**Topic Review Guide**: Gene Expression and Regulation

*AP Biology*

**To Think About**: How is heritable information passed to the next generation in eukaryotes, and how do changes in genotype result in changes in phenotype of an organism? What multiple processes increase genetic variation in biological systems, and how do environmental factors influence the expression of the genotype in an organism? How is DNA, and in some cases RNA, the primary source of heritable information? How does gene regulation result in differential gene expression, leading to cell specialization? In what ways do a variety of intercellular and intracellular signal transmissions mediate gene expression? How does viral replication result in genetic variation, and how can viral infection introduce genetic variation into the hosts? How do interactions between external stimuli and regulated gene expression result in specialization of cells, tissues, and organs?

**Post-It Annotations**: In your **BILL**, create a post-it note annotations page for each of the following sections. Make sure to include the “Power Line” that connects the concepts and topics from the reading.

* **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?
* **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?
* **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?
* **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?
* **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?
* **Figure 15.3**: The trp operon in E. coli - regulated synthesis of repressible enzymes pg. 295
  + **Power Line**: How is the trp operon repressible?
* **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?
* **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?

**Supplemental Videos**: Go to [www.bio-net.us](http://www.bio-net.us) for a list of videos that can help you in learning the concepts of the unit.

**Recall and Review**: Use your textbook reading to help you answer these questions in your BILL.

***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.
   1. Frederick Griffith
   2. Oswald Avery, Maclyn McCarty, and Colin MacLeod
   3. Alfred Hershey and Martha Chase
   4. Erwin Chargaff
2. **Explain** what is meant by “antiparallel” orientation of DNA.
3. Describe the four essential functions of the genetic material. **Explain** how the structure proposed by Watson and Crick makes these functions possible.
4. **Create** a t-chart that compares DNA to RNA. Include structure, location and function of both molecules in your comparison.
5. Meselson and Stahl claimed that the replication of DNA was semiconservative. **Describe** the evidence they used to support their claim.
6. **Describe** what the role of the following enzymes is in DNA replication:
   1. DNA polymerase
   2. DNA ligase
   3. DNA primase
7. Explain why the leading strand of DNA is replicated continuously, while the lagging strand is replicated discontinuously.
8. **Create** a graphic organizer that illustrates the differences between the process of DNA replication in prokaryotes and eukaryotes.
9. **Describe** the relationship between the following organizational units of DNA:

| ***DNA*** | ***Nucleosomes*** | ***Chromatin*** | ***Chromosome*** |
| --- | --- | --- | --- |

***Transcription and Translation***

1. **Compare** the processes of DNA replication with transcription. Be sure to include the following things in your comparison:
   1. Location of process
   2. Nucleic acids involved
   3. Enzymes responsible
2. **Create** a graphic organizer that explains the relationship between the following molecules:

| ***DNA*** | ***mRNA*** | ***tRNA*** | ***rRNA*** | ***RNAi*** |
| --- | --- | --- | --- | --- |

1. **Describe** the difference between an intron and an exon.
2. Eukaryotic mRNA is often modified before it leaves the nucleus. **Describe** how this happens.
3. **Explain** how the production of eukaryotic mRNA is like watching a tv show that is on Netflix.
4. **Create** a graphic organizer that illustrates the differences between the processes of transcription and translation, including how they operate in prokaryotes vs. eukaryotes.
5. **Explain** the relationship between protein synthesis and an organism’s phenotype.
6. **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?”

***Mutations***

1. **Create** a t-chart that explains the difference between somatic mutations and germline mutations.
2. **Create** a graphic organizer that illustrates how point mutations differ from chromosomal mutations. Which one has a greater effect on the organism’s phenotype?
3. **Create** a diagram that represents the following types of mutations:

| ***Silent mutation*** | ***Missense mutation*** | ***Nonsense mutation*** | ***Frameshift mutation*** |
| --- | --- | --- | --- |

1. **Create** a t-chart that compares gene mutations to chromosomal mutations
2. **Explain** what would happen to the process of gene expression if the gene for RNA polymerase was mutated.
3. 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.
4. **Describe** how proteins can be altered once they have been synthesized at the ribosome and what organelles are involved.

***Gene Regulation***

1. Define **operon.  Explain** how bacterial cells use operons to control gene expression.
2. **Describe** the relationship between the following components of an operon:

| ***Promoter*** | ***Operator*** | ***Repressor*** | ***Structural Genes*** | ***Regulatory Genes*** |
| --- | --- | --- | --- | --- |

1. **Create** a t-chart that **explains** how repressible operons differ from inducible operons.   Use the ***trp*** and ***lac operons*** as examples.
2. **Describe** the relationship between these terms and **explain** how these terms are used to describe eukaryotic gene regulation.

**Enhancer Promoter Silencer DNA**

1. **Explain** how transcription factors help to regulate eukaryotic gene expression.
2. **Create** a t-chart that describes the differences between lytic virus reproduction and lysogenic virus reproduction
3. **Describe** how the following tools are used to study or modify organismal genomes:

| ***Restriction Enzymes*** | ***Plasmids*** | ***Gel Electrophoresis*** | ***Polymerase Chain Reaction (PCR)*** |
| --- | --- | --- | --- |