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Question 1 4 pts



A molecule has a higher concentration inside of a cell than outside of a cell.

Which of the following would allow more of this molecule to enter the cell?

Adding more transporter proteins that have the ability to move the molecule down its concentration gradient

Allowing simple diffusion to take its course, which will eventually allow more of the molecule to enter the cell

Correct Answer

Using a pump powered by ATP to move the molecule against its concentration gradient

All of the other answers are correct



Question 2 4 pts



Which of the following statements about the cell membrane is TRUE?

Correct Answer

- ☐ Cholesterol stiffens cell membranes to help maintain optimal membrane fluidity
- ☐ Phospholipids help maintain optimal membrane fluidity following sudden changes in temperature
- ☐ The majority of the lipids in the cell membrane are cholesterol
- ☐ Phospholipids have a hydrophobic head and a hydrophilic tail



Question 3 4 pts



Which of the following is an example of facilitated diffusion?

Oxygen diffusing across the cell membrane of the lungs to enter the bloodstream

Correct Answer

Glucose entering the cell via the GLUT1 transporter in order for glycolysis to occur

Glucose being transported against its concentration gradient by the SGLT transporter in intestinal cells

All of the other answers are correct



Question 4 4 pts



If the membrane potential for a neuron is measured to be -60mV, which of the following would contribute to this measurement?

More negative charged ions outside of the cell and more positively charged ions inside the cell

Correct Answer

More positively charged ions outside of the cell and more negatively charged ions inside the cell

An equal distribution of positively and negatively charged ions on both sides of the cell membrane

None of the other answers are correct



Question 5 4 pts



Charged solutes are governed by both chemical and electrical gradients to determine their net flux across cell membranes.

Which of the following is FALSE?

Correct Answer



When the electrical and chemical gradients operate in opposing directions, there will never be net movement of ions across the membrane



It is possible for an ion to move against its concentration gradient if the electrical gradient operates in the opposing direction and is of greater magnitude



If the chemical and electrical gradients operate in the same direction across the cell membrane, it would require an input of energy to move ions in the opposite direction



If an ion is negatively charged and the inside of the cell membrane is positively charged relative to the outside of the cell membrane, the electrical gradient for this ion would be directed into the cell



Question 6 4 pts



Under conditions of low ATP and high oxygen availability, which of the following would you expect to happen to phosphofructokinase-1 activity?

Correct Answer



Phosphofructokinase-1 activity would increase, in order to continue glycolysis to produce intermediates for oxidative phosphorylation



Phosphofructokinase-1 activity would increase, in order to produce large amounts of lactic acid as an alternative energy source via fermentation



Phosphofructokinase-1 activity would decrease, because the conversion of fructose 6-phosphate to fructose 1,6-bisphosphate requires ATP to be consumed and the cell has limited ATP



Phosphofructokinase-1 activity would decrease because this is the rate limiting step of glycolysis



Question 7 4 pts



With regard to mitochondrial energy generation, which of the following is the most important product of the TCA cycle?

- ☐ CO₂
- ☐ GTP
- ☐ NADH and FADH₂
- ☐ Intermediates used in amino acid anabolism



Question 8 4 pts



Following the advice of a nutritional YouTuber, you decide to completely replace carbohydrates with fats in your diet.

If your rate of glycolysis begins to decline due to low glucose levels, would you expect similar decreases in oxidative phosphorylation?



Yes, because acetyl-CoA is necessary for the TCA cycle and is produced from pyruvate, the end product of glycolysis



Yes, because cellular respiration is a sequential process beginning with glycolysis and ending with oxidative phosphorylation

Correct Answer

- ☐ No, because β -oxidation of fat can produce acetyl-CoA directly, bypassing glycolysis
- ☐ No, because fats also utilize glycolysis to generate intermediates for cellular respiration



Question 9 4 pts



Which of the following cells would NOT significantly engage in lactate acid production?

Correct Answer

- ☐ Neurons under aerobic conditions
- ☐ Red blood cells, which lack mitochondria
- ☐ Skeletal muscle cells during intense exercise
- ☐ Kidney cells under anaerobic conditions



Question 10 4 pts



When we eat a sugary snack, how does the glucose we digest enter our lungs to be utilized for ATP generation?

- ☐ Glucose does not enter the lungs for ATP generation, the lungs are part of the respiratory system

Correct Answer



Glucose will enter the bloodstream following absorption in our stomachs and intestines and travel throughout the body, entering lung cells via facilitated diffusion



Glucose will go to the liver where all glycolysis takes place, and the ATP produced through cellular respiration will be distributed throughout the body, including to the lungs



Glucose will enter the lungs directly because some of the food that we eat goes to the lungs instead of the stomach



Question 11 4 pts



Which of the following is an accurate description of the electron transport chain?



The electron transport chain is a series of oxidation reactions beginning with the oxidation of NADH and ending with the oxidation of O_2 into H_2O



The electron transport chain is a series of reduction reactions beginning with the reduction of NADH and ending with the reduction of O_2 into H_2O

Correct Answer



The electron transport chain is a series of redox reactions beginning with the oxidation of NADH and ending with the reduction of O_2 into H_2O



The electron transport chain is a series of redox reactions beginning with the reduction of NADH and ending with the oxidation of O_2 into H_2O



Question 12 4 pts



Which of the following is FALSE regarding ATP Synthase?



ATP Synthase can operate bidirectionally, either converting ADP and P_i into ATP, or performing the reverse reaction



ATP Synthase is akin to a mechanical rotor whose ratcheting mechanism is powered by the proton-motive force



A steep electrochemical gradient provides a source of great potential energy that is dissipated across the mitochondrial inner membrane via ATP Synthase

Correct Answer



In the absence of ATP Synthase we would not be able to produce any ATP from the metabolic breakdown of glucose



Question 13 4 pts



Which of the following is NOT a reason FADH_2 enters the electron transport chain at a different point than NADH ?

- ☐ The active site of Complex I is specific to the structure of NADH , and FADH_2 would not be acted on by the enzyme
- ☐

The redox potential of FADH_2 is greater than that of Complex I and so it would not be able to donate its electrons to Complex I

Correct Answer



FADH_2 utilizes Complex II only to donate its electrons, which is not a proton pump, and so FADH_2 does not contribute to the electrochemical proton gradient utilized for oxidative phosphorylation

- ☐ These are all reasons why FADH_2 enters the electron transport chain at a different point than NADH



Question 14 4 pts



Which of the following is TRUE of photosynthesis?

Correct Answer



Photosynthesis is a reciprocal process of cellular respiration, utilizing water and carbon dioxide to produce oxygen and sugar

- ☐ In photosynthesis, the Calvin cycle is the chloroplasts version of the electron transport chain
- ☐ There is no ATP generation involved in photosynthesis, only ATP consumption
- ☐ Photosynthesis, not cellular respiration, is the main source of energy production in plants



Question 15 4 pts



You are a researcher investigating cellular ATP generation. You have the following inhibitors at your disposal:

Inhibitor X blocks the catalytic activity of the TCA cycle enzyme citrate synthase completely, preventing the conversion of oxaloacetate and acetyl-CoA into citrate

Inhibitor Y is a steric inhibitor of cytochrome C, and prevents the movement of electrons from Complex III to Complex IV in the electron transport chain

Usage of which inhibitor would lead to **less** ATP production per molecule of glucose?

Correct Answer



Inhibitor X, as the TCA cycle would be prevented from operating, and no high energy intermediates would be created for the electron transport chain and oxidative phosphorylation



Inhibitor X, because pyruvate produced through glycolysis would be sequestered to the cytosol



Inhibitor Y, because O_2 would not be able to be used as the final electron acceptor and so ATP production would not occur



Inhibitor Y, because the electrochemical proton gradient would not be produced and ATP would only be produced via glycolysis



Question 16 4 pts



Which of the following is TRUE of cytosolic vs. membrane-bound ribosomes?

These ribosomes are completely different, do not interact with each other, and perform separate functions
mRNA that produces ER-resident proteins will be trafficked to the rough ER and bind to ribosomes there to initiate translation

Correct Answer

These are the same ribosomes, some are transiently directed to the endoplasmic reticulum following recognition of a signal sequence in the newly synthesized peptide, then return to the cytosol after completing translation
All ribosomes begin as cytosolic, but some will eventually be destined for the endoplasmic reticulum, and will then remain there permanently, as part of the rough-ER



Question 17 4 pts



Would you expect GTP concentration to be higher in the nucleus or the cytosol?

Correct Answer



GTP will be higher in the nucleus, to facilitate the activation of Ran via GEFs



GTP will be higher in the nucleus, to activate Ran-GAP and lead to nuclear import factor binding



GTP will be higher in the cytosol, because Ran is a GTPase enzyme



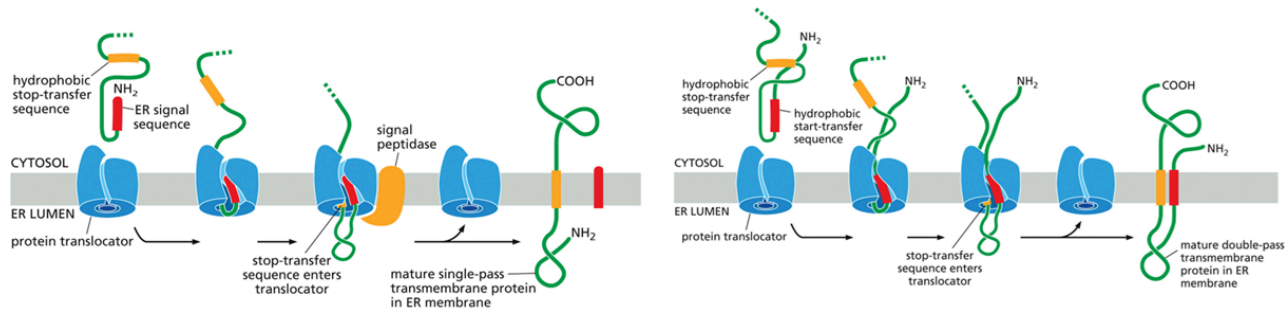
GTP will be higher in the cytosol, because Ran-GEFs will exchange GTP for GDP, leading to nuclear import factor dissociation



Question 18 4 pts



Which of the following is NOT an accurate interpretation for the image below?



☐ Internal hydrophobic start/stop transfer sequences determine the membrane orientation of the translated protein

Correct Answer

☐

The fact that the start/stop transfer sequences are hydrophobic is incidental to recognition by the SRP and protein translocator, and would be able to effectively perform their structural transmembrane roles irrespective of amino acid sequence

☐

An N-terminal ER-signal sequence would be cleaved by the signal peptidase, leading to the N-terminus of the protein remaining inside the ER lumen

☐

If there were only an N-terminal ER-signal sequence and no subsequent stop-transfer sequences, the result would be a free protein in the ER lumen, not anchored to the membrane

⋮

Question 19 4 pts

✎ ✕

Which of the following is TRUE of exocytosis?

☐ Exocytosis is the process by which cellular material is brought into the cell via clathrin

☐ Exocytosis only occurs in a highly regulated fashion following a signal which promotes secretion

Correct Answer

☐

Exocytosis involves tethering interactions between proteins on the vesicle and target membranes which fuse following a physical tug-of-war

☐

Exocytosis is generally considered to be a separate cellular process, completely unrelated to endomembrane transport via the ER and the Golgi

⋮

Question 20 4 pts

✎ ✕

If a cell performs endocytosis and the internalized cargo contains a protein with a C-terminal KDEL sequence, which of the following would you expect to occur?

Correct Answer

☐

Following early endosome formation, this KDEL sequence would be recognized by the cell and transported to the ER via retrograde transport



This protein would be degraded by the lysosome, because endocytosis is predominantly a means of recycling metabolites



This protein would be immediately sent back out of the cell back where it came from because it had been incorrectly trafficked



Following early endosome formation, the Golgi would recognize this protein and send it to the mitochondria for import via TOM and TIM



Question 21 4 pts



Platelet-derived growth factor (PDGF) is an important growth factor involved in development and wound healing.

Which of the following would be an accurate description of PDGF signaling across cell types?

As all of our cells contain the same DNA, we would expect PDGF to have the same signaling effect when binding to its receptor regardless of the cell type

For the same type of cell, we would expect PDGF binding to its receptor to elicit the exact same response irrespective of temporal environmental factors

PDGF binding to a skin cell would be expected to have a different effect than when it binds to a liver cell, because the DNA sequence is different for skin and liver cells, leading to different protein distributions and signaling cascades

Correct Answer

Depending on the needs and intracellular environment of the particular cell, PDGF binding to its receptor could have completely different signaling effects in one instance versus a separate instance, even within the same cell



Question 22 4 pts



Will cell signaling events typically alter protein function (i.e., "fast" signaling) or protein synthesis (i.e., "slow" signaling)?

Correct Answer



It depends whether the signaling event can be resolved with the proteins already present in the cell or if new proteins need to be produced to adapt to a new environment



Protein function will typically be leveraged, because this occurs significantly faster than protein synthesis, and the cell will always try to resolve the signaling event as quickly as possible



Protein synthesis will typically be leveraged, because most signaling involves intracellular trafficking to the nucleus to affect transcription



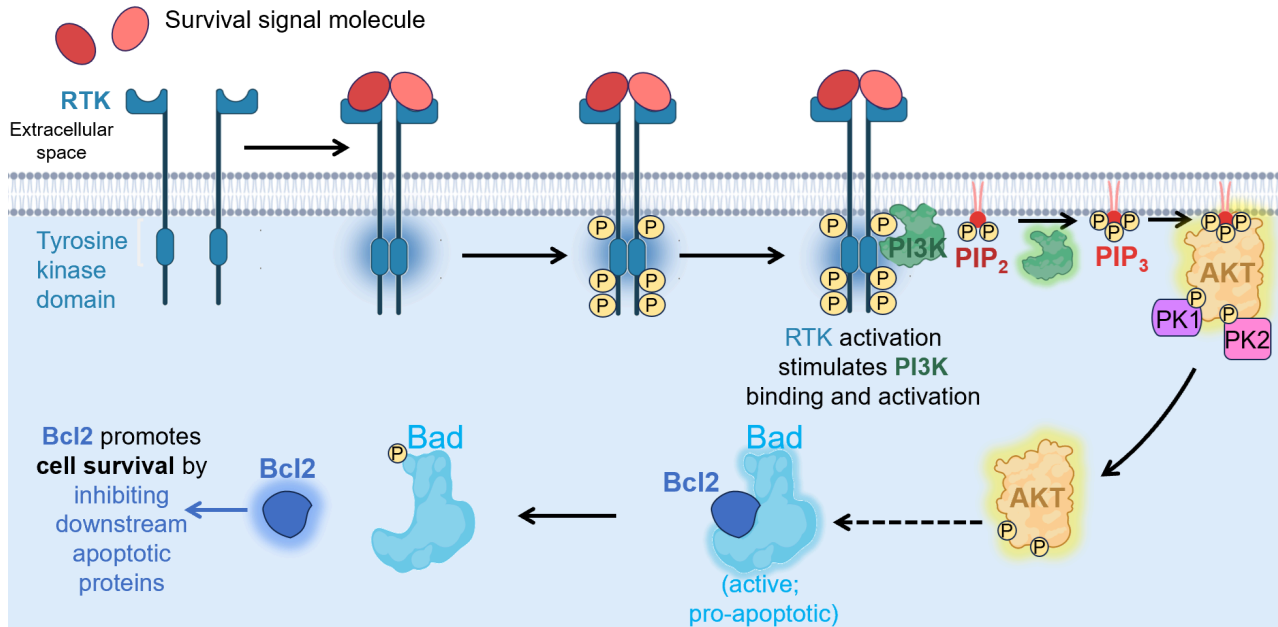
Signaling events will typically leverage protein synthesis first, and if this does not work effectively, they will alter protein function to attempt to address the signal



Question 23 4 pts



Below is shown the Bcl2 survival signaling cascade. Which of the following scenarios is accurate:



Correct Answer

A mutation in PI3K that causes it to phosphorylate PIP₂ in the absence of extracellular ligand binding would promote cell survival

A mutation in AKT that makes it catalytically inactive, and therefore unable to phosphorylate Bad, would promote cell survival

A mutation in the receptor tyrosine kinase that leads to autophosphorylation in the absence of extracellular ligand binding would promote apoptosis

A mutation in Bad that prevents it from binding to Bcl2 would promote apoptosis



Question 24 4 pts



Several signaling pathways rely on nuclear translocation to affect gene expression.

Which of the following is TRUE?



The 3-dimensional conformation of a protein is fixed due to thermodynamic equilibrium, and will not be altered by phosphorylation or second messenger binding. Rather, these events themselves signal for nuclear import to affect gene transcription

Correct Answer



Translocation generally occurs following a conformational change in the 3-dimensional structure of the protein, revealing a nuclear localization sequence



The nuclear translocation of species such as PKA occurs through a separate mechanism to the Ran-GTP cycle discussed for nuclear resident protein import

☐ Pathways which leverage nuclear translocation always use GPCR signaling



Question 25 4 pts



G α , Rab, Ran, and Ras are all GTPases. What is the purpose of GTPases in cell signaling?

☐ As the name suggests, GTPases hydrolyze GTP, this is their only role



The main role of GTPases is to couple with unfavorable reactions and allow them to occur, similar to how ATP is used in cells

Correct Answer



GTPases act as molecular switches that turn on cell signaling events when bound to GTP and turn off these same cascades when bound to GDP



GTPases are not enzymes themselves, but interact with enzymes such as kinases, GAPs, and adenylyl cyclase to activate them in signaling cascades

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