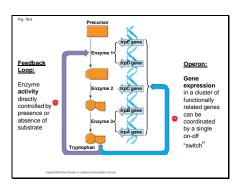


## Slide 2

#### Changes in the environment can regulate cell activity

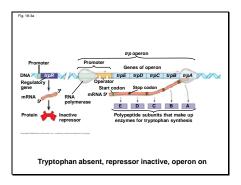
- Natural selection has favored single-celled organisms that produce only the products needed by that cell
- The fastest way is to directly control enzyme cascades
- In bacteria it is nearly as fast to change gene expression. This is controlled by the operon model – one promoter, many genes
- Eukaryotes also have coordinately controlled gene expression – but, like everything else about them it's more complicated (more on that later....)

Copyright © 2008 Pearson Education Inc., publishing as Pearson Benjamin Cumming

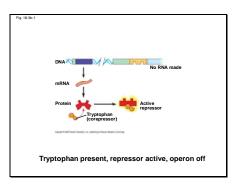


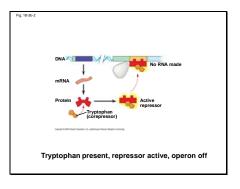
|      | <br> |  |
|------|------|--|
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> | <br> |  |
|      |      |  |
| <br> | <br> |  |
| <br> |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
| <br> |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |
|      |      |  |

| Slide 4 | Operons: the entire stretch of DNA that includes   | Ĩ |      |
|---------|--|---|------|
|         | operation are control success of 21 v1 and includes in   |   |      |
|         | The <b>promoter</b> which binds RNA polymerase.  |   | <br> |
|         | The operator: a regulatory "switch" in the<br>promoter that reacts to environmental change   |   |      |
|         | All of the related genes that they control   |   | <br> |
|         | <b>3</b>   |   |      |
|         |  |   |      |
|         | Oppright O 2008 Purson Education Inc., publishing as Porson Binjamin Cammings  |   |      |
|         | - Apple - And Andrews - An | 1 | <br> |
|         |  |   |      |
|         |  |   | <br> |
|         |  |   |      |
|         |  |   | <br> |
|         |  |   |      |
| Slide 5 | Negative vs. Positive Operons  |   | <br> |
|         | Turn Turner of Magnetius or "Passessers" Come Description  |   |      |
|         | Two Types of Negative, or "Repressor", Gene Regulation  Operons that involve negative control of genes are switched off by the active form of a repressor  |   | <br> |
|         | A repressible operon is one that is usually on; binding of a repressor to the operator shuts off transcription   |   |      |
|         | An <b>inducible operon</b> is one that is usually off; a molecule called an inducer inactivates the repressor and turns on transcription   |   | <br> |
|         | One Type of Positive, or "Activator", Gene Regulation  |   |      |
|         | An activator of transcription is a stimulatory protein that acts to bind RNA polymerase much like an eukaryotic transcription factor   |   | <br> |
|         | Copyright O 2000 Pourson Education Inc., publishing as Pourson Benjamin Commings   |   |      |
|         |  |   | <br> |
|         |  |   |      |
|         |  |   | <br> |
|         |  |   |      |
|         |  |   | <br> |
| CITAL C |  | 1 |      |
| Slide 6 | Example 1 of Negative, or "Repressor", Gene Regulation   |   | <br> |
|         | Repressible enzymes usually function in anabolic pathways; their<br>synthesis is repressed by high levels of the end product   |   |      |
|         | <ul> <li>The trp operon is a repressible operon: By default it is on and the<br/>genes for tryptophan synthesis are transcribed</li> </ul>   |   |      |
|         | <ul> <li>Tryptophan is a corepressor and when it is present, it binds to<br/>the trp repressor protein, which turns the operon off</li> </ul>  |   |      |
|         |  |   |      |
|         |  |   |      |
|         |  |   | <br> |
|         | Copyright © 2008 Pearwas Education Inc., publishing as Pearwas Benjamin Cammings   | j |      |
|         |  |   |      |
|         |  |   |      |
|         |  |   |      |



# Slide 8

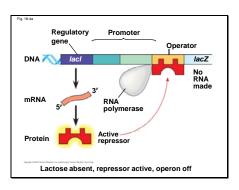


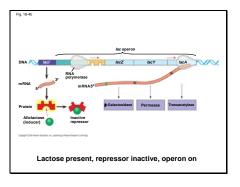


Example 2 of Negative, or "Repressor", Gene Regulation

- Inducible enzymes usually function in catabolic pathways; their synthesis is induced by a chemical signal
  - The *lac* operon is an inducible operon and by itself, the *lac* repressor is active and switches the *lac* operon off
  - Lactose is an **inducer** and inactivates the repressor to turn the *lac* operon on

## Slide 11





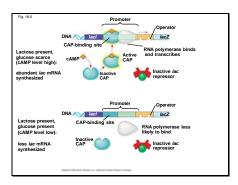
| <br> | <br> | <br> | <br> |
|------|------|------|------|
|      |      |      |      |
|      |      |      |      |
|      | <br> |      |      |
|      |      |      |      |
| <br> |      |      |      |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
| <br> |      |      |      |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> |      | <br> |
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
| <br> |      | <br> |      |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> | <br> | <br> |
|      |      |      |      |
|      |      |      |      |
|      |      |      | <br> |
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
|      |      |      |      |
| <br> | <br> |      | <br> |
|      |      |      |      |
|      |      |      |      |

#### **Positive Gene Regulation**

- Positive secondary control of the speed of an operon
- Sometimes lactose is present but glucose is scarce
- Catabolite Activator Protein (CAP) is activated by binding with cyclic AMP
- Activated CAP attaches to the promoter of the *lac* operon and increases the affinity of RNA polymerase, thus accelerating transcription
- When glucose levels increase, CAP detaches from the *lac* operon, and transcription returns to a normal rate
- CAP helps regulate other operons that encode enzymes used in catabolic pathways

Consciole C 2008 Person Education Inc., multiplinar as Person Revisario Commissos

#### Slide 14



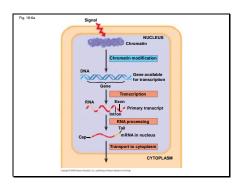
## Slide 15

Differential gene expression in multicellular development and cell specialization

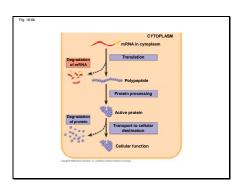
- Regulation of Chromatin Structure
- Regulation of Transcription Initiation
- Mechanisms of Post-Transcriptional Regulation
- Mechanisms of Post-Translational Regulation

Copyright © 2008 Pearson Education Inc., publishing as Pearson Benjamin Cumming

|      | <br> | <br> |  |
|------|------|------|--|
|      |      |      |  |
|      |      |      |  |
| <br> | <br> | <br> |  |
|      |      |      |  |
|      |      |      |  |
| <br> | <br> | <br> |  |
|      |      |      |  |
|      |      |      |  |
|      | <br> | <br> |  |
|      | <br> | <br> |  |
|      |      |      |  |
|      | <br> |      |  |
|      | <br> | <br> |  |
|      |      |      |  |
|      |      |      |  |
|      | <br> | <br> |  |
|      | <br> |      |  |
|      |      |      |  |
| <br> | <br> | <br> |  |
|      |      |      |  |
|      |      |      |  |
|      | <br> |      |  |
| <br> | <br> | <br> |  |
|      |      |      |  |
|      |      |      |  |
| <br> | <br> | <br> |  |
|      |      |      |  |
|      |      |      |  |



## Slide 17



## Slide 18

#### Regulation of Chromatin Structure

- Genes within highly packed heterochromatin are usually not expressed
- Chemical modifications to histones and DNA influence chromatin structure and gene expression by making a region of DNA either more or less able to bind the transcription machinery
- The histone code hypothesis proposes that specific combinations of modifications help determine chromatin configuration and influence transcription

Copyright © 2008 Pearson Education Inc., publishing as Pearson Benjamin Cumming

| <br> | <br> | <br> | <br> | <br> |
|------|------|------|------|------|
|      |      |      |      |      |
|      |      |      | <br> |      |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
|      |      |      |      |      |
|      | <br> |      |      | <br> |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
|      |      |      |      |      |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
| <br> | <br> |      | <br> |      |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
|      | <br> |      | <br> | <br> |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
|      |      |      |      |      |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
| <br> |      |      |      |      |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
| <br> |      |      |      |      |
|      |      |      |      |      |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
| <br> | <br> | <br> | <br> | <br> |
|      |      |      |      |      |
|      |      |      |      |      |

# Slide 19 | The addition of methyl groups are attached to positively charged lysines in histone tails | This process loosens chromatin structure, thereby initiating transcription | Unacetylated histones | Acetylated hist

- DNA methylation, the addition of methyl groups to certain bases in DNA, is associated with reduced transcription in some species
- DNA methylation can cause long-term inactivation of genes in cellular differentiation
- In genomic imprinting, methylation regulates expression of either the maternal or paternal alleles of certain genes at the start of development

pyright © 2008 Pearson Education Inc., publishing as Pearson Benjamin Cummings

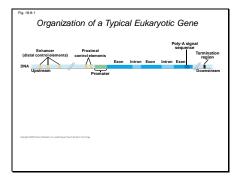
## Slide 21

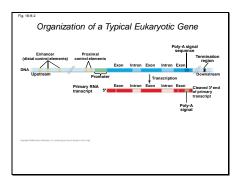
#### Epigenetic Inheritance

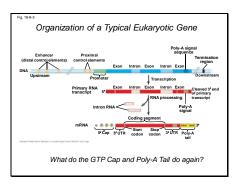
- Although the chromatin modifications just discussed do not alter DNA sequence, they may be passed to future generations of cells
- The inheritance of traits transmitted by mechanisms not directly involving the nucleotide sequence is called **epigenetic inheritance**

opyright © 2008 Pearson Education Inc., publishing as Pearson Benjamin Cumming

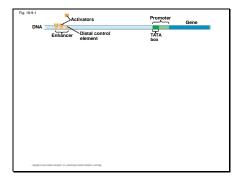
Slide 22

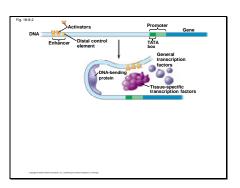


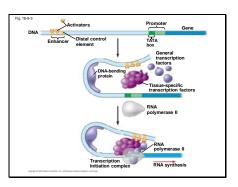


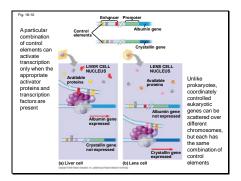


Slide 25

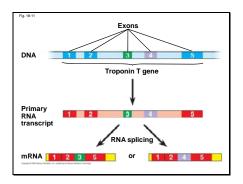


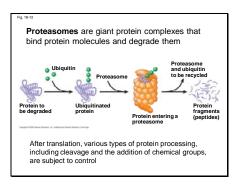






## Slide 29



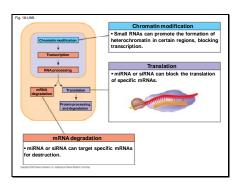


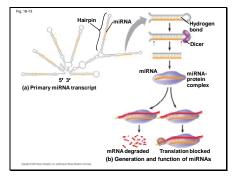
# Noncoding RNAs can control gene expression through RNA Interference (RNAi).

- Only a small fraction of DNA codes for proteins, rRNA, and tRNA. A significant amount of the genome may be transcribed into noncoding RNAs
- MicroRNAs (miRNAs) are small single-stranded RNA molecules that can bind to mRNA and degrade it or block its translation
- siRNAs and miRNAs are similar but form from different RNA precursors
- siRNAs play a role in heterochromatin formation and can block large regions of the chromosome
- Small RNAs may also block transcription of specific genes

Conversable C. 2008. Reservoir Educations Inc., multiplicities as Reservoir Remismin Committees

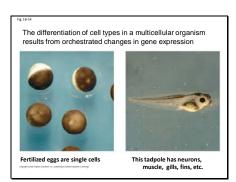
## Slide 32

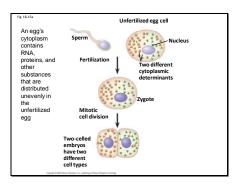


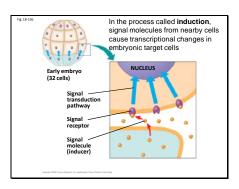


| <br> | <br> |      | <br> |  |
|------|------|------|------|--|
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> |      |      | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> | <br> | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> | <br> |      |      |  |
| <br> | <br> | <br> |      |  |
| <br> |      | <br> |      |  |
| <br> |      |      |      |  |
| <br> |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      | <br> |  |
|      |      |      |      |  |
| <br> |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      | <br> |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
| <br> |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      | <br> |      |      |  |
|      |      |      |      |  |
| <br> |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      | <br> |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |
|      |      |      |      |  |

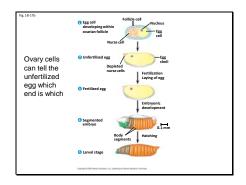
Slide 34

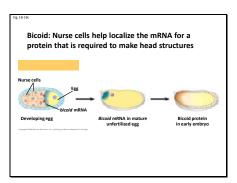


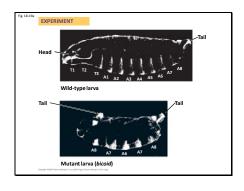




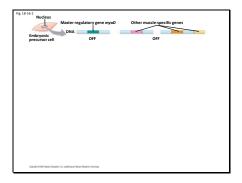
Slide 37

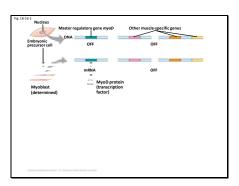


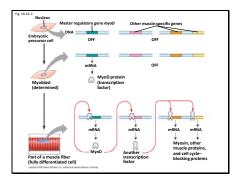




Slide 40







|  | <br> |      |
|--|------|------|
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  | <br> |      |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  |      | <br> |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  | <br> |      |
|  |      |      |
|  |      |      |
|  |      |      |
|  | <br> | <br> |
|  |      |      |
|  |      |      |
|  |      |      |