Cytology week 3 Test bank

Lecture: The Nucleus

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Q1. **How does Ran determine the directionality of nuclear import?** Book question

A. Ran-GTP is concentrated in the cytoplasm, ensuring import occurs in one direction
B. Ran-GTP is concentrated in the nucleus, and its gradient regulates the directionality of transport
C. Ran-GDP binds to importins to direct proteins into the nucleus
D. Ran determines directionality by directly binding to mRNA

Q2. **How would mutational inactivation of the nuclear export signal of a protein that normally shuttles back and forth between the nucleus and cytoplasm affect its subcellular distribution?** Book question
A. The protein would accumulate in the cytoplasm
B. The protein would shuttle between nucleus and cytoplasm more frequently
C. The protein would accumulate in the nucleus
D. The protein would be degraded

Q3 .What roles do lamins play in nuclear structure and function?Book question
A. They help transport proteins across the nuclear membrane
B. They form a structural network that supports the nuclear envelope and organize chromatin
C. They act as receptors for nuclear localization signals
D. They aid in transcription and translation inside the nucleus

Q4. You inject a frog oocyte with two globular proteins, one 15 kDa and the other 100 kDa —both of which lack nuclear localization signals. Will either protein enter the nucleus? Book question

A. Neither protein will enter the nucleus
B. Both proteins will enter the nucleus
C. Only the 15 kDa protein will enter the nucleus
D. Only the 100 kDa protein will enter the nucleus

Q5. You are studying a transcription factor that is regulated by phosphorylation of serine residues, which inactivates its nuclear localization signal. How would mutating these serines to alanines affect subcellular localization of the transcription factor and expression of its target gene?Book question

A. The transcription factor would remain in the cytoplasm and its target gene would not be expressed
B. The transcription factor would continuously enter the nucleus, leading to constitutive expression of its target gene
C. The transcription factor would be degraded
D. The transcription factor would fail to bind to DNA, preventing target gene expression

Q6 . **What role does the nuclear localization sequence (NLS) play in protein import?**

A. It allows proteins to bind to Ran-GTP.
B. It signals proteins for degradation.
C. It is recognized by importin to transport proteins into the nucleus.
D. It assists in protein phosphorylation.

Q7. What is the role of GTP hydrolysis in the Ran/importin cycle?

A. It helps bind cargo proteins to importin.
B. It releases Ran from importin and allows Ran to be transported back to the nucleus.
C. It assists in mRNA processing.
D. It promotes phosphorylation of importin.

Q8. Imagine a protein with a nuclear export signal (NES) is not able to exit the nucleus. What might be the most likely cause of this issue? (2 answers)

A. The protein lacks a functional Ran/GTP molecule to facilitate export.
B. Importin is unable to bind to the protein, preventing nuclear export.
C. The protein's nuclear export signal (NES) is mutated, preventing exportin binding.
D. Exportin has failed to hydrolyze GTP in the cytoplasm, trapping the protein in the nucleus.

Q9. If a cell suddenly upregulates the production of exportin proteins, how might this impact the export of ribosomal RNA and the assembly of ribosomes in the cytoplasm?

A. Ribosomal RNA export would increase, potentially enhancing ribosome assembly and protein synthesis.
B. Exportins would block ribosomal RNA export, causing a backup in the nucleus.
C. mRNA export would be inhibited as exportins take over all nuclear export processes.
D. Exportins would degrade ribosomal RNA, reducing protein synthesis.

Q10. Nucleolus-associated domains (NADs) are often associated with which form of chromatin?
A. Euchromatin, as it is transcriptionally active
B. Heterochromatin, which is less transcriptionally active
C. Chromatin that regulates nuclear import
D. Ribosomal DNA that controls protein synthesis

Q11. A geneticist studying the expression of immunoglobulin genes finds that genes from different chromosomes are transcribed in the same nuclear site. What is the most likely explanation?

A. Co-regulated genes, like immunoglobulin genes, often cluster in the same transcription factories to coordinate their expression.

B. The genes must be located next to each other on the same chromosome to be expressed simultaneously.

C. The genes are co-transcribed as a single polycistronic mRNA.

D. These genes are regulated by proteins exclusively located in the cytoplasm, where transcription occurs.

True - False Questions for review !!

1. The outer membrane of the nuclear envelope shares a similar protein composition with the endoplasmic reticulum, but it lacks ribosomes.
2. The nuclear lamina interacts with chromatin and localizes heterochromatin to the periphery of the nucleus, impacting gene regulation.
3. Lamin polypeptides form dimers through their α-helical regions, which then assemble into tetramers to create the structural support of the nuclear lamina.
4. Mutations in the emerin gene, which binds to the nuclear lamina, are associated with Hutchinson-Gilford progeria, an autosomal dominant disease.
5. The mechanical stress hypothesis suggests that the connection between the nuclear lamina and the cytoskeleton renders muscle cells particularly vulnerable to nuclear envelope defects.
6. The gene expression hypothesis proposes that nuclear lamina mutations lead to generalized changes in gene expression across all cell types.
7. Ran/GTP is responsible for both importing and exporting proteins through the nuclear pore complex by binding importin and exportin, respectively.
8. The bipartite nature of the nuclear localization sequence (NLS) means it consists of two distinct segments of basic amino acids.
9. Nucleoporins regulate the permeability of the nuclear pore complex, selectively allowing small molecules and macromolecules to pass through by passive diffusion.
10. Karyopherins, a family of transport proteins, play a crucial role in the nucleocytoplasmic transport of RNA, facilitated by Ran/GTP.

Answers Key

1. B
2. C
3. B
4. C
5. B
6. C
7. B
8. A - C
9. A
10. B
11. A

True / false ?

1. F
2. T
3. T
4. F
5. T
6. F
7. T
8. T
9. F
10. F