will be done by phosphorylation
Oxidation	-Loss of electrons -Loss of energy -Loss of hydrogen from carbons
Reduction	-Gain of electrons -Gain of energy -Gain of hydrogen to carbons

Phosphorylation	-Adding a phosphate group to a molecule -A phosphate group adds "energy" to the molecules for chemical rxns
Cell Respiration- Three parts	1. Glycolysis 2. Citric Acid Cycle (Krebs Cycle) 3. Electron Transport Chain and Oxidative Phosphorylation --Chemiosmosis
Glycolysis	-Glyco: glucose -lysis: to slpit -Universal step in all respiration types (aerobic and anaerobic) -Function: to split glucose into two pyruvate molecules and produce NADH and ATP -Location: Cytoplasm -ATPs produced directly by Substrate-Level Phosphorylation: the Pi group is transferred from a substrate to ADP
Electron Carrier Compounds	-Molecules that transport or shuttle electrons within the cell -Exist in two forms: >Oxidized (Ox) ex. NAD+, ADP >Reduced (Red) ex. NADH, ATP

Glycolysis-Requirements	-Glucose -Two ATP (to split the glucose) -ADP -NAD+
Glycolysis- Products	-Two pyruvic acids (from the glucose split) -Two ATP -Two NADH
Citric Acid (Krebs) Cycle	-Function: Oxidize pyruvic acid to CO_2 **Produce NADH and $FADH_2$ -Location: Mitochondria Matrix (center) -Produces most of the cell's energy in the form of NADH and $FADH_2$ -Does not require O_2 -ATPs produced directly by Substrate-Level Phosphorylation: the Pi group is transferred from a substrate to ADP
Krebs Cycle- Requirements	-Pyruvic Acid -CoEnzyme A -NAD+ -FAD -ADP

Krebs Cycle- Products	-CO_2 -Acetyl CoA -NADH -Two ATP -$FADH_2$
Electron Transport Chain	-A collection of proteins that are structurally linked into the inner membrane of mitochondria to produce ATP through e- transfer -Most of the ATP in cellular respiration is produced by Oxidative Phosphorylation: when NADH and $FADH_2$ relay their e- to the ETC and this energy is used to generate a lot of ATP through Chemiosmosis -Function: Convert NADH and $FADH_2$ into ATP -Location: Mitochondria Cristae (inner folds of the membrane)
ETC- Process	-Uses sets of cytochromes, Fe containing proteins to pass electrons down the chain -The cytochromes alternate between RED and OX forms and pass electrons down to O_2 -Each part of the chain becomes reduced as it accepts e- from the uphill neighbor which has a lower affinity for e- (less electronegativity) -It returns to its oxidized form as it passes these e- to the next neighbor
ETC- Requirements	-NADH -$FADH_2$ -ADP -O_2

ETC- Products	-NAD+ -FAD -H2O -ATP (32-34) through oxidative Phosphorylation and chemiosmosis
Chemiosmosis	-FADH2 and NADH provide NRG through e-transfer in the ETC, to actively move H+(protons) across the cristae membrane, building up a concentration gradient -ATP is then generated as the H+ diffuse back across the membrane into the matrix down their concentration gradient
ATP Synthase	-Membrane enzyme that uses the flow of H+ to make ATP As H+ flow back down their concentration gradient through this enzyme, it spins an enzyme complex that accelerates the production of ATP from ADP
How do we make ATP without Oxygen (anaerobic respiration)?	-Fermentation (uses only Glycolysis to make ATP, no ETC) -Two types: (differ in final end product) >Alcoholic >Lactic Acid -Both only produce two ATP -So it isn’t an efficient way to make ATP but if you don’t have O2, two are better than none so it will keep you alive in an unfavorable environment

Alcoholic Fermentation (yeast)	-Uses only Glycolysis -An incomplete oxidation-energy is still left in the products (alcohol) -Does NOT require O2
Lactic Acid Fermentation	-Uses only Glycolysis -An incomplete oxidation-energy is still left in the products (lactic acid) -Does NOT require O2 -Done by human muscle cells under exercise that creates oxygen debt to keep generating ATP -Lactic acid produced as a bi- product is recycled by the liver cells back into pyruvate so if O2 does become available later, we can break it down in respiration
Fermentation- Summary	-Way of oxidizing NADH to NAD+ so glycolysis can still run -Provides ATP to a cell even when O2 is absent (lower rate)
Anaerobes are organisms that carry out fermentation	-Strict Anaerobes: can only do Rs this way (no oxygen) >Ex. Some bacteria -Facultative Anaerobes: can switch Rs types depending on O2 availability >Ex. Yeast, muscle cells

Aerobic vs. Anaerobic	-Anaerobic: Rs without O_2 >AKA: fermentation- glucose goes through Glycolysis only (yields of two ATPs/glucose) -Aerobic: Rs with O_2 >Glucose goes though all three Rs steps (yield of 36 ATPs/glucose)
How did photosynthesis start?	Photosynthesis first evolved in prokaryotic organisms since scientific evidence supports that prokaryotic photosynthesis was responsible for the production of an oxygenated atmosphere. Prokaryotic photosynthetic pathways were the foundation of eukaryotic photosynthesis.
What is Photosynthesis?	-Anabolic process by which plants use light energy to make food -A process that makes complex organic molecules from simple molecules Importance: -Food: either directly or indirectly comes from plants -Oxygen in the air -CO_2 balance in atmosphere
Photosynthesis- Equation	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ Requires: -Chlorophyll -Light -Water

Both Cellular Rs and Photosynthesis occur in plants!	-Rs: splits sugar during Glycolysis to produce pyruvate and ATP (cytosol), which enter the Krebs cycle to produce ATP, $FADH_2$, and NADH that is used in the ETC to produce water and more ATP through oxidative phosphorylation (mitochondria) -Ps: splits H_2O releasing H^+ and e^- to make NADPH and ATP in the light rxns, then uses these compounds to build sugar in the dark rxns (chloroplasts)
Photosynthesis	-Has two chemical rxns that occur within the chloroplasts 1. Light rxn 2. Dark rxn (Calvin Cycle) >Names are from "light" as a requirement, not where or when they occur
Light Reaction Overview	-Occurs in the thylakoid -Water is split releasing H^+, O_2, and e^- -The e^- are energized by light and make NADPH and ATP from ADP and $NADP^+$ -These e^- carrying compounds then move into the dark rxns to make sugar
Dark Reaction (Calvin Cycle) Overview	-CO_2 is reduced by e^- in NADPH and with the energy of ATP to make sugar through several rxns -No light is required

Light	-A form of electromagnetic radiation -Visible light has the right energy for use in Ps Action Spectrum -Not all colors are useable to the same degree for Ps -Red and Blue light: absorbed and used in Ps -Green light: reflected or transmitted
Photosynthesis Pigments	1. Chlorophylls 2. Accessory Pigments
Chlorophylls (Light trapping molecules of Ps)	-Has CHON and Mg -Several types possible -Molecule has a lipophilic tail that allows it to dissolve into membranes -Contains Mg in a reaction center Structure -Double outer membrane -Inner membrane (thylakoid) folded and stacked into grana -Stroma: liquid that surrounds the thylakoid
Accessory Pigments	-Broaden the spectrum of light that can absorb energy and drive Ps -Absorb light energy and transfers it to chlorophyll -Ex. Carotene (orange) Xanthophyll (yellow)

Fall Leaf Colors	-Appear when chlorophyll breaks down -N and Mg from chlorophyll salvaged and moved into the stem for next year -Accessory pigments remain behind, giving the various fall leaf colors
Light Reaction	-Location: Thylakoid membrane within the grana of the chloroplasts -Function: Use light energy to split water and produce ATP and NADPH
Photosystems	-Collection of pigments that serve as a light trap -Made of chlorophyll and the accessory pigments that absorb photons (light particles) and transmit e- to a rxn center complex where they are finally transferred to a primary e- acceptor to produce NADPH and ATP -Two types know: PSI and PSII -Light energizes both photosystems which work together to generate ATP and NADPH to be transferred to the dark rxns so they can make glucose
Light Reaction- Requirements	-Light -Water -ADP +Pi -NADP+

Light Reaction- Products	-O_2 -ATP -NADPH
PSII Chemiosmosis Model	-The chloroplast produces ATP in PSII of the light rxns the same way the mitochondria made so many in Rs -Light energy is used to excite e-that will pump H+ across a membrane as e- move down an ETC -When the H+ diffuses back through ATP synthase, ATP is generated
PSI	-Has an ETC too, but instead of its e- producing ATP, it produces NADPH -Both the ATP from PSII and the NADPH from PSI move into the stroma and enter the dark rxns (Calvin cycle) to make sugar
Dark Reactions (Calvin Cycle)	-How plants actually makes food (carbohydrates) -Does not require light directly to run -Also known as the calvin cycle or C3 Ps -Function: to use ATP and NADPH from light rxns to build glucose from CO_2 -Location: stroma of the chloroplast

Rubisco	-Ribulose Bisphosphate Carbohydrate -Most important enzyme on earth -Enzyme that adds CO2 to an acceptor molecule and binds the glucose in the dark rxns
Photosynthesis: Requirement	-6CO2 -ATP -NADPH
Photosynthesis: Products	-C6H12O6 -ADP +Pi -NADP+
Ps:Rs Ratios	-Reflect a plant's balance in making food and using food. 1. Ps>Rs, extra free energy available for growth and reproduction 2. Ps=Rs, no growth but don't die either, just maintain 3.Ps<Rs, consuming more free energy than producing, eventual death by starvation

Factors that Affect Ps	1.Light: quantity and quality 2.Temperature: too hot or too cold 3.CO2: often limits C3 plants 4.Minerals: especially NPK and Mg