IDX G10 Biology H
Study Guide S1 Midterm
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7.3 Cell transport

- Solution (e.g.cytoplasm): liquld mixture with ≥2 substances
- Concentration→ mass/volume, mole/litre
- Passive transport→no need energy→diffusion, facilitated diffusion
- active transport

1) Diffusion
   - molecules tend to move from high concentration to low concentration until reaching equilibrium
   - cause substance to move across cell membrane but does not require energy
   - equilibrium: concentration on both side is the same
     - no further changes in concentration
     - solutes continue to move in both directions in equal number(no net movement)
   - higher temperature, faster rate of diffusion
   - greater concentration difference, faster rate of diffusion
2) Facilitated Diffusion
   - movement of specific molecules across cell membranes through transport protein
   - no energy consumes
   - high to low concentration
   - temperature, concentration difference, number of carrier or channel proteins in membrane increase, rate increases
   - Osmosis
     - Involve only diffusion of water across selectively permeable membrane, which only some substances can pass through
     - water move from low to high solute concentcacion to dilute the concentrated solutions
     - water moves from more free water to less free water spaces
     - many cells contain water channel proteins named aquaporins that allow water to pass faster through cell membrane
     - isotonic solution: concentration of water and solute be the same on both sides of membrane
     - hypertonic solution: higher concentcation of solute
     - hypotonic solution: lower concentoation of solute

- Osmosis: water moves from hypotonic solution to hypertonic
- Osmotic pressure: pressure exerted by osmosis on the hypertonic side of selectively permeable membrane
- Plant cell and bacteria have cell wall to prevent cell from expanding
- Contractile vacuole: in some protozoans, pump excess water out of cell

3) Active Transport

- requires energy(ATP)
- protein pump: moves materials against concentration difference (from low to high concentration)
  - Eg: Na+-K+ Pump: pumping Na+ out and K+ in against concentration gradients
- bulk transport: endocytosis and exocytosis, fuse of vescicle
  - transport large molecules or a large amount of small molecules/ions by movement of cell membrane
  - Endocytosis: process of taking material into cell by infoldings or pockets of cell membrane that forms a vescicle entering the cytoplasm
    - ① phagocytosis: process of large particles taken into cell by endocytosis
    - ② pinocytosis: process of solution taken into cell
  - Exocytosis: removal of large amount of material from cell, membrane of vesicles fuses with cell membrane

8.1 Energy and Life

- forms of energy include light, heat, electricity, and chemical energy
- Energy stored in ATP (Adenosine Triphesphate)→Adenine (contain nitrogen), ribose (5 carbon sugar), three phosphate group
- Adenosine diphosphate (ADP)→adenine, ribose, 2 phosphate groups
- Cells can store small amount of energy by adding a phosphate group to ADP
- ATP is used by all types of cell as basic energy source
- Release energy: subtract third phosphate gcoup
- Using the energy
  - ① Active transport: sodium potassium pump uses 1 ATP to move 3 Na+ out and 2 K+ in
  - ② Motor protein move organelles along microtubules using ATP
  - ③ Protein synthesis

4. Responses to chemical signals at cell surface
5. Produce light

- Glucose store 90 times more enegy than ATP
- cells regenerates ATP from ADP by using energy in food (e.g. glucose , protein, lipid)
- Autotroph: produce food by photosynthesis/chemosynthesis
- Animal(sea slug) can carry out photosynthesis
- Heterotroph: obtain energy from food that are consumed

8.2 Photosynthesis: An Overview

- Discovery of photosynthesis
  - 1643, Jan Van Helmont watered plant for 5 years and measured the mass of the soil. He found that most of the mass increase of plant came from water
  - 1711, Joseph Priestley used a candle, jar, mint plant to experiment. The mint released oxygen gas
  - 1779, Jam Ingenhousz, light is necessary for plants to produce oxygen gas
- In the presence of light, plants transform carbon dioxide and water into carbohydrates and release oygen
- Light and pigment
  - white sunlight is a mixture of different colors
  - visible light made by visible spectrum
  - photosynthesis requires light and pigment, molecules in chloroplast
  - chlorophyll: principle pigment, includes chlorophyll a and b
  - chlorophyll absorbs well in violet-blue and red regions, but not well in green region
  - carotenoid: red, orange, yellow pigments, absorb light in violet and blue green regions
    - As temperature drops, chlorophyII break down first, leaving carotenoids pigments to see in the autumn
- Chloroplast
  - outer and inner membranes
  - thylakoid: saclike photosynthetic membrane containing chlorophyll
  - stroma: fluid portion, outside of a thylakoid
  - grana: stacks of thylakoid membrane
- Energy Collection
  - chlorophyll absorbs light

    - the energy from light are collected in the electrons in chlorophyll--energy levels are raised--high energy electrons make photosynthesis work
- Electron Carriers
    - a compound that can accept a pair of high energy electrons and transfer them to another molecules
    - e.g. NADP+
- Oxidation and reduction
    - oxidized: substances lose electrons
    - reduction: gain electrons
- Light dependent reaction
    - thylakoid membrane
    - need light and water
    - release oxygen gas
    - produce ATP, NADPH
- Light independent reaction
    - stroma
    - need carbon dioxide
    - need ATP, NADPH
    - produce sugar

8.3 Reactions of Photosynthesis

Light dependent reaction

- Thylakoid membrane
- Photosystems
    - clusters of chlorophyll and proteins
    - contain light harvesting complex
        - accessory pigments
        - a matrix of protein
    - contain reaction center complex
        - a pair of chlorophyll a
        - a matrix of protein
        - a primary electron acceptor
- use solar energy to produce oxygen gas and convert ADP, NADP+ into ATP and NADPH
- photosystem I and II are connected by the transfer of electrons through electron transport chain

A. Photosystem II

- pigments(P680)
- energy--electron--ETC
- photolysis: water split to replenish the lost high energy electrons

B. Electron Transport Chain

- a series of electron carrier proteins that move the high energy electrons from PS II to PS I
- proteins in ETC use energy from electrons to pump hydrogen ions from stroma into thylakoid space
- plastoquinone(PQ): first electron carrier
- cytochrome complex: second carrier(pump hydrogen ions)
- plastocyanin(PC): third electron carrier

C. Photosystem I

- pigment uses solar energy to recognize electrons
- electrons pass down the second short ETC to protein ferredoxin(Fd)
- NADP+ picks up 2 high enegry electrons--NADPH
- NADP+ reductase catalyzes the transfer of electrons from Fd to NADP+

D. Hydrogen ion movement

- in thylakoid space: more hydrogen ions(positively charged)
- in stroma: fewer hydrogen ions(negatively charged)
- gradient of hydrogen ions provide energy to make ATP

E. ATP Formation

- hydrogen ions pass through ATP synthase
- ATP synthase rotates and produces ATP
- chemiosmosis: process that uses enegry stored in the proton gradient to make ATP

Calvin Cycle

- uses ATP and NADPH from light dependent reaction to produce high energy sugars in stroma
- ribulose biphosphate(RuBP): 5 carbon compound, combine with carbon dioxide

- glyceraldehyde-3 phosphate(G3P): 3 carbon compound

A. CO^2 enter the cycle

- $6CO^2$+6RuBP-->12 PGA
- catalyzed by an enzyme Rubisco

B. Energy Input

- 12 ATP and 12 NADPH provide energy to convert the 12 PGA into 12G3P

C. 6 carbon sugar produced

- two of 12 G3P convert into one 6-carbon sugar
- remaining 10 G3P converted to 6 RuBP

D. RuBP regenerated

- 10 G3P converted to 6 RuBP
- uses energy from 6 ATP
- 6 RuBP combine with 6 new carbon dioxide, new cycles begin

- Overall, 6 molecules of carbon dioxide is used to produce one 6-carbon sugar which stores long term energy, builds complex carbohydrate
- 12 NADPH and 18 ATP consumed

Measuring rate of photosynthesis

- oxygen gas production
- carbon dioxide consumption
- biomass increase of plant

Factors of Photosynthesis

- Water
    - raw material
    - plants have cuticle to prevent water loss
        - waxy waterproof layer on leaves
- Temperature
    - most enzymes work best between 0-35 degree celsius
    - too high temperature will denature the photosynthetic enzyme

- Light intensity
    - light intensity increase, rate increase
    - after maximum rate, reach a plateau
- Carbon dioxide
    - low to fairly high carbon dioxide concentrations: rate positively correlated to carbon dioxide concentration
    - very high carbon dioxide concentrations: reach plateau
    - very low carbon dioxide concentrations: no photosynthesis

C4 plants

- spatially separate capturation of carbon dioxide and usage of carbon dioxide
- PEP carboxylase has high affinity for carbon dioxide but low affinity for oxygen gas
- light dependent reaction happen in mesophyll cell
- bundle-sheath cell is a high carbon dioxide, low oxygen gas environment
- fix carbon dioxide into 4-carbon compounds instead of 3-carbon molecules
- capture at even very low levels of carbon dioxide
- enables photosynthesis to keep working under intense light and high temperatures
- E.g. Corn, sugarcane, sorghum

CAM plants

- adapted to dry climate
- keep stomata closed during the day, allow carbon dioxide to enter leaves only at night
- E.g. cacti, pineapple tree