Module 3 Questions

Section 1. Essay and Short Answers. Use diagrams wherever possible

1. With the use of a diagram, provide an overview of the general regulation strategies available to a bacterial cell.

2. Compare and contrast repressible and inducible operons.

3. Differentiate between gene regulation strategies in prokaryotes and eukaryotes

4. Site 3 examples of global control. Include the system name, environmental signal, the regulatory molecule and its activity and the number of genes regulated.

5. What is catabolite repression and how dies it work?

6. What is Quorum sensing?

7. Chemotaxis is an example of signal transduction. Explain, with the use of diagrams.

8. Explain the central dogma of molecular biology.

9. Gene expression can be regulated at several levels. Explain.

10. Gene expression can be regulated at the levels of transcription and translation. Discuss each with respect to energy efficiency of each mechanism.

11. Define the following terms:
    (a) operon
    (b) promoter
    (c) regulator
    (d) inducer
    (e) repressor
    (f) terminator
    (g) operator

12. Transcription termination generally involves one of two mechanisms. What are they and which one is used in the regulation of gene expression?

13. What is posttranscriptional regulation and how does it usually work?

14. What elements make up the lac operon and what roles do they play?

15. The lac operon is an inducible operon. Why and what does this mean?

16. Describe the process of induction in the lac operon. You should discuss both the induced and uninduced states.

17. The lac repressor completely stops transcription of the lac operon structural gene. True or false and explain.

18. The trp operon is an inducible operon. True or false and explain.

19. Describe the process of repression in the trp operon.

20. TrpL does not produce a functional protein. True or false and explain the role of the trpL gene.

21. Explain the process of attenuation in the trp operon under conditions of low and high tryptophan levels.

22. All secondary structures formed in the trp operon attenuator can act as transcription terminators. True or false and explain.

23. There is only one type of RNA polymerase. Yet it can bind to any promoter. What does that tell you about the nucleotide sequence in promoters?

24. The rate at which RNA polymerase can attach and bind to different promoters (and therefore the rate at which operons can be transcribed) is different in different cases. What could cause this?

25. What would be the effect of a mutation that prevented caused a non-functional version of the lac repressor (or no lac repressor at all) to be produced? What about for the trp operon?

26. In the case of the trp operon, is its **regulation** part of a negative or positive feedback process (see metabolic control notes) or neither? Explain.

Section 2. Multiple Choice Questions:

1. Which of the following is not part of the *lac* operon of *E. coli*?
   a. genes for inducible enzymes of lactose metabolism
   b. genes for the repressor, a regulatory protein
   c. gene for RNA polymerase
   d. a promoter, the RNA polymerase binding site
   e. the operator, the repressor binding site

2. The inducer:
   a. combines with a repressor and prevents it from binding to the promoter
   b. combines with a repressor and prevents it from binding to the operator.
   c. binds to the promoter and prevents the repressor from binding to the operator
   d. binds to the operator and prevents the repressor from binding at this site.
   e. binds to the termination codons and allows protein synthesis to continue

3. In *E. coli* strain is *lac Z*$^-$. The structural gene for ß-galactosidase is encoded at the *lac Z* locus. How would you describe the regulation of lactose metabolism in these cells?
normal regulation of lactose metabolism.
   a. constitutive expression of *lac Z*+.
   b. inability to synthesize the *lac Z*+ gene product, ß-galactosidase.
   c. *lac Z*+ gene is inducible, but unable to be repressed by high glucose
   d. no synthesis of the *lac I* gene product, the *lac* repressor

4 .Bacteria utilize glucose first, even if other sugars are present, through a mechanism called:
   a. operon repression.
   b. enzyme repression.
   c. catabolite repression
   d. gene regulation .
   e. glucose utilization

5. .In *E. coli* cell is grown in the presence of high amounts of glucose. Which of the following is true?
   a. The cell will utilize lactose as a carbon source exclusively
   b. The level of cyclic AMP in the cell will be low.
   c. The level of cyclic AMP in the cell will be high.
   d. Transcription of mRNA from the *lac* operon will be high
   e. The cell will be forced to carry out fermentation

6. Which of the following growth media would you expect to result in synthesis of high levels ofWhich of the following growth media would you expect to result in synthesis of high levels of mRNA for the enzymes of the *E. coli lac* operon?
   a. high glucose, high lactose
   b. no glucose, no lactose.
   c. high glucose, low lactose
   d. no glucose, high lactose
   e. none of these

7. An *E. coli* cell is grown in the absence of glucose. Which of the following will be true?
   a. The level of cyclic AMP will be low
   b. The CRP protein cannot bind to the DNA.
   c. If lactose is present, *lac* mRNA synthesis will occur at a high level
   d. The cell will manufacture glucose by fixing carbon dioxide
   e. The cell will be forced to carry out fermentation

8. An *E. coli* cell is grown in the absence of glucose. Which of the following will be true?
   a. The level of cyclic AMP will be low
   b. The CRP protein cannot bind to the DNA.
   c. If lactose is present, *lac* mRNA synthesis will occur at a high level
   d. The cell will manufacture glucose by fixing carbon dioxide
   e. The cell will be forced to carry out fermentation.

9.Unlike prokaryotes, the control of transcription by eukaryotes is designed to react to change by
   a. changing
   b. ignoring change
   c. remaining constant
   d. changing the environment

10 A form of binding motif containing a nearly identical sequence of 60 amino acids in many eukaryotes is the
   a. homeodomain motif
   b. zinc finger motif
   c. leucine zipper motif
   d. universal motif

11. Which of the following does not occur in the function of the catabolite activator protein (CAP) of E. coli?
   a. Cyclic-AMP binds to the CAP protein.
   b. The protein changes shape.
   c. Space is increased by the binding of tryptophan.
   d. Helix-turn-helix motifs are enabled to bind to the DNA.

12. Enhancers are
   a. proteins located adjacent to promoters
   b. distant sites where regulatory proteins bind
   c. expediters of RNA polymerase capture
   d. proteins that bind with repressors, deactivating them
   e. a bacterial form of promoters

13 When tryptophan is present in the medium, the transcription of tryptophan producing genes in E. coli is stopped by a helix-turn-helix regulator binding to the
   a. trp repressor
   b. trp operon
   c. trp promoter

d. trp operator
e. trp polymerase

14. The assembly of transcription factors on a promoter begins some 25 nucleotides upstream where it binds to a start ________________ sequence.

- ATAT
- AATT
- TTAA
- TAAT
- TATA

15 When tryptophan is present in the environment of E. coli, the tryptophan binds to the
a. trp operon
b. trp promoter
c. trp operator
d. trp repressor
e. trp polymerase

16 Regulatory domains of most activators interact with
a. the transcription factor complex
b. RNA polymerase
c. repressors
d. the regulatory factor complex
e. the DNA binding domain

17 The operon that controls tryptophan producing genes in E. coli consists of ________________ .
a. only one gene
b. two genes
c. three genes
d. four genes
e. five genes

18 In order for a gene to be transcribed, RNA polymerase must have access to the DNA helix and be able to bind to the genes
a. activator
b. regulator
c. promoter
d. operator
e. repressor

19 In the function of the lac operon in E. coli, the lac genes are transcribed in the presence of lactose because
a. RNA polymerase binds to the operator
b. the repressor cannot bind to the promoter
c. an isomer of lactose binds to the repressor
d. CAP does not bind to the operator
e. of the absence of cAMP

20. The most common form of gene expression regulation in both bacteria and eukaryotes is
a. translational control
b. transcriptional control
c. post-transcriptional control
d. post-translational control
e. control of passage from the nucleus

21 E. coli is able to use foods other than glucose in the absence of available glucose, because falling levels of glucose cause an increase of

a. cAMP
b. CAP
c. lactase
d. glu operons
e. tRNA

22 In the absence of glucose, E. coli can import lactose to change into glucose and galactose because CAP binds to the

a. cAMP
b. DNA
c. lac operon
d. operator
e. repressor

23 Which is not part of the lac operon?

a. repressor
b. activator protein
c. operator
d. promotor
e. structural gene

24 In an operon the location of the regulatory region occurs _________ the structural genes.

a. after
b. within
c. before

25 Proteins that block the passage of RNA polymerase are called:

a. operons
b. activators
c. repressors
d. enhancers
e. promoters

26 Which of the following is part of an operon?

a. structural genes
b. an operator
c. a promoter
d. a CAP binding site
e. all of the above

27 Which of the following are not matched correctly?

a. exon splicing-occurs in nucleus
b. post-translational modifications-phosphorylation
c. snRNA-splice out exons from transcript
d. activated enhancers-trigger transcription
e. all are matched correctly

28. A single gene may use a regulatory site to control the expression of that gene, but genes rarely have multiple regulatory sites.

a. True
b. False

29. Which of the following is *not* a difference between eukaryotic and prokaryotic **gene** **regulation**?
   a. DNA Methylation
   b. Alternative mRNA splicing
   c. **Regulation** of mRNA degradation
   d. Histone acetylation
   e. Enhancers

30. Your liver cells are liver cells and your heart cells are heart cells because__________________.
   a. they contain different sets of genes
   b. they contain different operons
   c. They contain unique promoters
   d. different genes are expressed in different tissues
   e. they contain different chromosomes

31. The lac repressor is a
   a. RNA molecule.
   b.lipid molecule.
   c.protein molecule.
   d.carbohydrate.
   e.DNA molecule

32. A mutation in the I gene directly affects
   a. the promoter.
   b.permease.
   c.the repressor.
   d. ß-galactosidase.

33. What would be the effect of a mutation in the operator that blocked the lac repressor binding?
The genes would be inducible by lactose.
   a. The lacZYA genes would not be expressed.
   b. The lacZYA genes would be repressed by lactose.
   c. The lacZYA genes would be expressed constitutively.
   d. None of the above

34 What would be the effect of a mutation in the lacI gene that blocked binding of the lac repressor to the operator?
   a. The lacZYA genes would not be expressed.
   b. The lacZYA genes would be expressed constitutively
   c. The lacZYA genes would be repressed by lactose.
   d. The genes would be inducible by lactose
   E None of the above

35 What would be the effect of a mutation in the lacI gene that blocks the binding of lactose to the repressor?
   a. The genes would be inducible by lactose.
   b. The lacZYA genes would be expressed constitutively.
   c. The lacZYA genes would be repressed by lactose
   d. The lacZYA genes would not be expressed.
   e. None of the above

36 Genes that are always transcribed are called:
   a. constitutive genes
   b. repressor genes.
   c. transposons.
   d. operons.
   e. operator genes

37 The catabolite-activating protein is involved in

a. activating transcription when glucose is present
b repressing the expression of the lac operon when glucose is present
c activating the expression of the lac operon when glucose is present.
d. repressing the lac operon when lactose is present.

38 The role of glucose in catabolite repression is to

a. increase the activity of cAMP by inhibiting the lac operon
b. inhibit the activity of adenyl cyclase, causing a decline in the level of cAMP in the cell.
c. increase the activity of adenyl cyclase, causing the decline of cAMP in the cell.
d. inhibit the activity of the operon causing an increase in cAMP levels in the cell.

39 A regulatory site within the leader sequence of the tryptophan operon that controls this operon by diminishing transcription is called:

a. operator
b attenuator
c repressor
d. transcriptor
e. upregulator

40. In the absence of tryptophan

a The repressor is active and does not bind to the promoter. Transcription does not occur.
b The trp operon is repressed and transcription occurs.
C The repressor binds to the co-repressor. Transcription is initiated.
D The repressor is inactive and does not bind to the promoter. Transcription is initiated
E The repressor binds to the co-repressor. Transcription is initiated.
F The repressor is active and does not bind to the promoter. Transcription does not occur.

41 In the lac and trp operators, the repressor is said to be an allosteric molecule because:

a It diminishes the transcription of the related gene structure.
b Interaction with another molecule causes a conformational change in the repressor's active site.
C It represses the production of lactose or tryptophan.
D It induces the production of lactose or tryptophan.

42 Which gene in an operon is incorrectly matched with its function?

a) promoter - where RNA polymerase first binds to DNA
b) regulator - binds to the repressor protein
c) structural - make mRNA by transcription
d) operator - if unbound, allows RNA polymerase to bind to DNA

43. Which statement is Not correct about the *lac* operon?
a) It regulates the production of a series of five enzymes.
b) It is normally turned off if glucose is present.
c) Lactose binds to the repressor protein and inactivates it.
d) It is an inducible system.
e) The structural genes make products that allow lactose metabolism.

44 . Which statement is Not correct about the *trp* operon?
a) The structural genes make products that act in a metabolic pathway to produce tryptophan.
b) It is normally turned off if tryptophan is present.
c) Tryptophan acts as the corepressor.
d) The regulator gene product is inactive by itself.
e) Tryptophan binds to the repressor protein and inactivates it.

45. Which statement is Not true about genetic control in prokaryotes?
a) RNA polymerase must bind to a promoter on the DNA to begin RNA synthesis.
b) Most gene expression is regulated at the level of translation.
c) An active repressor protein keeps RNA polymerase from binding to DNA.
d) Structural genes produce enzymes that act in a metabolic pathway.

46. Stopping mRNA from being continuously translated into protein is an important mechanism when enough protein product is available. How is this accomplished?
a) Transcribe antisense RNA from ordinarily inactive DNA; this will bind with sense mRNA and prevent the ribosome from further translating it.
b) Regulator genes produce repressor proteins that physically bind to mRNA and stop its activity in ribosomes.
c) mRNA contains stop units encoded in its sequence so only a limited number of passes can be made through ribosomes.
d) The protein products of mRNA translation are feedback repressors that limit translation.
e) Other genes turn on to produce enzymes that digest mRNA.

47. The universal regulatory mechanism in eukaryotes for controlling gene expression includes
a) control of the genes transcribed and the rate they are transcribed.
b) control of the processing of mRNA after it is transcribed from DNA but before it leaves the nucleus, and control of the rate it leaves the nucleus.
c) control the mRNA in the cytoplasm after it leaves the nucleus, including changes to mRNA before translation begins.
d) control of polypeptides after they have been synthesized but before they are functional.
e) All of the above are used; there is no single universal mechanism.

48. Which level of primary control in eukaryotic gene activity involves the life span of the mRNA molecule and the ability of the mRNA to bind to ribosomes?
a) feedback b) translational c) transcriptional d) posttranscriptional e) posttranslational

49. Which level of primary control in eukaryotic gene activity involves processing earl RNA transcripts to mRNA and control of the rate at which mRNA leaves the nucleus?
a) feedback b) translational c) transcriptional d) posttranscriptional e) posttranslational

50. Which level of primary control in eukaryotic gene activity involves changes in the polypeptide chain before it becomes functional?
a) feedback b) translational c) transcriptional d) posttranscriptional e) posttranslational

51. An enhancer site is
a) part of an operon
b) located at a distance from genes it effects
c) found only in prokaryotes
d) an attachment site for RNA polymerase

52. In the *lac* operon of *E. coli*, lactose functions as
a) a promoter b) an operator c) a repressor protein d) an inducer

53. In eukaryotic cells, transcription occurs
a) on parts of the DNA that are uncoiled
b) only on exons
c) only on introns
d) on all parts of the DNA

54. Unlike gene expression in prokaryotes, gene expression in eukaryotes
a) cannot be regulated before transcription has occurred
b) can be regulated after transcription has occurred
c) does not involve promoters
d) involves the transcription of groups of genes called operons

55. Enhancers
a) code for proteins called inducers
b) are found only in prokaryotic genomes
c) must be located close to the genes they activate
d) facilitate transcription by binding to transcription factors

56. Operons have been identified in
a) prokaryotes only b) eukaryotes only c) archaebacteria only d) both prokaryotes and eukaryotes

57. The activation of a gene that results in the formation of a protein is called
a) translation b) gene expression c) enhancement d) gene repression

58. An operon consists of
a) a group of operators
b) an operator, a promoter, and structural gene
c) a group of structural genes
d) lactose, polymerase, and operators

59. The *lac* operon
a) is found in eukaryotic cells
b) codes for the sequence of amino acids in lactose
c) regulates the translation of mRNA
d) regulates transcription by turning on or off the production of a repressor protein
e) regulates DNA replication by turning on or off the production of inducer protein

60. In prokaryotic cells, group of genes that code for functionally related proteins is a(n)
a) exon b) intron c) operon d) riboson

61. The function of an operator is to
a) regulate access to RNA polymerase to structural genes
b) control the process of transcription within the nucleus
c) turn on and off the molecules of tRNA
d) generate amino acids for protein synthesis

62. A repressor protein
a) prevents DNA synthesis
b) attaches to ribosomes during translation
c) blocks movement of RNA polymerase
d) destroys amino acids before protein synthesis occurs

63. Inducer molecules allow the transcription to proceed by
a) destroying repressor molecules
b) activating the ribosomes
c) unwinding the cell's DNA molecules
d) changing the shape of repressor molecules

64. What type of gene codes for a repressor?
a) regulator b) promoter c) operon d) enhancer

65. An inducer molecule functions by
a) causing DNA replication
b) removing a repressor molecule from an operator
c) binding the rRNA subunits of a ribosome
d) digesting lactose molecules in bacteria cells

From the reading
The two regulatory processes we looked at in the notes are both called **negative regulation**. What is positive **regulation**? Simply define it; you need not describe the process

Positive Regulation
The two previous examples are termed negative **regulation**. What is common to both of them is that the binding of a protein to the operator **stops** transcription and protein production. In negative **regulation**, the binding site that blocks RNA polymerase (the operator) is always located on the 5' (downstream) side of the promotor (so it can block the movement). On the other hand, in positive **regulation**, the regulatory sequence(s) is/are located on the 3'

(upstream) end of the promoter. Thus they do not block the movement of RNA polymerase. On the other hand, they form complexes that enhance the abiltiy of RNA polymerase to attach to the promoter. How should you think about this? Imagine that the promoter/RNA polymerase "match" is not perfect. Thus, RNA polymerase will bind to the promoter but not at a high rate. With positive **regulation**, the attachment of "inducer" or "activator" molecules to the DNA upstream from the promoter helps the RNA polymerse to attach and increases the transcription rate