AP Biology Review Packet 4: Viruses, Bacteria and Expression & DNA Technology

3A1- DNA, and in some cases RNA, is the primary source of heritable information.

3B1- Gene Regulation results in differential gene expression, leading to cell specialization.

3C3- Viral Replication results in genetic variation, and viral infection can introduce genetic variation into the hosts.

2C1- Organisms use feedback mechanisms to maintain internal environments and respond to external environmental changes.

**1. Chromosome structure**

1. Nucleosome- packing unit of DNA wrapped around a histone
2. Nucleosomes coil together to make fiber; loops coil; further compacted into chromosomes
3. Euchromatin is loosely coiled DNA (can be read for mRNA so it is turned on)
4. Heterochromatin is tightly coiled DNA (cannot be read for mRNA so it is turned off)
5. Histone acetylation refers to chemical that causes DNA to become less packed (turned on)
6. **Satellite DNA (Tandemly Repetitive DNA)**- Repeated DNA sequences that are present in hundreds or thousands of copies (usually 5-10 nucleotides)
7. **Interspersed Repetitive DNA**- Repeats not adjacent- scattered throughout the genome.
8. Telomeres are repeated sequences (usually TTAGGG) at tips of chromosomes. Used to conserve chromosomes because of lagging strand problems.

**2. Regulation of Transcription/Translation**

1. Enhancers- Areas on genome that are non-coding that are located at a distance from a promoter. Transcription factors can bind to these areas and cause transcription of certain genes. (turns on)
2. MRNA Degradation- mRNA has a life span in the cytoplasm (can last a few hours to a week). (turns off)
3. RNA processing (intron splicing, poly a tail, gtp cap) (turn on and alter expression)
4. Histone Acetylation (turn on)
5. Methylation- marks on outside that turn DNA on or off (epigenetics)
6. Translation Repressors (turn off)
7. Posttranslational modifications- folding, cleaving, etc. (alter expression)
8. Transposons- jumping genes can enhance or reduce transcription translation by where they land
9. **Viruses (not alive)**
10. Can be DNA or RNA (injected into host and takes over host energy/enzymes to make more of itself)
11. Protein coat called capsid
12. Retroviruses have reverse transcriptase; which is used in recombinant DNA tech- ex. AIDS
13. Can allow for new gene combination in host by transduction (taking a piece of DNA with them when they break out)
14. Lytic cycle (virulent/active) and Lysogenic cycle (dormant/temperate)

**4. Regulation of Gene Expression in Bacteria as Model**

1. Bacteria are prokaryotic with a single circular chromosome
2. Bacteria express all the genes needed for a product (more than one gene at a time)
3. Organization includes the promoter region of DNA, operator, and structural genes
4. Trp operon = repressible; anabolic pathway; used to make enzymes that help make tryptophan if none is present
5. Repressor is naturally INACTIVE so it will make tryptophan
6. Repressor only becomes ACTIVE when trp (called corepressor) is in excess and binds to repressor changing its shape
7. Lac operon-catabolic pathway; inducible; used to make enzyme to break down lactose when it is available
8. Repressor is naturally ACTIVE so it will block gene transcription unless lactose (allolactose- called inducer) binds and makes repressor INACTIVE

**5. Recombinant DNA**

1. **Natural chromosomal mechanisms**
2. crossing over
3. independent assortment (during meiosis I metaphase)
4. transformation (taking in foreign DNA from environment- bacteria)
5. transduction (viruses taking DNA from one cell to another)
6. conjugation (donation of copy of genes from one organism to another; bacteria/protists)

6. transposable elements (transposons can be simple or complex)

1. **Genetic engineering**
2. Toolkit includes plasmid (piece of round DNA from bacteria/yeast) or other vector such as viruses; restriction enzymes; host cell (usually bacteria like E. coli)
3. Restriction enzymes cut genes at restriction sites to make blunt or sticky ends
4. Cut gene of interest (g.o.i.) with same enzyme to get same ends
5. Insert vector into host using: 1) transformation, 2) gene gun, 3) electroporation, 4) needle
6. Used to clone and make copies or to produce a foreign protein such as HGH or insulin
7. **Techniques**
8. Probes/Hybridization- technique used for selection where a probe is created that binds to complimentary DNA; also used in PCR and electrophoresis
9. Expression Vectors/YAC/BAC- engineered plasmids or vectors that have known promoter regions and DNA; artificial chromosomes like YAC/BAC can be used for larger pieces of DNA
10. PCR- Used to make large amounts of clones of DNA without using a host; heat which opens ; use a probe with nucleotides; cool; repeat
11. Electrophoresis- Used to look at unique pattern created by fragments of DNA; cut DNA using enzyme; load into a gel that is covered with buffer; turn on electricity; DNA runs from negative to positive; larger chunks move less; unique for each person if testing variable areas of DNA; can be used for protein or mRNA too
12. DNA Sequencing- used to determine unknown DNA sequence; mainly done by computers and capillary electrophoresis/lasers; old technique involved putting multiple fragments of unknown DNA in with labeled probe, regular nucleotides and blocker nucleotides; read gel by lanes and each one ends in particular base
13. cDNA libraries- created by using reverse transcriptase to produce DNA from mRNA (takes out introns) so it can be placed in bacterial host
14. Microarray- method of putting fragments of ssDNA on a slide; fragments are tested for hybridization with various samples of fluorescently-labeled cDNA molecules; areas that light up show expression.

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***AP Biology Investigation 8: Biotechnology- Bacterial Transformation***

Overview- Bacteria were transformed by introducing plasmids with the glowing gene by chemical induction and heat shocking and then plated on two different media- luria broth or luria broth with ampicillin.

IV: plasmid

DV: Growing or Glowing; RESULTS- Growth on no plasmid without ampicillin, no growth with no plasmid amp; growth on plasmid amp and no amp but glowed on amp

Equations: Transformation Efficiency- total number of colonies growing on the agar plate/ amount of DNA spread on the LB /amp plate in ug

***AP Biology Investigation 9: Biotechnology- Restriction Enzyme Analysis of DNA***

Overview: A sample electrophoresis experiment was performed regarding cancer in patients. A patient was tested to see if the DNA from her breast, blood, surrounding tissue and a control group.

IV: Sample location

DV: RFLP’s or banding pattern on electrophoresis gel; one hit = carrier; two hit= cancer

Equations: This lab was a substitution lab the original AP lab asked students to make a standard curve (we did this in class as an activity) by electrophoresing known fragment lengths and then measuring the distance they traveled to create a standard curve. This curve was used to estimate the sizes of UNKNOWN sized fragments in other lanes.

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**Molecular Genetics**

conjugation

DNA Sequencing

DNA ligase

DNA polymerase

gel electrophoresis

gene expression

gene induction

gene repression

genetic engineering

homeotic genes

*HOX* genes

Human genome project

inducible genes

lac operon

micro RNA (miRNA)

plasmid

polymerase chain reaction

probe

regulatory sequence

restriction enzyme

reverse transcriptase

RNAi

small interfering RNA (siRNA)

small regulatory RNA

transgenic organism

transposon

transformation

vector

virus

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1. What are some mechanisms by which gene expression is regulated in prokaryotes and eukaryotes?
2. What is the structure of viruses?
3. How do viruses transfer genetic material between cells?
4. What are some current recombination technologies?
5. What are some practical applications of nucleic acid technology?

6.If you were to observe the activity of methylated DNA, you would expect it to

|  |  |
| --- | --- |
| a. | be replicating nearly continuously. |
| b. | be unwinding in preparation for protein synthesis. |
| c. | have turned off or slowed down the process of transcription. |
| d. | be very actively transcribed and translated. |
| e. | induce protein synthesis by not allowing repressors to bind to it. |

7.Genomic imprinting, DNA methylation, and histone acetylation are all examples of

|  |  |
| --- | --- |
| a. | genetic mutation. |
| b. | chromosomal rearrangements. |
| c. | karyotypes. |
| d. | epigenetic phenomena. |
| e. | translocation. |

8.In both eukaryotes and prokaryotes, gene expression is primarily regulated at the level of

|  |  |
| --- | --- |
| a. | transcription. |
| b. | translation. |
| c. | mRNA stability. |
| d. | mRNA splicing. |
| e. | protein stability. |

9.In eukaryotes, transcription is generally associated with

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| --- | --- |
| a. | euchromatin only. |
| b. | heterochromatin only. |
| c. | very tightly packed DNA only. |
| d. | highly methylated DNA only. |
| e. | both euchromatin and histone acetylation. |

10.This binds to a site in the DNA far from the promoter to stimulate transcription:

|  |  |
| --- | --- |
| a. | enhancer |
| b. | promoter |
| c. | activator |
| d. | repressor |
| e. | terminator |

11.Gene expression might be altered at the level of post-transcriptional processing in eukaryotes rather than prokaryotes because of which of the following?

|  |  |
| --- | --- |
| a. | Eukaryotic mRNAs get 5' caps and 3' tails. |
| b. | Prokaryotic genes are expressed as mRNA, which is more stable in the cell. |
| c. | Eukaryotic exons may be spliced in alternative patterns. |
| d. | Prokaryotes use ribosomes of different structure and size. |
| e. | Eukaryotic coded polypeptides often require cleaving of signal sequences before localization. |

12.Which of the following experimental procedures is most likely to hasten mRNA degradation in a eukaryotic cell?

|  |  |
| --- | --- |
| a. | enzymatic shortening of the poly(A) tail |
| b. | removal of the 5' cap |
| c. | methylation of C nucleotides |
| d. | memethylation of histones |
| e. | removal of one or more exons |

13.The functioning of enhancers is an example of

|  |  |
| --- | --- |
| a. | transcriptional control of gene expression. |
| b. | a post-transcriptional mechanism for editing mRNA. |
| c. | the stimulation of translation by initiation factors. |
| d. | post-translational control that activates certain proteins. |
| e. | a eukaryotic equivalent of prokaryotic promoter functioning. |

14.Which of the following is an example of post-transcriptional control of gene expression?

|  |  |
| --- | --- |
| a. | the addition of methyl groups to cytosine bases of DNA |
| b. | the binding of transcription factors to a promoter |
| c. | the removal of introns and splicing together of exons |
| d. | gene amplification during a stage in development |
| e. | the folding of DNA to form heterochromatin |

15.Within a cell, the amount of protein made using a given mRNA molecule depends partly on

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| --- | --- |
| a. | the degree of DNA methylation. |
| b. | the rate at which the mRNA is degraded. |
| c. | the presence of certain transcription factors. |
| d. | the number of introns present in the mRNA. |
| e. | the types of ribosomes present in the cytoplasm. |