LEC 13 Q CYTOLOGY:

1. What is the primary role of MAP kinases in cell signaling?

A) To initiate DNA replication
B) To regulate processes like cell proliferation, survival, and differentiation
C) To prevent apoptosis in cancer cells
D) To transport proteins into the nucleus

2. In cancer, what is a common result of the dysregulation of MAP kinase pathways?

A) Decreased cell proliferation
B) Uncontrolled or excessive cell proliferation
C) Increased apoptosis
D) Suppressed tumor formation

3. What does the RAS protein do when it is activated?

A) Inhibits MAP kinase signaling
B) Increases the activity of GTPase-activating proteins (GAPs)
C) Binds to Raf and activates the MAP kinase pathway
D) Hydrolyzes GTP to GDP, leading to its own inactivation

4. Which of the following cancers is most commonly associated with mutations in the RAS gene?

A) Prostate Cancer
B) Pancreatic Cancer
C) Breast Cancer
D) Lung Cancer

5. What is the role of GTPase-activating proteins (GAPs) in the RAS activation process?

A) They exchange GDP for GTP on RAS
B) They help turn off RAS by stimulating GTP hydrolysis to GDP
C) They directly activate Raf
D) They recruit MEK to the plasma membrane

6. Which of the following best describes the function of RAF in the Ras/Raf/MAPK signaling pathway?

A) RAF directly phosphorylates transcription factors
B) RAF binds to RAS and is activated to phosphorylate MEK
C) RAF hydrolyzes GTP to GDP to inactivate RAS
D) RAF transports ERK to the nucleus for gene activation

7. What is a key difference between a proto-oncogene and an oncogene?

A) A proto-oncogene is a mutated gene that promotes cancer, while an oncogene is normal
B) A proto-oncogene promotes cancer when mutated, while an oncogene is always active

C) A proto-oncogene is always active, while an oncogene is dormant
D) An oncogene is involved in regulating cell death, while a proto-oncogene promotes cell growth

8. Which of the following is a characteristic of RAF inhibitors in cancer treatment?

A) They inhibit PI3K activity
B) They specifically target mutated RAF to prevent tumor growth
C) They activate the Ras/Raf/MEK/ERK pathway to enhance cell survival
D) They inhibit apoptosis in cancer cells

9. What is the main function of the PI 3-kinase/Akt pathway in cells?

A) To regulate transcription factor activity in the nucleus
B) To activate the Raf/MEK/ERK pathway
C) To promote cell survival, metabolism, and protein synthesis
D) To inhibit cell proliferation

10. What role does Akt play in the PI 3-Kinase/Akt signaling pathway?

A) Activates GSK (glycogen synthase kinase) to promote protein synthesis
B) Inhibits pro-apoptotic factors to enhance cell survival
C) Phosphorylates Raf to activate the MAPK pathway
D) Stimulates GTP hydrolysis to turn off PI 3-kinase activity

11. How does sustained ERK activation influence cell differentiation?

A) It leads to rapid cell division and increased proliferation
B) It promotes neuronal differentiation when combined with PI3-kinase pathway activation
C) It leads to apoptosis in differentiated cells
D) It inhibits the differentiation process and promotes undifferentiated cell states

12. What happens when NF-κB is activated in response to signaling pathways like MAPK?

A) NF-κB directly suppresses inflammation
B) NF-κB is trapped in the cytoplasm and prevents transcription
C) NF-κB activates genes involved in immune response and inflammation
D) NF-κB binds to GSK to regulate protein synthesis

13. How does the PI 3-kinase pathway contribute to feedback regulation in signaling?

A) By inhibiting ERK signaling to prevent excessive cell growth
B) By activating Akt, which inhibits Raf, maintaining balance between signaling pathways
C) By directly phosphorylating IκB to release NF-κB
D) By promoting the differentiation of stem cells into specific tissue types

14. What is one challenge in developing effective RAS inhibitors for cancer therapy?

A) Ras is difficult to target due to its small size and inability to bind other proteins
B) Ras is involved in many cellular functions, making its inhibition toxic to normal cells
C) RAS inhibitors are ineffective because RAS mutations do not affect the MAPK pathway
D) RAS inhibitors cause excessive apoptosis, reducing the overall effectiveness of cancer treatment

15. What is the significance of chromatin structure (euchromatin vs. heterochromatin) in signaling responses?

A) Chromatin structure determines whether transcription factors can bind to DNA and activate gene expression
B) Chromatin structure affects the translation of mRNA into proteins
C) Euchromatin inhibits gene expression, while heterochromatin promotes cell proliferation
D) Both euchromatin and heterochromatin are equally accessible for transcription factors

Answers:

1. **B**
2. **B**
3. **C**
4. **B**
5. **B**
6. **B**
7. **B**
8. **B**
9. **C**
10. **B**
11. **B**
12. **C**
13. **B**
14. **B**
15. **A**

16. What is the function of Grb in the Ras/Raf/MAPK signaling pathway?

A) To phosphorylate ERK in the nucleus
B) To recruit GEF to activate Ras
C) To inhibit the activation of Raf
D) To bind directly to MAPK to initiate gene expression

17. In the MAPK signaling pathway, what does the activation of ERK lead to?

A) Inhibition of transcription factors
B) Translocation to the nucleus to activate genes involved in cell proliferation
C) Degradation of Raf
D) Inactivation of RAS through GTP hydrolysis

18. How does the RAS mutation contribute to cancer progression?

A) It decreases the activity of the Raf/MEK/ERK pathway
B) It keeps RAS in its active GTP-bound state, leading to continuous activation of downstream signaling pathways

C) It prevents the activation of MAP kinases
D) It reduces the cell's ability to respond to growth factors

19. Which of the following is true regarding the feedback loop involving NF-κB?

A) NF-κB activation results in the degradation of IκB, but IκB synthesis eventually inhibits further NF-κB activity
B) NF-κB inhibits the transcription of IκB, leading to prolonged NF-κB activation
C) NF-κB directly phosphorylates and activates MAP kinases
D) The NF-κB feedback loop is unrelated to inflammation and immune responses

20. How does the PI 3-Kinase/Akt pathway affect protein translation?

A) By inhibiting translation machinery in the cytoplasm
B) By phosphorylating translation initiation factors to promote protein synthesis
C) By suppressing the expression of ribosomal proteins
D) By degrading mRNA in the nucleus to prevent translation

21. What is the role of PIP3 in the PI 3-Kinase/Akt pathway?

A) It inhibits Akt activation
B) It acts as a docking site for Akt and other kinases, facilitating their activation
C) It directly activates mTORC2
D) It phosphorylates PDK1, leading to the activation of Akt

22. How does Akt regulate cell survival in the PI 3-Kinase/Akt pathway?

A) By promoting apoptosis and cell death
B) By inhibiting pro-apoptotic factors like BAD and FOXO
C) By activating NF-κB to promote immune responses
D) By increasing the expression of pro-apoptotic genes

23. What is one of the challenges associated with RAS-targeted cancer therapy?

A) Ras is difficult to target directly due to its strong binding affinity for GTP
B) Ras mutations do not significantly alter cancer cell growth
C) Inhibition of Ras leads to increased cell differentiation
D) The high mutability of Ras makes it difficult to design stable inhibitors

24. What occurs when PI 3-Kinase is recruited to an activated receptor?

A) It phosphorylates PIP2 to produce PIP3, which activates downstream signaling pathways
B) It directly phosphorylates the receptor to create docking sites for Akt
C) It deactivates the MAPK signaling pathway by blocking Raf activation
D) It inhibits GTP exchange on Ras, preventing its activation

25. Which of the following best describes the effect of sustained ERK activation in cells?

A) It inhibits cell proliferation and leads to cell death
B) It promotes cell differentiation, particularly in neurons

C) It prevents the activation of PI 3-kinase
D) It decreases the expression of growth factors

26. How does chromatin structure influence gene expression in signaling pathways?

A) Chromatin compaction prevents signal transduction by inhibiting receptor binding
B) Loose chromatin (euchromatin) allows access to transcription factors, promoting gene expression
C) Heterochromatin allows for increased transcription factor binding
D) Chromatin structure has no effect on gene expression

27. What is the role of mTORC2 in the PI 3-Kinase/Akt signaling pathway?

A) It inhibits Akt activation by preventing its binding to PIP3
B) It phosphorylates Akt, aiding in its activation
C) It inactivates MEK to prevent ERK phosphorylation
D) It inhibits protein synthesis in response to nutrient levels

28. In the context of cancer therapy, why is personalized medicine important when targeting mutations in RAS or RAF?

A) Genetic testing allows for the identification of specific mutations, which can be targeted with specific inhibitors
B) Personalized medicine focuses on inhibiting the NF-κB pathway in all patients
C) Targeted therapies can be applied universally regardless of mutation status
D) It guarantees complete suppression of tumor growth in all patients

29. Which of the following is a key feature of receptor tyrosine kinases (RTKs) in the Ras/Raf/MAPK signaling pathway?

A) They translocate to the nucleus upon ligand binding
B) They contain a cytosolic domain with kinase activity that undergoes autophosphorylation
C) They bind directly to transcription factors for gene activation
D) They act as a direct binding site for Akt

30. Which of the following best describes the outcome of activating the PI 3-Kinase/Akt pathway in a cell?

A) Increased cell proliferation and differentiation, but inhibition of survival pathways
B) Promotion of cell survival and metabolism, with inhibition of apoptosis
C) Suppression of cell cycle progression and initiation of apoptosis
D) Decreased protein synthesis and nutrient uptake

Answers:

16. **B**
17. **B**
18. **B**
19. **A**
20. **B**

21. **B**
22. **B**
23. **A**
24. **A**
25. **B**
26. **B**
27. **B**
28. **A**
29. **B**
30. **B**

31. How does the activation of GTP-bound Ras influence the downstream signaling cascade in the Ras/Raf/MAPK pathway?

A) It directly phosphorylates MEK, leading to ERK activation
B) It binds to Raf, activating it to phosphorylate MEK
C) It binds to ERK, leading to nuclear translocation
D) It deactivates GAPs, preventing GTP hydrolysis on Ras

32. Which protein complex is responsible for deactivating Ras through GTP hydrolysis in the Ras/Raf/MAPK pathway?

A) Grb2
B) GEF
C) GAP
D) MEK

33. What is the key molecular difference between a mutated Ras and wild-type Ras in the context of cancer?

A) Mutated Ras binds to GDP instead of GTP, making it inactive
B) Mutated Ras cannot be inactivated because it cannot hydrolyze GTP to GDP
C) Mutated Ras binds more strongly to GTPase-activating proteins (GAPs)
D) Wild-type Ras is always active, while mutated Ras is inactive

34. In the Ras/Raf/MAPK signaling pathway, what role does MEK play after activation by Raf?

A) MEK phosphorylates Raf to amplify signaling
B) MEK phosphorylates and activates ERK, which then translocates to the nucleus
C) MEK directly activates transcription factors in the cytoplasm
D) MEK inactivates RAS by hydrolyzing GTP

35. Which of the following best describes how the PI 3-Kinase/Akt pathway promotes cell survival?

A) Akt phosphorylates and inactivates the pro-apoptotic protein BAD, preventing cell death
B) PI 3-Kinase phosphorylates PIP2 to form PIP3, which then directly inhibits apoptosis
C) Akt phosphorylates p53 to promote apoptosis
D) PI 3-Kinase enhances protein degradation, reducing cell growth

36. What is the function of Grb2 in the Ras/Raf/MAPK signaling cascade?

A) Grb2 binds to Ras and activates it directly
B) Grb2 acts as an adapter protein, linking the receptor tyrosine kinase to GEF
C) Grb2 binds to ERK to promote its nuclear translocation
D) Grb2 inhibits the activation of MEK by Raf

37. Which of the following best describes the role of Raf in activating MEK in the Ras/Raf/MAPK pathway?

A) Raf recruits MEK to the plasma membrane to activate ERK
B) Raf phosphorylates and activates MEK by adding phosphate groups
C) Raf dephosphorylates MEK, turning it off to prevent overactivation
D) Raf promotes the exchange of GDP for GTP on Ras, leading to MEK activation

38. How does the activation of NF-κB contribute to cancer progression in relation to the MAP kinase pathway?

A) By promoting the expression of pro-apoptotic factors that lead to cell death
B) By amplifying inflammation and immune responses, which contribute to the tumor microenvironment
C) By inhibiting cell proliferation pathways, slowing tumor growth
D) By inactivating MAP kinases and preventing tumor cell survival

39. What is the role of mTORC1 in regulating the PI 3-Kinase/Akt signaling pathway?

A) mTORC1 phosphorylates Akt to increase its activity
B) mTORC1 inhibits protein translation by phosphorylating translation factors
C) mTORC1 is activated by Akt and regulates protein synthesis, promoting cell growth
D) mTORC1 directly inhibits PI 3-Kinase to block cell survival pathways

40. Which of the following best describes the relationship between the Ras/Raf/MAPK and PI 3-Kinase/Akt pathways?

A) They are completely independent and do not influence each other's signaling events
B) The Ras/Raf/MAPK pathway negatively regulates the PI 3-Kinase/Akt pathway to prevent excessive cell growth
C) The activation of Ras leads to the activation of both the Ras/Raf/MAPK and PI 3-Kinase/Akt pathways
D) The PI 3-Kinase/Akt pathway inhibits Ras activation to prevent aberrant signaling

41. How does chromatin structure (euchromatin vs. heterochromatin) affect gene expression in response to signaling pathways like MAPK and PI 3-Kinase?

A) Euchromatin allows transcription factors to bind DNA, promoting gene expression, while heterochromatin prevents this, silencing gene expression
B) Euchromatin prevents gene expression by blocking transcription factor binding, while heterochromatin activates gene expression
C) Both euchromatin and heterochromatin are equally permissive for transcription factor binding
D) Heterochromatin is essential for the activation of the PI 3-Kinase pathway, while euchromatin is essential for MAPK activation

42. In terms of targeted cancer therapy, what is the main challenge in inhibiting Ras compared to Raf?

A) Ras mutations lead to the complete loss of MAPK signaling, making Ras inhibitors ineffective
B) Ras is a small GTPase that binds tightly to GTP, making it difficult to target with small molecules
C) Raf inhibitors work more effectively in blocking tumor growth compared to Ras inhibitors due to their specificity
D) Ras is involved in processes outside of cell proliferation, making it less important in cancer progression

43. What is the significance of PI 3-Kinase recruiting other kinases like PDK1 and mTORC2 to the plasma membrane?

A) To activate PI 3-Kinase through phosphorylation, amplifying the signal
B) To phosphorylate Akt and other downstream targets, activating survival and metabolic pathways
C) To prevent Akt from binding to PIP3, effectively silencing the pathway
D) To inactivate transcription factors like NF-κB, preventing inflammation

44. What is the primary function of IκB in regulating NF-κB activation during signaling cascades?

A) IκB binds to and prevents NF-κB from entering the nucleus, regulating immune responses and inflammation
B) IκB amplifies NF-κB signaling by phosphorylating transcription factors
C) IκB degrades Ras to prevent activation of the MAPK pathway
D) IκB activates the PI 3-Kinase pathway by phosphorylating PIP2

45. What is the importance of feedback loops in signaling pathways like MAPK and PI 3-Kinase in maintaining cellular homeostasis?

A) Feedback loops prevent the activation of growth-promoting pathways, ensuring proper cell differentiation
B) Feedback loops enhance pathway activation, leading to continuous cell proliferation
C) Feedback loops regulate the intensity and duration of signaling to prevent excessive activation or inhibition, maintaining cellular balance
D) Feedback loops prevent gene expression in response to external signals, controlling metabolic activity

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Answers:

31. **B**
32. **C**
33. **B**
34. **B**
35. **A**
36. **B**
37. **B**
38. **B**

39. **C**
40. **C**
41. **A**
42. **B**
43. **B**
44. **A**
45. **C**

46. What is the significance of Raf binding to GTP-bound Ras in the Ras/Raf/MAPK signaling pathway?

A) It prevents Raf from phosphorylating MEK, maintaining cellular quiescence
B) It activates Raf, allowing it to phosphorylate and activate MEK
C) It inactivates MEK, stopping the MAPK cascade
D) It directly phosphorylates ERK, bypassing MEK

47. Which of the following best explains why RAS mutations are often implicated in late-stage cancers like pancreatic cancer?

A) RAS mutations are usually silent and do not affect tumor progression
B) Mutated Ras is constitutively active, driving cell proliferation without external growth signals
C) RAS mutations prevent the activation of downstream MAPK and PI 3-Kinase pathways
D) Mutated Ras reduces the effectiveness of chemotherapy agents

48. What role do GTPase Activating Proteins (GAPs) play in Ras regulation?

A) GAPs promote the exchange of GDP for GTP on Ras, activating it
B) GAPs inhibit Ras activation by accelerating the hydrolysis of GTP to GDP
C) GAPs directly bind to Raf to activate the MAPK pathway
D) GAPs recruit Grb2 to activate Ras in response to growth factors

49. What is the function of Grb2 in the context of receptor tyrosine kinase activation in the Ras/Raf/MAPK pathway?

A) Grb2 directly activates Ras by exchanging GDP for GTP
B) Grb2 serves as an adapter protein, linking the activated receptor to Ras-specific GEFs
C) Grb2 prevents Ras from binding to GTP, keeping Ras inactive
D) Grb2 phosphorylates and activates Raf, promoting the downstream cascade

50. In cancer therapy, what is the major reason RAF inhibitors have been successful in treating certain cancers like colorectal cancer?

A) RAF inhibitors target mutant RAS directly, preventing the activation of MAPK signaling
B) RAF inhibitors block the Ras/Raf/MAPK signaling pathway downstream of mutated Ras, reducing cancer cell proliferation
C) RAF inhibitors inhibit PI 3-Kinase, preventing the activation of Akt
D) RAF inhibitors stimulate tumor suppressor pathways, inducing cell death in cancer cells

51. How does the activation of ERK lead to the regulation of gene expression in the nucleus?

A) ERK directly binds to DNA to initiate transcription
B) ERK phosphorylates transcription factors, enabling them to bind DNA and regulate target genes
C) ERK inhibits chromatin remodeling enzymes to prevent transcription
D) ERK activates histone deacetylases to repress gene expression

52. What is the consequence of sustained activation of the PI 3-Kinase/Akt pathway in tumor cells?

A) Decreased protein synthesis and cellular differentiation
B) Increased cell survival, proliferation, and resistance to apoptosis
C) Decreased glycolytic activity and enhanced oxidative phosphorylation
D) Inhibition of DNA repair mechanisms and increased tumor cell sensitivity to radiation

53. What is the relationship between mTORC1 and ERK signaling in the context of cancer cell metabolism?

A) mTORC1 inhibits ERK activation, reducing cell proliferation
B) mTORC1 activation by ERK enhances protein synthesis, promoting cell growth and metabolism
C) ERK phosphorylates mTORC1 to suppress its activity, inhibiting protein synthesis
D) mTORC1 downregulates ERK expression, reducing tumor progression

54. Which of the following best explains the role of PIP3 in the PI 3-Kinase/Akt pathway?

A) PIP3 serves as a membrane-bound docking site for Akt and other kinases, facilitating Akt phosphorylation and activation
B) PIP3 inhibits Akt activation by preventing its binding to the plasma membrane
C) PIP3 promotes the degradation of Akt, silencing the pathway
D) PIP3 activates mTORC2, leading to the inhibition of Akt

55. How does the interaction between PI 3-Kinase and Akt contribute to cell survival?

A) PI 3-Kinase phosphorylates BAD, allowing it to promote apoptosis
B) Akt inhibits pro-apoptotic proteins like FOXO and BAD, preventing cell death
C) PI 3-Kinase activates caspase-3, triggering programmed cell death
D) Akt dephosphorylates the pro-apoptotic protein BAX, promoting cell survival

56. What is the role of mTORC2 in Akt activation within the PI 3-Kinase/Akt signaling pathway?

A) mTORC2 directly activates Akt by phosphorylating it at a specific site
B) mTORC2 suppresses Akt activation by preventing its binding to PIP3
C) mTORC2 inhibits PI 3-Kinase, reducing PIP3 levels and suppressing Akt activation
D) mTORC2 prevents Akt from translocating to the nucleus, thereby inhibiting its functions

57. In the context of signaling, how does NF-κB contribute to the feedback regulation in the MAPK pathway?

A) NF-κB directly phosphorylates IκB to deactivate it, allowing NF-κB to enter the nucleus
B) NF-κB activates a negative feedback loop by inducing the transcription of IκB, which inhibits further NF-κB activation
C) NF-κB phosphorylates Ras, inhibiting its GTP-binding activity
D) NF-κB suppresses the transcription of genes involved in inflammation, blocking MAPK pathway activity

58. What effect does the activation of PI 3-Kinase have on glucose metabolism in cancer cells?

A) It promotes glucose uptake and glycolysis, supporting increased ATP production for cell growth
B) It suppresses glycolysis by inhibiting glucose transporter proteins
C) It activates oxidative phosphorylation, shifting metabolism from glycolysis to mitochondrial respiration
D) It inhibits glucose metabolism by promoting autophagy

59. Which of the following best explains how cancer cells can hijack the PI 3-Kinase/Akt pathway for survival?

A) By increasing PI 3-Kinase activity and decreasing apoptosis pathways, leading to uncontrolled cell proliferation
B) By downregulating Akt expression, preventing cell cycle progression
C) By inhibiting the mTORC1 complex, leading to reduced cell survival signals
D) By preventing phosphorylation of PIP2, silencing the pathway

60. How do mutations in the RAS gene specifically affect downstream signaling in tumorigenesis?

A) RAS mutations increase the GTPase activity, inactivating Ras and preventing tumor growth
B) Mutated Ras remains in its active GTP-bound form, continuously activating the Ras/Raf/MAPK and PI 3-Kinase pathways, promoting cancer cell proliferation
C) Mutated Ras inhibits the activation of Raf and MEK, suppressing cell division
D) RAS mutations prevent the binding of GEFs, rendering the Ras pathway inactive

Answers:

46. **B**
47. **B**
48. **B**
49. **B**
50. **B**
51. **B**
52. **B**
53. **B**
54. **A**
55. **B**
56. **A**
57. **B**
58. **A**
59. **A**

60. **B**

61. How does the activation of Raf by GTP-bound Ras specifically contribute to the Ras/Raf/MAPK signaling cascade?

A) Raf directly dephosphorylates MEK to prevent downstream signaling
B) Raf phosphorylates and activates MEK, which then activates ERK
C) Raf activates PI 3-Kinase, which in turn activates Akt
D) Raf inhibits ERK activation to control cell proliferation

62. Why are mutations in the RAS gene particularly significant in pancreatic cancer?

A) They result in complete loss of function of the MAPK pathway, leading to cellular senescence
B) Mutated Ras remains permanently active, continuously driving cell proliferation even without external signals
C) Mutated Ras enhances apoptosis, leading to tumor cell death
D) Mutations in Ras reduce glucose metabolism in cancer cells, limiting tumor growth

63. What is the key consequence of a Raf mutation in the Ras/Raf/MAPK signaling pathway in the context of cancer?

A) Raf mutations prevent the activation of MEK, thus halting the MAPK signaling cascade
B) Raf mutations lead to the overactivation of MEK and ERK, promoting uncontrolled cell proliferation
C) Raf mutations block Akt activation, reducing cancer cell survival
D) Raf mutations inhibit Ras binding, preventing MAPK pathway activation

64. In cancer therapy, why are RAS inhibitors considered a major challenge to develop?

A) Ras activation occurs at the DNA level, making it impossible to target with drugs
B) Ras has a very short half-life, complicating its inhibition by small molecules
C) Ras is difficult to directly target due to its smooth surface and lack of distinct binding sites
D) Ras mutations cause the protein to be inactive, reducing its potential as a therapeutic target

65. Which of the following is a primary function of Akt once it is activated in the PI 3-Kinase/Akt pathway?

A) Akt increases the synthesis of pro-apoptotic factors, promoting cell death
B) Akt inhibits the translation of proteins required for cell division
C) Akt promotes cell survival by inhibiting apoptotic factors and activating pro-survival proteins
D) Akt reduces glucose uptake, slowing down cell metabolism

66. How does the feedback loop between IκB and NF-κB control excessive inflammation in response to MAPK activation?

A) IκB promotes NF-κB activation by recruiting additional transcription factors
B) NF-κB activation leads to the transcription of IκB, which binds to NF-κB and prevents its nuclear translocation
C) NF-κB inhibits the transcription of IκB, leading to sustained NF-κB activity
D) IκB blocks MAPK signaling at the level of Ras activation, preventing further inflammatory responses

67. What role does mTORC1 play in integrating signals from both the Ras/Raf/MAPK and PI 3-Kinase/Akt pathways?

A) mTORC1 primarily inhibits MAPK signaling to maintain metabolic homeostasis
B) mTORC1 acts downstream of ERK to regulate protein synthesis and cell growth
C) mTORC1 directly inhibits Akt signaling, suppressing cell survival
D) mTORC1 inhibits PI 3-Kinase activation, preventing Akt phosphorylation

68. In the context of tumorigenesis, how does sustained ERK activation influence cellular differentiation and proliferation?

A) Sustained ERK activation promotes differentiation into specialized cell types, inhibiting proliferation
B) Short-term ERK activation promotes cell proliferation, while sustained activation favors differentiation
C) Sustained ERK activation blocks differentiation and leads to uncontrolled cell proliferation
D) ERK activation leads to DNA damage, forcing the cell into apoptosis

69. What role does PIP3 play in the activation of Akt within the PI 3-Kinase/Akt pathway?

A) PIP3 serves as a substrate for the phosphorylation of Akt, directly activating it
B) PIP3 recruits PI 3-Kinase to the membrane, where it catalyzes the conversion of PIP2 to PIP3
C) PIP3 acts as a docking site for Akt, which is then phosphorylated and activated by PDK1 and mTORC2
D) PIP3 is a negative regulator that inhibits Akt activation, preventing excessive cell survival signals

70. In the PI 3-Kinase/Akt pathway, how does the phosphorylation of Akt affect protein synthesis?

A) Phosphorylated Akt activates translation machinery, promoting protein synthesis required for cell growth
B) Phosphorylated Akt inhibits mTORC2, decreasing protein synthesis
C) Akt activation prevents the expression of genes necessary for cell cycle progression
D) Phosphorylated Akt downregulates ribosomal activity, reducing protein translation

71. Why is NF-κB considered a key regulator of immune responses and inflammation in the context of signaling?

A) NF-κB directly activates apoptosis pathways to clear damaged cells
B) NF-κB promotes the expression of genes that regulate inflammation and immune responses, balancing signaling activity
C) NF-κB inhibits all inflammatory responses by deactivating pro-inflammatory cytokine

signaling
D) NF-κB induces the expression of growth factors that promote immune cell proliferation

72. What is the function of GEFs (Guanine Nucleotide Exchange Factors) in the activation of Ras?

A) GEFs catalyze the hydrolysis of GTP to GDP, inactivating Ras
B) GEFs bind to Ras, facilitating the exchange of GDP for GTP, thereby activating Ras
C) GEFs bind to Raf, preventing the activation of the Ras/Raf/MAPK pathway
D) GEFs stabilize Ras-GDP, preventing the activation of the Ras/Raf/MAPK pathway

73. How does the interaction between Ras and PI 3-Kinase contribute to cancer progression?

A) Ras inhibits PI 3-Kinase activity, preventing Akt activation
B) Ras activates PI 3-Kinase, promoting cell survival and proliferation via Akt
C) Ras suppresses PI 3-Kinase, leading to a reduction in cellular metabolism
D) Ras binds to mTORC1, preventing cell growth and survival

74. How does chromatin structure influence gene expression in response to signaling pathways like MAPK and PI 3-Kinase?

A) Euchromatin promotes the activation of pro-apoptotic genes, while heterochromatin silences them
B) Euchromatin allows transcription factors to bind DNA, activating gene expression involved in proliferation
C) Heterochromatin actively promotes gene expression by increasing chromatin accessibility
D) Both euchromatin and heterochromatin suppress transcriptional activity, limiting cell proliferation

75. What is the effect of Akt's inhibition of GSK3 (Glycogen Synthase Kinase 3) in the context of protein synthesis and cell survival?

A) Akt inhibits GSK3 to promote the degradation of translation machinery, preventing cell growth
B) Akt activates GSK3 to inhibit protein synthesis and induce apoptosis
C) Akt inhibition of GSK3 allows the activation of protein translation machinery, supporting cell growth
D) Akt activates GSK3, leading to the transcription of survival genes and enhanced protein synthesis

Answers:

61. **B**
62. **B**
63. **B**
64. **C**
65. **C**
66. **B**
67. **B**
68. **C**
69. **C**
70. **A**

71. **B**
72. **B**
73. **B**
74. **B**
75. **C**

76. What is the primary function of GTPase Activating Proteins (GAPs) in the regulation of Ras signaling?

A) GAPs facilitate the exchange of GDP for GTP, activating Ras
B) GAPs inhibit Ras activity by accelerating the hydrolysis of GTP to GDP
C) GAPs activate Raf, promoting the MAPK pathway
D) GAPs phosphorylate Ras, keeping it in an inactive state

77. How does the activation of MEK contribute to the Ras/Raf/MAPK signaling cascade?

A) MEK inhibits Raf, reducing downstream signaling
B) MEK phosphorylates and activates ERK, leading to gene expression changes
C) MEK binds to Ras, preventing its activation
D) MEK directly activates PI 3-Kinase to promote cell survival

78. In the context of colorectal cancer, how do mutations in RAS and RAF genes typically affect tumor progression?

A) Mutations in RAS and RAF lead to the suppression of the MAPK pathway, reducing tumor progression
B) Mutations in RAS and RAF lead to continuous activation of the MAPK pathway, promoting uncontrolled cell division
C) RAS mutations prevent Raf activation, leading to cell cycle arrest
D) RAF mutations inhibit the PI 3-Kinase pathway, reducing survival signals in tumor cells

79. What is the significance of PI 3-Kinase's role in the activation of Akt?

A) PI 3-Kinase directly phosphorylates Akt, leading to its activation
B) PI 3-Kinase generates PIP3, which serves as a docking site for Akt, facilitating its activation
C) PI 3-Kinase dephosphorylates PIP2, preventing Akt activation
D) PI 3-Kinase binds to Akt, inhibiting its activation

80. Which of the following describes the feedback regulation between Akt and RAF signaling?

A) Akt inhibits Raf, preventing the overactivation of the Ras/Raf/MAPK pathway
B) Akt activates Raf to promote further signaling in the MAPK pathway
C) Akt and Raf operate independently, with no regulatory influence on each other
D) Raf inhibits Akt, preventing excessive cell survival signals

****81. How does the activation of ERK in the MAPK pathway affect transcriptional regulation in cancer cells?**

A) ERK activates transcription factors that suppress cell division genes, promoting differentiation
B) ERK translocates to the nucleus to phosphorylate transcription factors, promoting genes involved in cell division and proliferation
C) ERK reduces the expression of pro-survival genes, leading to apoptosis
D) ERK directly inhibits transcriptional machinery to prevent uncontrolled proliferation

****82. In the PI 3-Kinase/Akt pathway, how does Akt activation regulate cell metabolism and growth?**

A) Akt promotes the degradation of key metabolic enzymes, limiting cell growth
B) Akt activates pathways that inhibit glucose uptake, leading to reduced cell metabolism
C) Akt promotes protein translation and cell growth by activating mTOR and other pathways
D) Akt suppresses metabolic processes to induce cell differentiation

****83. How does the interaction between Ras/Raf/MEK/ERK pathway and PI 3-Kinase/Akt pathway contribute to cancer progression?**

A) The two pathways work independently to promote apoptosis in tumor cells
B) Cross-activation of the two pathways leads to uncontrolled cell proliferation and survival, promoting cancer
C) The crosstalk between the two pathways reduces cancer cell metabolism, suppressing tumor growth
D) The two pathways synergistically block tumor cell survival signals, leading to cell death

****84. What is the role of Grb2 in the Ras/Raf/MAPK signaling pathway?**

A) Grb2 directly activates Ras by facilitating GDP to GTP exchange
B) Grb2 binds to Ras and inhibits its activation to prevent excessive signaling
C) Grb2 serves as an adapter protein, recruiting GEF to activate Ras
D) Grb2 phosphorylates Raf, directly activating the MAPK pathway

****85. In the MAPK signaling pathway, receptor dimerization is essential because it:**

A) Increases the affinity of the receptor for ligands, ensuring efficient signaling
B) Triggers the phosphorylation of the receptor, creating docking sites for downstream signaling molecules
C) Inhibits the receptor's autophosphorylation, preventing the activation of the signaling pathway
D) Blocks receptor internalization, ensuring sustained signaling

****86. Which of the following best describes the role of mTORC1 in the PI 3-Kinase/Akt pathway?**

A) mTORC1 acts as a negative regulator of Akt signaling, inhibiting cell survival
B) mTORC1 is activated by Akt and promotes protein synthesis, contributing to cell growth
C) mTORC1 deactivates Akt, ensuring proper cell cycle progression
D) mTORC1 inhibits PIP3 production, preventing Akt activation

****87. Why is NF-κB activation considered an important part of the feedback regulation in the MAPK pathway?**

A) NF-κB promotes the degradation of IκB to prevent excessive inflammatory responses
B) NF-κB inhibits MAPK signaling by directly deactivating ERK
C) NF-κB activates the transcription of IκB, which then inhibits NF-κB signaling, maintaining homeostasis
D) NF-κB activates Ras, enhancing the Ras/Raf/MAPK signaling pathway

****88. What is the role of mTOR in the PI 3-Kinase/Akt pathway?**

A) mTOR suppresses Akt activation, promoting cell death in response to nutrient stress
B) mTOR regulates protein synthesis and cell growth by integrating signals from Akt and other pathways
C) mTOR directly activates Ras, driving the Ras/Raf/MAPK pathway
D) mTOR inhibits cell cycle progression by deactivating Akt

****89. How does PI 3-Kinase regulate cell survival and proliferation in the context of cancer?**

A) PI 3-Kinase suppresses Akt activation, promoting apoptosis in tumor cells
B) PI 3-Kinase produces PIP3, which activates Akt and promotes cell survival and proliferation
C) PI 3-Kinase inhibits PI3P production, reducing cell survival signals
D) PI 3-Kinase inhibits mTOR activity, limiting cell growth

****90. In the Ras/Raf/MAPK pathway, autophosphorylation of the receptor initiates signaling by:**

A) Creating docking sites for adapter proteins like Grb2
B) Activating Ras directly to begin the signaling cascade
C) Blocking Raf activation to prevent downstream signaling
D) Suppressing the MAPK pathway to maintain cellular homeostasis

Answers:

76. **B**
77. **B**
78. **B**
79. **B**
80. **A**
81. **B**
82. **C**
83. **B**
84. **C**
85. **B**
86. **B**
87. **C**
88. **B**
89. **B**
90. **A**

91. What is the role of Ras in the MAPK signaling pathway when it is bound to GTP?

A) It remains inactive and prevents the activation of downstream signaling proteins
B) It binds to Raf, promoting its activation and initiating the MAPK cascade
C) It directly activates MEK, bypassing Raf activation
D) It inhibits the activation of ERK by preventing Raf binding

92. Which of the following best explains the relationship between PI 3-Kinase and Ras in cancer cells?

A) Ras activation inhibits PI 3-Kinase, preventing Akt activation
B) Ras activates PI 3-Kinase, which generates PIP3 to activate Akt and promote survival signals
C) PI 3-Kinase directly activates Ras, enhancing MAPK signaling
D) Ras and PI 3-Kinase are unrelated and operate independently in tumor cells

****93. In the MAPK signaling pathway, the activation of ERK leads to:**

A) Suppression of cell cycle progression and induction of cell death
B) Transcriptional activation of genes that promote cell proliferation and survival
C) Inhibition of MAPK signaling to maintain cellular homeostasis
D) Deactivation of Raf to prevent excessive signaling

****94. How does Akt contribute to cell survival in cancer cells?**

A) By inhibiting pro-apoptotic proteins and promoting protein synthesis
B) By activating apoptosis through inhibition of PI 3-Kinase
C) By suppressing Ras signaling, leading to reduced cell proliferation
D) By directly phosphorylating transcription factors that suppress cell growth

****95. The primary mechanism by which Ras mutations drive uncontrolled cell proliferation is:**

A) Ras binds irreversibly to GDP, preventing the activation of downstream signaling
B) Ras remains constitutively active (GTP-bound), continuously activating the MAPK pathway
C) Ras fails to activate Raf, preventing the initiation of the MAPK cascade
D) Ras inhibits PI 3-Kinase signaling, leading to reduced cell survival

****96. Which of the following is a critical feature of RAF mutations in cancer?**

A) RAF mutations reduce the activation of MEK, leading to impaired cell proliferation
B) RAF mutations lead to constitutive activation of the MAPK pathway, driving uncontrolled cell division
C) RAF mutations block the activation of ERK, preventing transcriptional changes
D) RAF mutations inhibit the activity of downstream MAPK components, reducing tumor growth

****97. What is the role of mTORC2 in Akt activation within the PI 3-Kinase pathway?**

A) mTORC2 inhibits Akt phosphorylation, reducing its activation
B) mTORC2 phosphorylates Akt at a critical residue, fully activating it
C) mTORC2 blocks the formation of PIP3, preventing Akt recruitment
D) mTORC2 promotes the hydrolysis of GTP by Ras, deactivating Akt

****98. The activation of NF-κB through the MAPK pathway has a significant effect on:**

A) Suppressing immune responses to tumor cells
B) Enhancing cell survival and inflammatory responses in the tumor microenvironment
C) Inducing apoptosis and preventing cancer cell proliferation
D) Inhibiting the MAPK pathway to maintain cellular homeostasis

****99. **The feedback loop involving IκB in NF-κB signaling helps to:**

A) Promote NF-κB activation by preventing IκB degradation
B) Terminate NF-κB signaling by promoting IκB synthesis and re-inhibiting NF-κB activity
C) Enhance the activation of MAPK signaling through IκB degradation
D) Suppress NF-κB nuclear translocation by inhibiting IκB phosphorylation

****100. Which of the following statements correctly describes the role of Grb2 in the Ras/Raf/MAPK signaling pathway?**

A) Grb2 directly phosphorylates Ras, activating the MAPK cascade
B) Grb2 binds to phosphorylated receptors and recruits **GEF** to activate Ras
C) Grb2 inhibits Ras activation by binding to GAP
D) Grb2 serves as an adapter protein to activate Raf directly

****101. How does chromatin structure influence the cellular response to signaling in cancer?**

A) Tight chromatin (heterochromatin) enhances gene expression, promoting cell survival
B) Loose chromatin (euchromatin) inhibits gene transcription, preventing uncontrolled proliferation
C) Changes in chromatin structure can affect the accessibility of transcription factors, altering gene expression in response to signals
D) Chromatin structure has no significant role in the response to signaling in cancer cells

****102. **Which of the following is true about feedback loops in signaling pathways?**

A) Feedback loops only amplify the initial signal to ensure a stronger cellular response
B) Negative feedback loops in pathways like **MAPK** and **PI 3-Kinase** help to regulate and prevent excessive signaling
C) Feedback loops have no regulatory function and merely propagate signals downstream
D) Positive feedback loops are irrelevant to cancer progression and cell proliferation

****103. In the PI 3-Kinase/Akt signaling pathway, the conversion of PIP2 to PIP3 by PI 3-Kinase is crucial for:**

A) Activating the NF-κB pathway to promote cell survival
B) Recruiting Akt to the membrane and allowing its phosphorylation and activation

C) Inhibiting Ras signaling to reduce cell proliferation
D) Suppressing protein synthesis to limit cell growth

****104. In cancer, PI 3-Kinase/Akt signaling is often dysregulated, leading to:**

A) Increased apoptosis and reduced cell survival
B) Enhanced cell differentiation and growth arrest
C) Sustained cell survival and proliferation signals, contributing to tumor growth
D) Inhibition of protein translation and cell cycle progression

****105. **In the context of personalized medicine, the use of genetic testing to identify RAS and RAF mutations in cancer patients:**

A) Allows for the selection of chemotherapy regimens based on the presence of mutations
B) Enables the use of targeted therapies such as **RAF inhibitors** to block mutated pathways
C) Provides insights into immune response effectiveness in individual patients
D) Helps to predict the patient's likelihood of responding to immune checkpoint inhibitors

****106. The major challenge in developing effective RAS inhibitors for cancer therapy is:**

A) Ras activation is rare in cancer, limiting its therapeutic potential
B) The GTP-bound form of Ras has high affinity for most drugs, preventing inhibition
C) Ras is difficult to target due to its small size and the lack of suitable binding pockets
D) Ras mutations only occur in non-critical regions, making inhibitors ineffective

Answers:

91. **B**
92. **B**
93. **B**
94. **A**
95. **B**
96. **B**
97. **B**
98. **B**
99. **B**
100. **B**
101. **C**
102. **B**
103. **B**
104. **C**
105. **B**
106. **C**

Done By: Khaled Ghanayem