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# KINE 2P09

Lecture 2

## Cell Membrane

“phospholipid bilayer” hydrophobic tails  and hydrophilic heads, have polar heads and non-polar tails, and more cholesterol in the membrane the stiffer it gets

Which cells membrane has the lowest lipid (or fat content) and why? Inner mitochondrial membrane

## Cell Organelles: Nucleus

- most cells not red blood cells
- stores genetic material, chromatin (DNA), nucleolus (ribosomal RNA or rRna), nuclear pres

## Cell Organelles: Mitochondrion

- energy productions
- inner and outer membrane
- matrix - inside first membrane then second membrane thats the matrix
- consumes O2 and makes ATP, krebs/TCA cycle, Oxidative phosphorylation

## Cell Organelles: Endoplasmic Reticulum (ER) and Ribosomes

- smooth and rough lumen (ER) ribosomes can be embedded or floating around
- network of intracellular membranes
- ribosomes: protein synthesis

## Cell Organelles: Lysosomes and Peroxisomes

- Lysosomes: degrading enzymes, autophagy, liver - alternate bioenergetic function, white blood cells - bacterial digestion (very acidic)
- Peroxisomes: liver and kidney, consume O2, do not produce energy, produce hydrogen peroxide, deal with excess fatty acids - alternate route of metabolism, remove dangerous toxins and compounds

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## Cell Organelles: Golgi

- packages things for secretion
- e.g., hormones, breast milk, known for storage

## Vaults

- mRNA or ribosomal subunits transport
- may contribute to “multi-drug resistance”
- cancer cells
- exact function is not clear

## Cytoskeleton

- determine the shape of the cell, structural support, organizes the con-tense of the cell, linking enzymes in metabolism, assembly of cells into tissue, movement of cell, intracellular transport (microtubules)
- microtubule, microfilaments, intermediate filaments

## Kinesin

- formed by two proteins, heads attach to microtubule to transport things
- two way vascular axonal transport facilitated by the micro tubular “highway” in a nerve cell

## Protein Synthesis

* appendix C *

### What are proteins?

- essential for cell function: muscle contraction - contractile proteins, Enzymes - for energy metabolism; synthesis, Transporters - to move molecules in and out, string of amino acids so we call them “Polymers” or chains of different amino acids
- every protein is different, and have a different sequence
- order is important
- must be identical for good working order
- no room for error

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## The DNA Code:

- DNA is a nucleic acid (not a protein)
- Bases:
- A (adenine)
- G (guanine)
- C (cytosine)
- T (thymine)
- create 3 letter “words” to code for the 20 amend acids used in proteins
- called “ codons ”
- G and C will always bind together and A to T will bind
- bases line up in pairs called “double helix”
- DNA is located in the nucleus
- need to make copy for protein synthesis in cytoplasm
- to make a copy of DNA we need to create messenger RNA

DNA copied to messenger RNA

- a “copy” of the “message” is made in RNA
- Very similiar to DNA, except U (uracil) replaces T
- single strand
- copies one of the DNA strand is called Transcribe a copy
- process known as “ transcription ”

Cell structure and Function Other types of RNA

## The code:

- DNA, AAA would become UUU in the mRNA
- translated into phenylalanine (Phe)

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- order of the DNA bases dictates order of the proteins amino acids

Types of RNA:

Messenger RNA or mRNA:

- copy of the DNA strand to be brought to cytosolic ribosomes

Ribosomal or rRNA:

- part of the ribosomal structure

Transfer or tRNA:

- integral in the actual building of the protein on the ribosomes
- “smart” assembly line “wheelbarrow”

The process

- working copy the DNA, what we call transcription
- RNA polymerase is an enzyme
- Transcription = a copy of DNA strand is made into mRNA
- this is regulated !! = gene expression
- mRNA is “processed” or “spliced”
- final mRNA leaves nucleus through nuclear pores
- messenger RNA is attached to the ribosomes
- the stronger the signal the more it wants to respond
- making the protein is called translation, tRNA brings appropriate amino acids as it “reads” the mRNA codons
- tRNA bringing in the amino acids for protein chain being synthesized
- mRNA attaches to ribosomes, tRNA brings appropriate amino acids as it “reads” the mRNA codons, amino acids are attaches in order, proteins are synthesized “translation”, process stopped when a “stop” codon is encountered, end up with your completed protein.

## Muscle Adaptation and Gene Expression

- certain proteins increase/decrease expression

- especially important in muscle :
- e.g., body building )increased expression of contractile proteins)
- e.g., increased aerobic capacity (increased expression of mitochondrial enzymes)

Muscle adaptation - changing the [protein]

DNA —> mRNA —> protein

“transcription factors” in order to start the process

“increased transcription or “gene expression” = more mRNA for that gene

RNases - enzymes that digest mRNA (destroy mRNA)

“mRNA stability”

increased [mRNA] (either increased transcription or increased stability)

translation stage occasionally this does not mean that the [protein] increases

***slide 8 **

Tissue compartments

- total body water (~42L)
- ICF = Intracellular fluid (inside cell)
- ~28 vL (2/3 of TBW)
- ECF = extracellular fluid (outside cell)
- ~12L (1/3 of TBW)
- 1. interstitial fluid (between cells) = cellular environment > ~11 L
- 2. plasma (~3L)

Movement of Molecules across membrane

Endo (in) - and Exo (out) - cytosis

examples of endocytosis - pinocytosis, receptor-mediated endocytosis and phagocytosis

exocytosis - fusion pore and secretion

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Diffusion - molecules are going to move from high concentration to low concentration to distribute evenly (balanced)

Factors that influence  the rate of diffusion

1. concentration the higher the better
2. temperature - move faster with higher temperature
3. mass/size of the molecule - smaller molecule faster the rate of diffusion
4. surface area - increase diffusion the faster diffusion happens (classroom example)
5. medium - air faster then water
6. distance - how far does it have to go

Simple diffusion through a membrane

- rate of diffusion is faster through a membrane if:
- the membrane surface area is larger
- the membrane is thinner
- the concentration gradient is larger
- the membrane is more permeable to the molecule
- permeability depends on:
- lipid solubility of the molecule
- molecules size
- the lipid composition of the membrane

Simple Diffusion

- does it happen to any significant extent in humans? (oxygen)

Facilitated diffusion - e.g., Pores

Osmosis (movement of water)  and cell volume determined by tonicity

Faciitated diffusion - pores

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-aka “water pores”

- some water travels through membrane
- aquaporins speed things up
- tunnels
- easier for water to pass through ‘hydrophobic’ regions of membrane

Osmosis and Cell Volume

- water diffuses through aquaporins from higher to lower concentration
- must consider [water]
- high [solute] (osmolality), then water moves towards it
- hypo = under hyper= over

“Simple (unassisted) diffusion” and “Facilitated (assisted) diffusion”

simple diffusion

- pores vs channels
- open and close

Facilitated diffusion “ligand -gated channel

“gated channels”

- ligand - gated : a molecule binds to the receptor on or near the channel to change the conformation and open it
- voltage - gated: a change in the electrical charge in the membrane near to the channel will open it
- How is a transporter different from a channel: they are the same because they both move along there concentration gates but a transporter has a binding site for its molecule of interest

Facilitated Diffusion *** test exam

- pores
- channels

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- transporters
- - what do they have in common? how do they differ? * exam long answer

Facilitated Diffusion Glucose Transporters

- GLUT1 and GLUT4
- bring glucose into the cells
- most GLUTs are facilitated diffusion
- in skeletal muscle and adipose tissue: GLUT1 = basal
- GLUT4 = “insulin stimulated”

REMEMBER!!!!!!!!!!

- simple diffusion - from high to low concentration - no protein carrier
- facilitated diffusion - transporters or channels or pores
- sometimes must move things against concentration gradient
- “Active Transport”

Movement of molecules along a concentration gradient

- simple/facilitated diffusion goes down
- active transport goes up : similiar to transporters, but against concentration gradient, must use energy = ATP, ATPase to break down to ADP and Pi
- to examples:
- calcium ATPase in muscle
- sodium/potassium (ATPase) pump

1. Sarcoplasmic ca2+ -ATPase “SERCA” : this is an endoplasmic reticulum in muscle = sarcoplasmic reticulum, there are calcium channel whether they are open or closed they can still flow through. You can close CA2+ channels but that does not change the cytosolic [Ca2+], angry contraction: mechanical work of actin/myosin: myosin ATPase (future study) energy of relaxation: sarcoplasmic Ca2+ -ATPase (SECRA)
2. Sodium/ Potassium pump: intracellular K+, extracellular Na+ , pumps 3 Na out and 2 K in , uses 1 ATP to do this, higher concentration of sodium outside the cell and

higher potassium inside the cell, therefore pumps ions against concentration gradient. Chemical gradient: difference in concentration. Electrical gradient: different charge.. Primary active transport vs secondary active transport