General Biology II (101-HTK)
Photosynthesis Concepts and Learning Outcomes

Topic	Concept	Learning Outcomes
Overview of photosynthesis	1. Photosynthesis is a metabolic process by which light energy (sun) is captured to reduce CO_2 into carbohydrates, and in that process H_2O is oxidized into O_2: $6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ 2. In eukaryotic cells, photosynthesis occurs in chloroplasts and involves 2 metabolic pathways: light-dependent reactions (driven by light energy captured by chlorophyll and resulting in the production of ATP and NADPH + H^+) and light-independent reactions (Calvin cycle) (does not use light directly; uses ATP, NADPH + H^+, and CO_2 to produce sugars).	1. Describe the overall photosynthetic process in terms of redox reactions 2. Distinguish between light-dependent reactions and light-independent reactions
Properties of light and photon absorption by molecules	3. Light is a form of electromagnetic radiation; amount of energy in light is inversely proportional to its wavelength. 4. Light acts like a particle (called photon) as well as like a wave; each photon has a specific amount of energy. 5. Molecules become excited when they absorb photons, causing electrons to move to higher energy shells (more reactive).	3. Describe the physical properties of visible light and explain the relationship between a wavelength of light and it's energy level 4. Outlines the 3 different possible interactions between photons and atoms or molecules
Pigments and absorption/action spectra	6. Pigments are molecules that absorb wavelengths in the visible range. 7. Several types of pigments absorb energy for photosynthesis; these pigments include chlorophylls, carotenoids, and phycobilins. 8. The green pigment chlorophyll is found in thylakoid membranes and mostly absorbs blue and red light. 9. In some plants, accessory pigments, such as carotenoids, absorb wavelengths between red and blue and transfer that energy to chlorophyll. 10. The absorption spectrum of a pigment is a plot of absorbed light against wavelength, while an action spectrum is a plot of biological activity of an organism as a function of light wavelength.	5. Define pigment and give examples of pigments used in photosynthesis 6. Distinguish between absorption spectrum and action spectrum of a pigment
Chlorophyll and	11. Plants have 2 predominant types of chlorophyll: chlorophyll *a* and	7. Describe the basic structure of

photosystems	chlorophyll *b*, which absorb blue and red wavelengths (near the ends of the visible spectrum). 12. Both chlorophyll pigments consist of a porphyrin ring and a long hydrocarbon tail. 13. In the thylakoid membrane, 200 to 300 chlorophyll molecules and accessory pigments are grouped together in complexes called photosystems. 14. A photosystem consists of 2 main parts: antenna complex (light-harvesting) and reaction center (energy conversion by chlorophyll *a*). 15. Chlorophyll *a* in the reaction center converts light energy into chemical energy by absorbing light energy and transforming it into excited e^- that is transferred to other molecules.	chlorophyll and explain its association with photo systems in chloroplasts 8. Describe what happens to an electron in chlorophyll when light energy is absorbed
Light reactions: cyclic and non-cyclic electron transport and photophosphorylation	16. There are 2 different electron transport systems in photosynthesis: noncyclic electron transport, in which the excited e^- is "lost" and the process ends up with the formation of a reduced compound (NADPH), and cyclic electron transport that involves the return of the excited e^- back to chlorophyll in photosystem I after giving up energy to make ATP. 17. Noncyclic electron transport (aka noncyclic photophosphorylation) results in the formation of NADPH + H^+ and ATP and O_2. 18. Light energy captured by photosystem II (or I) is used to build a proton-motive force in thylakoids, which in turn is coupled to ATP production via chemiosomosis and ATP synthase activity (photophosphorylation).	9. Describe the flow of electrons through photo systems I and II in the non-cyclic electron transport pathway and the products produced; contrast this with cyclic electron transport 10. Using a diagram, explain how a proton gradient is established across the thylakoids membrane and how this gradient functions in ATP synthesis