Guide Questions for Topic: Transcriptional Regulation

Terms

Lac operon
- Operator
- Repressor protein
- CAP (catabolite activator protein)

Trans acting factors vs. *Cis* acting elements

Transcription factor
- Transcriptional activator vs. repressor
- DNA-binding domain
- Transcription factor binding site
- Activation vs. Repression domains

Chromatin
- Nucleosome
- 10nm- vs. 30nm-fibers
- Euchromatin vs. heterochromatin
- Histones vs. core histones vs. H1 linker histone vs. nucleosome core particle
- Histone-fold domain vs. amino terminal tail domain

Histone Acetylation
- Histone acetyltransferase (HAT)
- Histone deacetylase (HDAC)
- Chromatin decondensation vs. chromatin condensation
- Transcriptional coactivators & corepressors

Guide Questions

The lac operon

1. The term "*lac* operon" refers to _____.

2. In *E. coli*, the *lac* operon is expressed when _____, but is repressed when _____.

3. In the experiments that characterized the *lac* operon, researchers isolated an *E. coli* strain with mutations in its promoter (denoted P^-) that did not express the lac operon regardless of whether lactose was present or not. What is the molecular explanation for why the *lac* operon is constitutively repressed in this strain?

4. Unlike the mutations in the *lac* operon promoter, an *E. coli* strain with mutations in the *lac* operon Operator (denoted O^-) result in constitutive expression of the *lac* operon regardless of whether lactose is present. What is the molecular explanation for why the *lac* operon is constitutively expressed in this strain?

5. Similar to the effect in the O^- strains, an *E. coli* strain with mutations in the *i* gene (denoted i^-) also exhibit constitutive expression of the *lac* operon. What is the molecular explanation for why the *lac* operon is constitutively expressed in this strain?

6. As opposed to the i^- mutant *E. coli* strain, a strain with a different *i* gene mutation (denoted i^S) exhibited constitutive repression of the *lac* operon. What is the molecular explanation for why the *lac* operon is constitutively repressed in this strain?

7. The term "*cis*-acting elements" refers to _____.

8. The term "*trans*-acting factors" refers to _____.

9. The effect of lactose on the repressor protein is an example of what type of protein regulation that we discussed during Topic 3: Protein Function & Regulation?

Eukaryotic transcription factors

10. Transcription factors at function as transcriptional activators contain two domains, which are _____ and _____.

11. What role does the DNA-binding domain play for transcription factors?

12. KROX24 and Myt1 are two transcription factors with zinc finger domains. Based on this information, what would you predict KROX24 and Myt1 have in common? How would you predict they differ?

13. The term "transcription factor binding site" (aka, "TF binding site") refers to _____.

14. Transcription factor binding sites are most often found where within genomic DNA?

15. Transcription factor binding sites could also be referred to as *cis*-acting elements because _____.

16. Transcription factors (both activators and repressors) could also be referred to as *trans*-acting factors because _____.

17. E2F1 is a transcription factor that activates expression of its target genes (e.g., cyclin D) by forming protein-protein interactions with TBP (TATA-binding protein). Based on this information, which of the following mutations in E2F1 would you predict to block E2F1-mediated induction of cyclin D expression?

Chromatin composition, structure, and condensation states

18. The term “chromatin” refers to _____.

19. Which of the following distinguishes 10-nm chromatin fibers and 30-nm chromatin fibers?

20. What are histones?

21. Histones contain a higher percentage of arginine and lysine residues compared to most other proteins. How does the higher percentage of these amino acids contribute to histone function?

22. The core histones (H2A, H2B, H3, and H4) each have two domains: the _____ domain and the _____ domain.

23. How do the two domains of core histones compare to each other in terms of their relative orientations / structures within nucleosomes?

24. Histone acetylation refers to the covalent attachment of _____ to _____.

25. How and why does histone acetylation affect chromatin condensation?

26. How and why does histone acetylation affect gene expression?

27. Histone acetylation is catalyzed by _____.

28. Histone deacetylation is catalyzed by _____.

29. How and why does histone deacetylation affect chromatin condensation?

30. How and why does histone deacetylation affect gene expression?

31. CREB is a transcription factor that activates expression its target genes through protein-protein interactions with the histone acetyltransferase (or, HAT) CBP. Based on this information, which of the following statements would you predict is true about how CREB activates target gene expression?

32. Ataxin-3 is a transcription factor that represses expression of its target genes through protein-protein interactions with the histone deacetylase (or, HDAC) HDAC-3. Based on this information, which of the following statements would you predict is true about how Ataxin-3 represses target gene expression?