Unit 6 BILL

Unit Essentials

1. ☑ Unit map
2. ☑ Traffic light

2 - Traffic Light

Term	Pre-Assessment	Post-Assessment
mut-	✅	✅
syn-	🟨	✅
script-	✅	✅
trans-	✅	✅
Mutation	✅	✅
Transcription Factor	✅	✅
Semiconservative Replication	✅	✅
Antiparallel	✅	✅
Bacteriophage	✅	✅
Purines	✅	✅
Pyrimidines	✅	✅
Operon	🟨	✅
Enhancers	✅	✅
Methylation	🟥	✅
Introns	✅	✅
Transcription	✅	✅
TATA Box	🟨	✅
Enhancer	✅	✅
Codon	✅	✅
Transfer RNA	✅	✅
Messenger RNA	✅	✅
Central Dogma	✅	✅
Translation	✅	✅
Promoter	✅	✅
Anticodon	✅	✅
Repressor	✅	✅
Inducer	✅	✅

Term	Pre-Assessment	Post-Assessment
Acetylation	🟥	✅
Exons	✅	✅

3. Test topics

3 - Test Topics

- Discovery of DNA as the genetic material
  - Griffith
  - Hershey-Chase, Avery
  - Franklin
  - Chargaff
  - Watson and Crick
- Genetic code is universal – what does that mean?
  - Genetic code remains of the same structure across all organisms
- Structure of DNA
  - Consists of Nucleic Bases, made of the Phosphate backbone and nucleotides
- Central dogma (DNA → RNA → protein)
  - Names of processes
    - Transcription → Translation
  - Descriptions of processes
    - Reads and copys DNA to mRNA, converts mRNA into proteins with help of tRNA
- mRNA processing in eukaryotes
  - Remove the exons, leaving only the introns, add a sugar hat and A tail
- Telomeres/telomerase
  - The ends of DNA
- Mutations
  - Types and effects
    - Point - switch one base
    - Insertion - inserts a base
    - Deletion - remove a base
    - Frameshift - everything after is changed
    - Missense - Amino acid changed
    - Nonsense - Amino acid changed that modifies the start or end of the protein
- Differences between transcription in prokaryotes and eukaryotes
  - prokaryotes have circular DNA, and dont do processing on the mRNA
- Differences between DNA in prokaryotes and eukaryotes
  - circular DNA
- Control of gene expression in prokaryotes
  - Lac and trp operons
    - repressed and inducible genes
  - Inducible versus repressible operons
    - inducible - can be turned on - off by default
    - repressible - can be turned off - on by default
- Control of gene expression in eukaryotes
  - Methylating
    - Adding methane groups to the histones
  - Acetylating
    - Spreading of histones apart to activate DNA

    - Euchromatin versus heterochromatin
        - Eu - spread out histones, active
        - Hetero - closely packed, inactive
- Viruses
    - Lytic versus lysogenic cycle - bacteria replication
        - Lytic - replicate until host cell explodes, killing the host
        - Lysogenic - puts DNA into host cell and lets it reproduce, then explode
    - Reverse transcription
        - Putting of mRNA back into DNA
- Biotechnology (purpose, steps)
    - PCR
        - Split a DNA with heat, the spray bases everywhere and let it bind by itself
    - Recombinant DNA
        - Combining DNA from two different samples to create new DNA
    - Electrophoresis
        - Measure similarities in different DNA samples by using electricity and a gel

4. Unit summary

4 - Unit Summary

Objectives

1. Construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, that RNA are the primary sources of heritable information.
2. Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information.
3. Describe representations and models that that illustrate how genetic information is copied for transmission between generations.
4. Describe representations and models illustrating how genetic information is translated into polypeptides.
5. Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
6. Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression.
7. Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms.
8. Describe the connection between the regulation of gene expression and observed differences between individuals in a population.
9. Explain how the regulation of gene expression is essential for the processes and structures that support efficient cell function.
10. Use representations to describe how gene regulation influences cell products and function.
11. Refine representations to illustrate how interactions between external stimuli and gene expression result in specialization of cells, tissues, and organs.
12. Justify a claim made about the effect(s) on a biological system at the molecular, physiological, or organismal level when given a scenario in which one or more components within a negative regulatory system is altered.
13. Explain how signal pathways mediate gene expression, including how this process can affect protein production.
14. Use representations to describe mechanisms of the regulation of gene expression.
15. Connect concepts in and across domains to show that timing and coordination of specific events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms.

16. Use a graph or diagram to analyze situations or solve problems (quantitatively or qualitatively) that involve timing and coordination of events necessary for normal development in an organism.
17. Justify scientific claims with scientific evidence to show that timing and coordination of several events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms.
18. Describe the role of programmed cell death in development and differentiation, the reuse of molecules, and the maintenance of dynamic homeostasis.
19. Justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies.
20. Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.
21. Explain the connection between genetic variations in organisms and phenotypic variations in populations.
22. Predict the effects of a change in an environmental factor on the genotypic expression of the phenotype.

Major Topics and Textbook Correlations

Chapter 16 – The Molecular Basis of Inheritance (not 16.3)

- Search for Genetic Material
- DNA Replication and Repair

Chapter 17 – From Gene to Protein

- Connection between Genes and Proteins
- Protein Synthesis: Transcription and Translation
- Comparing Protein Synthesis in Prokaryotes and Eukaryotes
- Mutation Types and their Effect on the Protein

Chapter 18 – Regulation of Gene Expression (not 18.5)

- Regulation of Gene Expression in Bacteria
- Organization and Control of Eukaryotic Genomes
- Genome Organization at the DNA level
- The Control of Gene Expression

Chapter 19 – Viruses (not 19.3)

- History of Virus Discovery
- Viral Genomes
- Lytic vs. Lysogenic Cycles
- Evolution of Viruses

Chapter 20 – Biotechnology (not 20.3 or 20.4)

- DNA Technology and Cloning
- DNA Fingerprinting
- Practical Application of DNA Technology

Chapter 21 – Genomes and Their Evolution (only 21.2 and 21.5)

5. ☑ Official AP Biology unit summary
6. ☑ Topic review guide
   - ☑ ~~6.1 & 6.2 DNA Structure and Replication~~
   - ☑ ~~6.3 & 6.4 Transcription, RNA Processing and Translation~~
   - ☑ ~~6.5 & 6.6 Gene Regulation and Biotechnology~~
   - ☑ ~~6.7 & 6.8 Mutations and Biotechnology~~

Post-It Annotations

- Concept 13.2: Many Proteins work together in DNA Replication and Repair pgs. 251-259
  - Power Line: How is genetic information copied for transmission between generations?
    - DNA is condensed into chromosomes, then replicated with DNA polymerase, then it is separated to the two poles of the cell when it splits into two.
    - When it is being passed on into gametes, only one of each gene is passed instead of two to each cell, which then gets recombined with the other parent in order to form a full genome
- Concept 13.3: A chromosome consists of a DNA molecule packed together with proteins pgs. 259-260
  - Power Line: How does the organization of chromosomes impact DNA Replication?
    - It effects how the genes are inherited when going through reproduction, as genes closer to each other on the chromosome are less likely to be recombined, meaning the child will likely have both genes together
- Concept 14.2: Transcription is the DNA-directed synthesis of RNA - a closer look pgs. 274-276
  - Power Line: What is the importance of the genetic flow from DNA to RNA?
    - DNA stores the information, RNA copies it and makes it ready to be used in the cell
- Concept 14.4: Translation is the RNA-directed synthesis of a polypeptide - a closer look pgs. 279-286
  - Power Line: How does translation generate polypeptides that determine genotypes?
    - Polypeptides are the expression of genes, so they are by definition what shows from the genetic code of DNA
- Concept 14.5: Mutations of one or a few nucleotides can affect protein structure and function pgs. 288-290
  - Power Line: How does the various types of mutations impact genotype and phenotype?
    - Mutations can change the genetic code of a gene, changing the resulting protein and therefore the phenotype and genotype if the mutation is sensical
- Figure 15.3: The trp operon in E. coli - regulated synthesis of repressible enzymes pg. 295
  - Power Line: How is the trp operon repressible?
    - When tryptophan is present, the transcription of the gene is turned off
- Figure 15.4: The lac operon in E.coli - regulated synthesis of inducible enzymes pg. 296
  - Power Line: How is the lac operon an inducible?
    - It is off by default, but in the lack of glucose and surplus of lactose, the gene will turn on to digest the lactose
- Figure 15.6: Stages in gene expression that can be regulated in eukaryotic cells pg. 298
  - Power Line: In what ways do eukaryotic cells regulate gene expression?
    - Through histones and repressors/activators

Recall and Review

DNA Structure and Replication

1. Explain how the experiments that each of the following people/groups of people performed provided evidence that DNA is the genetic material.
   I. Frederick Griffith
   - Did the killing bateria experiment to prove that dead DNA can be picked up and used (R cells replicating dead S cells)

   II. Oswald Avery, Maclyn McCarty, and Colin MacLeod
   - Remove protein, RNA, and DNA separately to see which mattered in cell division, and proved that DNA was essential

III. Alfred Hershey and Martha Chase
    - Proved that DNA was the carrier of genetic material through experiment with radiolabeled bacteriophages
IV. Erwin Chargaff
    - Proved A and T, and G and C match in DNA by measuring how much of each are in the DNA

2. Explain what is meant by “antiparallel” orientation of DNA.
    - The two strands of DNA point in opposite directions even though they are bound to each other
3. Describe the four essential functions of the genetic material. Explain how the structure proposed by Watson and Crick makes these functions possible.
    - Store hereditary information
    - Recombining to produce variation
    - Useful for producing a result (creating proteins)
    - Can be replicated and passed on to inherit information
4. Create a t-chart that compares DNA to RNA. Include structure, location and function of both molecules in your comparison.
    - DNA double strand, antiparallel, ATCG, nucleolus, makes RNA
    - RNA single strand, AUCG, nucleolus, cytoplasm, makes protein
5. Meselson and Stahl claimed that the replication of DNA was semiconservative. Describe the evidence they used to support their claim.
    - When radiolabeling DNA and reproducing, each new strand of DNA will have one radiolabeled strand, and when reproducing again, only half of the remaining strains have one strand of radiolabeled DNA
6. Describe what the role of the following enzymes is in DNA replication:
    I. DNA polymerase
        - makes DNA from DNA
    II. DNA ligase
        - Patches up the okazaki fragments
    III. DNA primase
        - Gets the DNA polymerase ready to replicated the DNA
7. Explain why the leading strand of DNA is replicated continuously, while the lagging strand is replicated discontinuously.
    - Replication happens in the 5 → 3 direction, so one strand will be following the strand and one will be going the other direction in chunks
8. Create a graphic organizer that illustrates the differences between the process of DNA replication in prokaryotes and eukaryotes.
    - Prokaryotes have circular DNA and only start from one point, they are also significantly faster
    - Eukaryotes dont have circular DNA and have to take extra precautions for the telomeres, they also replicate at multiple places at once
9. Describe the relationship between the following organizational units of DNA:
    I. DNA
        - All the genetic info
    II. Nucleosomes
    III. Chromatin
        - The unwound DNA
    IV. Chromosome
        - Wound up DNA, ready for replication
    V. Transcription and Translation

- Reading the DNA to make protein through RNA

10. Compare the processes of DNA replication with transcription. Be sure to include the following things in your comparison:
    I. Location of process
        - Replication in nucleolus while transcription also happens in the same place, but leaves into the cytoplasm
    II. Nucleic acids involved
        - ATCG vs AUCG
    III. Enzymes responsible
        - DNA polymerase vs RNA polymerase, Ribosomes
11. Create a graphic organizer that explains the relationship between the following molecules:
    I. DNA
        - origin of genetic info
    II. mRNA
        - transcribed DNA
    III. tRNA
        - RNA that connects sequences of mRNA to amino acids
    IV. rRNA
        - RNA that folds up into ribosomes in order to facilitate protein production
    V. RNAi
        - RNA that binds to other RNA to prevent it from creating proteins, it eventually breaks down each other
12. Describe the difference between an intron and an exon.
    - Exons get used to create the final protein, Intons do not
13. Eukaryotic mRNA is often modified before it leaves the nucleus. Describe how this happens.
    - Introns are removed, and a cap and poly a tail are added
14. Explain how the production of eukaryotic mRNA is like watching a tv show that is on Netflix.
    - It reads and copies what it sees
15. Create a graphic organizer that illustrates the differences between the processes of transcription and translation, including how they operate in prokaryotes vs. eukaryotes.
    - Transcription is DNA → mRNA while translation is mRNA → proteins
16. Explain the relationship between protein synthesis and an organism's phenotype.
    - Phenotype is a trait that is displayed, protein synthesis is just what is produced from active genes, which may influence the phenotype
17. Explain how the "one-gene-one protein" hypothesis was derived by Beadle and Tatum. Why has this hypothesis been refined to "one gene-one polypeptide," and now "one gene-one (protein) domain?"
    - Proteins can be made up of more than one polypeptide chain, and sometimes the gene has to be modified drastically before it is made into a protein
18. Create a t-chart that explains the difference between somatic mutations and germline mutations.
    - Germline happens before the fertilization of the egg, so damaged DNA is passed to the entire new organism, while somatic is after, so only portions are effected by it
19. Create a graphic organizer that illustrates how point mutations differ from chromosomal mutations. Which one has a greater effect on the organism's phenotype?
    - Chromosomal, because a lot more DNA material is effected by it
20. Create a diagram that represents the following types of mutations:
    I. Silent mutation
        - Different bases, same amino acid

II. Missense mutation
- Different base, different amino acid

III. Nonsense mutation
- Different base, early start or early stop

IV. Frameshift mutation
- Entire Sequence after mutation is effected, changing every amino acid after the mutation

21. Create a t-chart that compares gene mutations to chromosomal mutations
- gene mutations are small, chromosomal mutations cause entire sections to be moved around of made ineffective

22. Explain what would happen to the process of gene expression if the gene for RNA polymerase was mutated.
- Likely, no RNA will be able to be made, and therefore no proteins

23. Each amino acid has a tRNA synthetase enzyme that is responsible for attaching it to a tRNA molecule. Explain what would happen if there was a mutation in the gene encoding one of these enzymes.
- Certain amino acids will not be able to be used in the production of proteins and the tRNA sequences for that amino acid will be nonfuctional

24. Describe how proteins can be altered once they have been synthesized at the ribosome and what organelles are involved.
- They may be folded differently, added more parts to it, combined to other proteins

25. Define operon. Explain how bacterial cells use operons to control gene expression.
- The portion on the DNA before the gene that will govern whether the DNA is transcribed or not depending on the environment

26. Describe the relationship between the following components of an operon:

I. Promoter
- Attracts the RNA polymerase to the site, before the Operator

II. Operator
- The part that is either blocked or unblocked depending on the circumstances

III. Repressor
- A protein that binds to the operator to block the transcription of the genetic code

IV. Structural Genes
- Genes that are necessary for structure or functions in the cell

V. Regulatory Genes
- Genes that are necessary to create proteins that will regulate the production or activation of other proteins in the cell

27. Create a t-chart that explains how repressible operons differ from inducible operons.
- Repressible are active by default and can be turned off, inducible operons are off by default and can be turned on

28. Describe the relationship between these terms and explain how these terms are used to describe eukaryotic gene regulation.

I. Enhancer
- A portion of DNA that will bind to the other side of the RNA polymerase, increasing its effectivity

II. Promoter
- Portion of DNA before the gene that will attract the RNA polymerase to the site

III. Silencer
- A protein that binds to the promoter to disable its promoting functions

IV. DNA
- The genetic code that is being read and used to produce functional proteins

29. Explain how transcription factors help to regulate eukaryotic gene expression.
    - Presence of an enhancer, silencer, and repressors, activators, as well as activity of the histones
30. Create a t-chart that describes the differences between lytic virus reproduction and lysogenic virus reproduction
    - Lytic: DNA is injected, created quickly until cell explodes with the bacteriophage
    - Lysogenic: DNA is injected and incoporated, multiple cell cycles undergo, there is a chance that the lytic cycle will be activated after each reproduction
31. Describe how the following tools are used to study or modify organismal genomes:
    I. Restriction Enzymes
        - Cuts open the DNA with some bases left unpaired at the end (Sticky) and will bind to new inserted DNA
    II. Plasmids
        - A small piece of DNA in a circle that has the gene, has an origin of replication, restriction sites, and antibiotic resistence genes, which will be activated in presence of an antibiotic to keep the bacteria alive
    III. Gel Electrophoresis
        - A process that involves putting DNA in a gel and using electricity to move the DNA portions to compare and measure lengths of DNA portions
    IV. Polymerase Chain Reaction (PCR)
        - Repeated heating (to split DNA) and adding of unpaired bases in order to quickly replicate DNA

Activity log

Activities

1. ☑ Transcription in action

    1 - Transcription in Action

    ### Visualizing transcription

    1. 1
    2. 2
        I. A gene is section of DNA that when read will produce proteins which will effect the functional or physical attributes of the cell/organism
        II. mRNA
        III. Uracil (U)
        IV. Nucleolus

    ### Mechanics of transcription

    1. 1
    2. mRNA is made from DNA (after unzipped), mRNA leaves cell, gets processed then goes to the ribsomes where proteins are formed from amino acids with the help of tRNA.

    ### Practicing transcription

    1. 1
        I. DNA: `TACGGGTTAAAAATCCCGCTACAGGCTTCCGTA`
        II. mRNA: `AUGCCCAAUUUUUAGGGCGAUGUCCGAAGGCAU`
    2. 2
        I. DNA: `TACAGGAGAAAATAAGACCGAAGCTGCTCAATT`
        II. mRNA: `AUGUCCUCUUUUAUUCUGGCUUCGACGAGUUAA`
    3. 3
        I. DNA: `TACTTTTGGAGAGAGGGCTCGCATAATTTCCGA`

II. mRNA: `AUGAAAACCUCUCUCCCGAGCGUAUUAAAGGCU`

2. Genetic Variation at the Molecular Level

2 - Genetic Variation at the Molecular Level

Key:

Positive
Negative
Polar
Nonpolar

Hb-b

DNA: CAC ***GTG*** GAC **TGA** GGA *CTC CTC*
mRNA: GUG ***CAC*** CUG **ACU** CCU *GAG GAG*
Amino Acid: val ***his*** leu **thr** pro *glu glu*

Hb-s

DNA: CAC ***GTG*** GAC **TGA** GGA CAC *CTC*
mRNA: GUG ***CAC*** CUG **ACU** CCU GUG *GAG*
Amino Acid: val ***his*** leu **thr** pro val *glu*

1. 3
   I. Hb-s's second last codon changed from *glu (Negative)* to val (Nonpolar)
   II. The interactions between the R-groups of the amino acids making up this protein will change and cause the shape of the protein to differ
   III. The shape will be different and malformed, possibly preventing the protein from executing its purpose

Check your Hypothesis

1. Makes it sickle shaped (malformed)
2. It is the same, malshapen
3. Its the SAME

3. The Effects of Mutations

3 - The Effects of Mutations

Myostatin

Normal myostatin

DNA: TGT GAT GAA CAC TCC ACA GAA TCT CGA TGC TGT CGC TAC CCC CTC ACG
mRNA: ACA CUA CUU GUG AGG UGU CUU AGA GCU ACG ACA GCG AUG GGG GAG UGC
Amino Acid: Thr Leu **Leu Val Arg Cys Leu Arg Ala Thr Thr Ala Met Gly Glu Cys**

Belgian Blue myostatin

DNA: TGT GAC AGA ATC TCG ATG CTG TCG CTA CCC CCT CAC GGT GGA TTT TGA
mRNA: ACA CUG UCU UAG AGC UAC GAC AGC GAU GGG GGA GUG CCA CCU AAA ACU
Amino Acid: Thr Leu **Ser Stop Ser Tyr Asp Ser Asp Gly Gly Val Pro Pro Lys Thr**

1. 1

2. 2

3. Everything after the second codon is different

4. 1

    I. A molecule that plays a part in controlling cell division
    II. Mice used for testing

5. Frameshit, caused by addition or deletion because it modifies every amino acid after it

6. Skeletal muscle of mammals

7. Is a growth factor in muscle cells

8. It could be an insertion or deletion, I cant tell, but it does cause frameshift, because since the incident all the amino acids are changed

9. Frameshit

10. Missense, because it modifies the amino acid strain without completely breaking it

11. It may be more effective at promoting growth in the cells or possibly is a broken cell growth inhibitor

Hemoglobin

Normal Hemoglobin

DNA: CAC GTG GAC TGA GGA CTC CTC
mRNA: GUG CAC CUG ACU CCU GAG GAG
Amino Acid: Val His Leu Thr Pro Glu Glu

Mutated Hemoglobin

DNA: CAC GTG GAC TGA GGA CAC CTC
mRNA: GUG CAC CUG ACU CCU GUG GAG
Amino Acid: Val His Leu Thr Pro Val Glu

9. Red Blood Cell malformation
10. Missense, because no start/stop codons were modified
11. Because it gives them an advantage at surviving malaria, increasing the probability of survival and reproduction (since malaria is more common there)
12. We know what it is and how to take care of it

4. ☑ Molecular Genetics of the Color Mutations in Rock Pocket Mice

4 - Molecular Genetics of the Color Mutations in Rock Pocket Mice

Gene Table 1: Wild-Type MC1R Gene (Light coat)

DNA:

```
5' TTG AGG TGG GCG TGT CCG CAA GGA 3'
5' CGG GAC CGG TGG GCC CAC TGA CAC 3'
5' TCA TAA CAC TGT GAC GGG GCC CGA 3'
```

5' GTG TAC GAA CGT 3'

5' GAA CAG GTG GTT CCA AAG GCT GAG 3'

mRNA:

5' AAC UCC ACC CGC ACA GGC GUU CCU 3'

5' GCC CUG GCC ACC CGG GUG ACU GUG 3'

5' AGU AUU GUG ACA CUG CCC CGG GCU 3'

5' CAC AUG CUU GCA 3'

5' CUU GUC CAC CAA GGU UUC CGA CUC 3'

Amino Acid:

N- Asn Ser Thr Arg Thr Gly Val Pro -C

N- Ala Leu Ala Thr Arg Val Thr Val -C

N- Ser Ile Val Thr Leu Pro Arg Ala -C

N- His Met Leu Ala -C

N- Leu Val His Gln Gly Phe Arg Leu -C

Gene Table 2: Mutant MC1R Gene (Dark coat)

Changes are in uppercase

DNA:

5' ttg agg tgg ACG tgt ccg caa gga 3'

5' cgg gac cgg tgg ACC cac tga cac 3'

5' tca taa cac tgt gac ggg ACC cga 3'

5' gtg tac GAG cgt 3'

5' gaa cag gtg GTG cca aag gct gag 3'

mRNA:

5' aac ucc acc UGC aca ggc guu ccu 3'

5' gcc cug gcc acc UGG gug acu gug 3'

5' agu auu gug aca cug ccc UGG gcu 3'

5' cac aug CUC gca 3'

5' cuu guc cac CAC ggu uuc cga cuc 3'

Amino Acid:

N- Asn Ser Thr CYA Thr Gly Val Pro -C

N- Ala Leu Ala Thr TRP Val Thr Val -C

N- Ser Ile Val Thr Leu Pro TRP Ala -C

N- His Met LEU Ala -C **Silent Mutation**

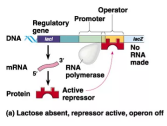
N- Leu Val His HIS Gly Phe Arg Leu -C

Bell Ringers

1. Prokaryotic gene regulation

   1 - Prokaryotic Gene Regulation

   The diagrams below represent operons, clusters of genes that control gene expression in bacteria. Answer the questions for each diagram below.



1. What is the role of each of the following:
    I. Regulatory gene:
        - The gene that codes for repressors / activators of other genes
    II. RNA polymerase:
        - Reads the DNA and transcribes it into RNA for it to

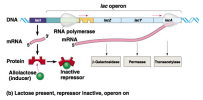
be made into a protein

III. Promoter:
    - The site before a gene that attracts the RNA polymerase to bind and transcribe the DNA
IV. Operator:
    - The part after the pro

moter, but before the gene code that will either block or allow the RNA polymerase to pass, it can be activated or deactivated by regulatory proteins

V. Repressor:

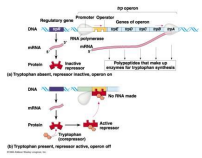
- The protein that will bind to the operator to block the RNA polymerase



2. What is the effect of the inducer on the repressor? Why is it called an inducer?
    - The inducer malforms the active site of the repressor, deactivating

the repressor and removing it from the operator

3. Is this an inducible or a repressible operon? Justify your answer.
    - This is a inducible operon, as the repressor is bound to the operator by default, and only deactivated when the inducer is present



4. Examine the diagram of the trp operon at left. How is

it similar to the diagram of the lac operon above?
    - It has a repressor, promoter, and operator
5. Why do you think it is called a corepressor? What is the effect of the corepressor on gene expression?
    - Because both the repressor and the corepressor need to be present to actually repress the gene
6. Is this an inducible or a repressible operon? Justify your answer.
    - Repressible, as it is on by default, but only blocke

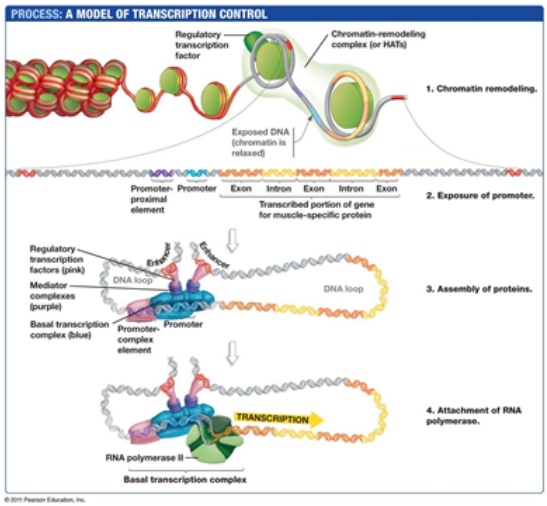
d when two protein s are present

2. Eukaryotic gene regulation

2 - Eukaryotic Gene Regulation

The diagrams below represent eukaryotic gene regulation: the regulation of eukaryotic gene expression by a combination of molecules before, during, and after gene transcription and mRNA translation. Answer the questions for each diagram below.

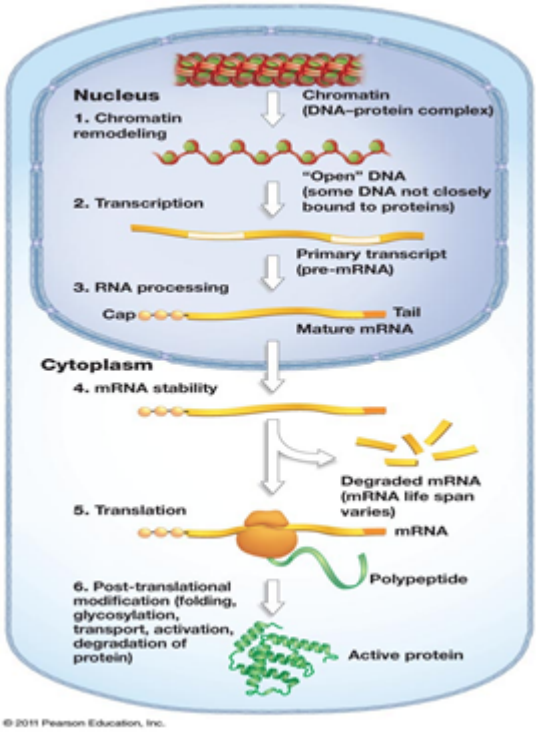
Regulation of Transcription



1. What is the regulatory role of each of the following:
    - I. Histones
        - Keeps DNA untangled and easy to transcribe
    - II. Acetylation of Histones
        - Spreads the histones apart from each other, increasing transcription rates
    - III. Methylation of Histones
        - Methyl groups bind to tails of the Histones which can spread them apart, increasing transcription rate
    - IV. Transcription Factors
        - Things required for transcription to be happening, the more there is the more often transcription happens
    - V. Enhancer Region / Switch
        - Section of DNA that will increase and increase the probability of binding to a promoter, are more often known as part of the transcription factors
    - VI. Promoter Region
        - The beginning of the gene, it attracts the RNA polymerase to start at the beginning of the gene expression

Post-Transcriptional and Translational Regulation

1. What is the difference between introns and exons? Which ones are removed



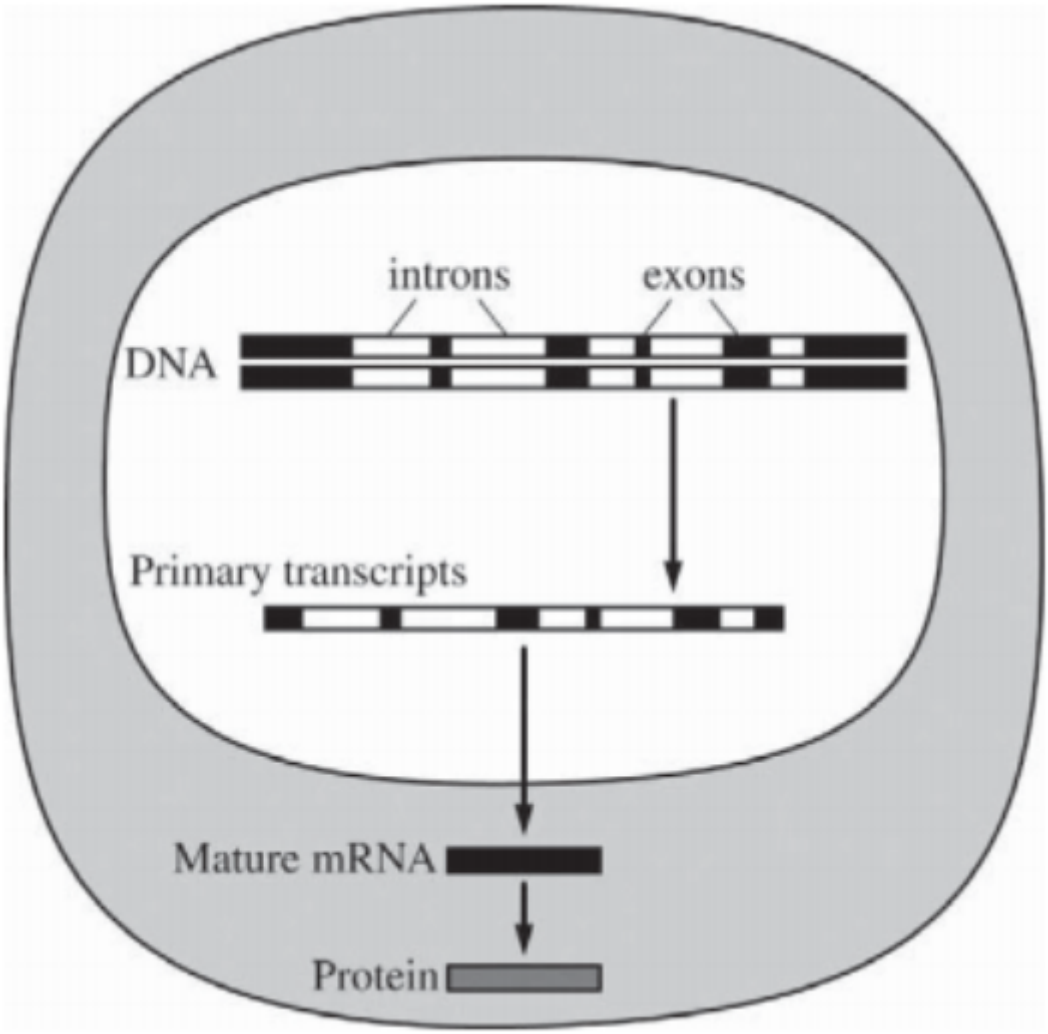
during post-transcriptional RNA Splicing?

- Introns get removed before the RNA gets made into a polypeptide chain
- Exons are exactly what makes up the polypeptide chain at the end

2. What is the purpose of the 5'Cap and the Poly-A Tail?
    - The 5' Cap helps maintain the stability of the RNA strain and protects the strain from falling apart
    - The poly-A tail ensure that whatever transcriber goes through the RNA, there will be enough space at the end to transcribe all the important information
3. One of the post-translational modifications is degradation of protein. How could this relate to cell signaling?
    - Allows stagnant signals to be removed after some time and return to normal levels within the cell

3. ☑ Central Dogma FRQ

    3 - Central Dogma FRQ



The figure represents the process of expression of gene X in a eukaryotic cell.

1. The primary transcript in the figure is 15 kilobases (kb) long, but the mature mRNA is 7kb in length. Describe the modification that most likely resulted in the 8kb difference in length of the mature mRNA molecule. Identify in your response the location in the cell where the change occurs.
   - The Introns are removed from the sequence, leaving only the exons when RNA processing happens
   - In the Nucleus
2. Predict the length of the mature gene X mRNA if the full-length gene is introduced and expressed in prokaryotic cells. Justify your prediction
   - It would be more than double in length (15kb), as the amount of RNA is also about double, because RNA pre-processing does not often occur in prokaryotic cells

Case Studies

1. ☑ The Mona Lisa case study

   1 - The Mona Lisa Molecule

   1. They created an accurate model of DNA from the X-ray data from Franklin Rosalind
   2. Because DNA is what holds all the information to code for life forms - the language of living things
   3. To understand how DNA would code for genes which would effect living forms. It also allows for a deeper understanding of inheritance
   4. With enough research we could probably synthesize our own DNA and modify life forms

5. Radiolabeled sulfur in the proteins did not show up in the children bacteriophage, while the radiolabeled phosphorus in DNA did show up in the children.
6. Building a simulation to simulate how it would behave virtually. We can solve for the components of a molecule based on it its properties.
7. Shooting X-ray beams through molecules and measuring the diffraction or reflection of such beams to gain an understanding of the shape of a molecule. X-rays' wavelength is roughly the distance between the atoms, which would give a good enough resolution to model the locations of the atoms
8. Imagine taking a picture of something, you can see it
9. Both are useful for understanding different aspects of the molecule. A simulation would give greater understanding of more than just the shape of it, but would require more computational time.
10. Two polyneucleotides that coil around each other to form a double helix. It also consists of deoxyribose sugar, nitrogeneous base, and phosphate groups
11. A-T C-G
12. It describes the ratio between the different bases in the cell
13. It is helical in shape indicated by the cross in the photo. They also figured out that the bases stack and the phosphate is on the outside
14. It was the 51st photo and it was taken by rosalind franklin
15. Yes, it offered great insight into what it was long before anyone else was looking into it.
16. 16
    I. Hydrogen bonding
    II. Nucleoside only consists of the r group, when nucleotides also have the phosphate group
    III. The run in opposite directions
    IV. Between the base and the sugar
    V. Phosphate backbone
    VI. 3' T A A A T C C C C G C T 5'
17. There are minor grooves and major grooves in B-DNA and also G and C are held together with 3 bonds not 2
18. 18
    I. Miescher identifies DNA 1860s
    II. Levene reseach identified primary componets
    III. Chargaff's Law
    IV. Rosalind Franklin's photo
    V. Watson and Crick propose first accurate description of double helix
    VI. correction of CG only 2 H bonds and identify Z and A forms of DNA
19. Replication of DNA through the pairing of the bases
20. She took the first photo, which showed the helix shape of DNA, which sparked interest in the molecule
21. It would have been, but her discovery definitely sparked interest and research into it earlier

2. ☑ Gene Expression in Stem Cells

2 - Gene Expression in Stem Cells

Spreadsheet

		Gene Expression in fibroblast and iPS cells							
		Human Fibroblast Cells				Induces Pluripotent stem cells (iPS)			
Genes		HFF 1	HFF 2	HFF 3	HFF Mean	iPS 1	iPS 2	iPS 3	iPS Mean
1	SOX2	2.2	2.6	2.5	2.43	6.6	7	7.2	6.93
2	MYC	1.2	1.3	1.3	1.27	4.1	4.5	4.6	4.4
3	NANOG	1.8	1.5	1.5	1.6	3.9	4.2	4.3	4.13
4	KLF4	3.4	3.7	3.9	3.67	12	11	10	11
5	COL1A2	9.1	9.8	9.6	9.5	1.1	1.2	1.5	1.27
6	FSP1	10.2	10.4	11	10.53	1.7	1.7	1.9	1.77
7	TSLP	15.2	16	14.4	15.2	2.5	2.4	2.6	2.5
8	GAPDH	5.6	5.9	5.8	5.77	5.7	5.5	6	5.73
9	ACTB	8.8	8.5	8.2	8.5	8.4	8.7	8.3	8.47
10	CDK1	2.2	2.4	2.6	2.4	2.5	2.7	3	2.73

Independent variable: Genes
Dependent variable: Average gene expression

Questions

1. The Gene expression differs greatly between the HFF and iPS cells.
    - For example in the SOX2-KLF4 genes, the iPS cells display significantly more gene expression than the HFF cells
    - The exact opposite can be seen in the COL1A2-TSLP genes, and they appear to be roughly similar on the GAPDH-CDK1 genes
2. Look at the graph, red bar much bigger, then blue bar big, then same
3. This supports my claim that environmental factors in development effect the expression of genes. Since iPS and HFF cells were probably made for different purposes (and through different methods) it is unlikely that they express the same genes, and this data agrees with that.
4. What cells display similar traits to that of the iPS cells? Is it possible to manufacture a cell with similar gene expression to that of the HFF cell?

Doodle Notes

1. ☑ Scientists with their findings related to DNA

Flash Talks

1. [ ] Prokaryotic Gene Regulation (on FlipGrid)

Labs

1. [x] DNA, Proteins & Protein Folding (G-Drive)

   1 - DNA, Proteins, and Protein Folding

   DNA: `ATG TTT CAT CTC GTT GAC TTT CAG GTT ACT ATA GCA GAG ATA TTA CTA ATT ATT ATG AGG`
   Template: `TAC AAA GTA GAG CAA CTG AAA GTC CAA TGA TAT CGT CTC TAT AAT GAT TAA TAA TAC TCC`
   mRNA: `AUG UUU CAU CUC GUU GAC UUU CAG GUU ACU AUA GCA GAG AUA UUA CUA AUU AUU AUG AGG`
   Amino A.: `Met Phe His Leu Val Asp Phe Gln Val Thr Ile Ala Glu Ile Leu Leu Ile Ile Met Arg`

   1st: the chain of amino acids
   2nd: Creation of helices and sheets from interactions between the local amino acids
   3rd: The final shape of a strand of amino acids through interactions with the entire strand of amino acids
   4th: Interaction between multiple strands of amino acids to produce one large protein

   1. Why do you think some amino acids (nonpolar) cluster on the inside of the protein and some are more often found on the outside (polar)? Think about the aqueous environment that proteins usually are in.
      - The polar amino acids will be more attracted to the water in the cell, so they will rise to the surface of the protein
   2. Why should we continue to study proteins, including their shapes and the DNA that codes for them?
      - So that we can know how they interact in order to more effectively produce synthetic proteins or block bad proteins to living organisms
   3. How is protein research contributing to ending this pandemic?
      - We can learn how proteins interact through the infections throughout the pandemic and learn how to effectively counter it
   4. What is the connection between DNA, RNA, and proteins?
      - DNA is the information that RNA gets written with, and the information on the RNA get translated into amino acids making a protein
   5. How do proteins get their shape?
      - From interactions between the R-groups of each amino acid, pulling and pushing apart or together

2. [x] Bacterial Transformation (G-Drive)

   2 - Bacterial Transformation

   ## Questions

   1. To facilitate the uptake of DNA that contains a gene of interest
   2. Red fluorescent protein
   3. 3
      I. Ori: The origin of the replication
      II. pBAD promoter and araC genes regulate the rfp production
      III. ampR indentifies transformed bacteria
   4. Able to bind to specific DNA in its environment
   5. It makes the membrane more permeable for the DNA to enter
   6. It neutralizes negatively charged DNA, allowing the cells to be competent
   7. 7
      I. Luria Broth solution: Growth medium containing biological macromolecules necessary for growth

II. pARA-R solution: Solution with recombinant pARA-R plasmids (with the rfp gene)
III. Competent cells: Tube with prepared cells ready to accept DNA

8. Tube 4
9. Control group is the current standard way of producing the result (if done before) to be used as a reference and comparison point to the new method
10. Negative Control group is when all the necessary preparations are done to the investigative group, but no treatment is actually administered, it is expected to show no results
11. The experimental group is the group with the new treatment, and is used to see how different things produce different results to be compared with the controls
12. Tube 2, as no treatment (plasmids) were administered to the solution
13.
    -
14.
    -
15. Yes, the P- tube had no plasmids so it did not show any effect, and the P+ tube did
16. Compare it to the controls and see how the results differ
17.
    -

Reflection

1. A process where external DNA is merged with competent cells in order to replicate the DNA and possibly proteins
2. P- doesnt have the recombinant plasmid, and P+ does
3. True
4. To prevent the test groups to contaminate each other or the environment from contaminating the test groups
5. Because the membranes will be more permeable to the recombinant plasmids

3. ☑ Strawberry DNA Extraction Lab (Handouts only)

POGILs

1. ☑ Genetic expression - Translation

1 - Gene Expression - Translation

1. 1
    I. Uracil, Cytosine, Adenine, Guanine, the base on the RNA strand
    II. The amino acid on the chain produced by the bases
    III. The bases are read in triples to produce one amino acid
2. 300 / 3 = 100 - 1 = 99 amino acids (removal of the stop coding region)
3. 3
    I. 4
    II. All start with CC
    III. In case an error in transcription occurs, there is still a higher chance that the correct protein will be made
4. 4
    I. AUG GAA GCC UAC CAG UGA
    II. Met Glu Ala Tyr Gln (stop)
5. Met (AUG)
6. They share a common ancestor or creator
7. 7
    I. Initiation, Elongation, Termination

    II. Starting of the process, Building the chain, Stopping the production
8. Cytoplasm / Ribosomes
9. It is the start codon and begins the chain of amino acids
10. It moves down the mRNA, reading it in triplets
11. 11
    I. GUA
    II. CAU
    III. ✅
    IV. CCA
12. It transfers amino acids to the ribosome while matching to the mRNA
13. 2, the previous and current
14. Goes and finds more amino acids
15. Binds water to the end and detaches from the ribosome
16. It creates a chain of amino acids (protein) simply from DNA, through RNA
17. 17
    I. 4×4×4 = 64
    II. 4×4 = 16 (less than 20)
18. UUUUUUUUUUUU ⇒ UUCUUUUUUUUU

Worksheets

1. ☑ Translation and Open Reading Frame Practice

1 - Translating and Open Reading Frame Practice

1. Given the following sense strand of DNA sequence, transcribe it into mRNA, showing the orientation of the mRNA i.e. 3' and 5' ends. Then translate this sequence into protein indicating amino and carboxy termini, be sure to check for an open reading frame as well.

DNA:

```
5' GGGATCGATGCCCCTTAAAGAGTTTACATATTGCTGGAGGCGTTAACCCCGGA 3'
```

mRNA:

```
5' GGGAUCG-AUG-CCC-CUU-AAA-GAG-UUU-ACA-UAU-UGC-UGG-AGG-CGU-UAA-CCCCGGA 3'
```

Amino Acid:

```
Met Pro Leu Lys Glu Phe Thr Tyr Cys Trp Arg Arg Stop
```

2. You have just sequenced a short segment of DNA. You wish to analyze this DNA sequence to determine whether it could encode a protein.
    I. Find the longest open reading frame (ORF). Remember, there are six possibilities.
    II. Label which strand on the DNA will be the sense strand, and which will be antisense when this DNA is transcribed.
    III. Transcribe this ORF into mRNA, indicating the 5' and 3' ends.
    IV. Translate this mRNA into amino acids, indicating the amino (N) and carboxy (C) termini.

DNA:

```
5' TCAATGTAACGCGCTACCCGGAGCTCTGGGCCCAAATTTCATCCACT 3'
```

```
5' AGTGGATGAAATTTGGGCCCAGAGCTCCGGGTAGCGCGTTACATTGA 3'
```

mRNA:

```
5' UCAAUGUAACGCGCUACCCGGAGCUCUGGGCCCAAAUUUCAUCCACU 3'
```

`5' AGUGGAUGAAAUUUGGGCCCAGAGCUCCGGGUAGCGCGUUACAUUGA 3'`

`5' AGUGG- AUG-AAA-UUU-GGG-CCC-AGA-GCU-CCG-GGU-AGC-GCG-UUA-CAU-UGA 3'`

Amino Acid:

`N- Met Lys Phe Gly Pro Arg Ala Pro Gly Ser Ala Leu His Stop -C`

2. Big protein synthesis foldable

2 - Big protein synthesis foldable

1. 1
   - Initiation: RNA polymerase binds to the promoter site, then separates the DNA strands
   - Elongaion: RNA strand elongates by zipping down the DNA and creating the RNA strand (in the 5' to 3' direction)
   - Termination: Once the polymerase hits a termination section, it signals that the strand is complete, and depending if it is Rho dependent or not, it either waits for the Rho to come and detach the polymerase, or a hairpin is formed by the RNA binding itself and stalling the polymerase
2. 2
   - Introns are removed from the pre-mRNA
   - Polydenyletion happens, where a poly-A tail is added to the 3' end
   - A cap enzyme is also added to the 5' head
3. 3
   - Initiation: Ribsome binds to the mRNA cap, and find the start codon
   - Elongation: Matching amino acids are added to the polypeptide chain, matching with the codon on the mRNA
   - Once a stop codon is hit, a water molecule is added to the end of the chain and the chain is released from the ribsome as well as the mRNA
4. 4
   - The golgi apparatus may take the protein and further modify it by folding it in different ways to change the function and form of the protein.
   - It may also modify the functional group on the amino acids
   - Phosphylation and Glycosylation may also happen to the protein