

1  **Chapter 8**

Microbial Genetics

2  **Terminology**

- Genetics: The study of what genes are, how they carry information, how information is expressed, and how genes are replicated
- Gene: A segment of DNA that encodes a functional product, usually a protein
- Chromosome: Structure containing DNA that physically carries hereditary information; the chromosomes contain the genes
- Genome: All the genetic information in a cell

3  **Terminology**

- Genomics: The molecular study of genomes
- Genotype: The genes of an organism
- Phenotype: Expression of the genes

4  **Determine Relatedness**5  **Determine Relatedness**

- Which strain is more closely related to the Uganda strain?

6  **Genetic Map of the Chromosome of *E. coli***7  **The Flow of Genetic Information**8  **DNA**

- Polymer of nucleotides: Adenine, thymine, cytosine, and guanine
- Double helix associated with proteins
- "Backbone" is deoxyribose-phosphate
- Strands are held together by hydrogen bonds between AT and CG
- Strands are antiparallel

9  **Semiconservative Replication**10  **DNA Synthesis**11  **DNA Synthesis**

- DNA is copied by DNA polymerase
  - In the 5' → 3' direction
  - Initiated by an RNA primer
  - Leading strand is synthesized continuously
  - Lagging strand is synthesized discontinuously
  - Okazaki fragments
  - RNA primers are removed and Okazaki fragments joined by a DNA polymerase and DNA ligase

12 13 14  **DNA Synthesis**15  **Replication of Bacterial DNA**16  **Replication of Bacterial DNA**

17 

- ✓ Give a clinical application of genomics. 8-1
- ✓ Why is the base pairing in DNA important? 8-2
- ✓ Describe DNA replication, including the functions of DNA gyrase, DNA ligase, and DNA polymerase. 8-3
- ✓
- ✓

18 **Transcription**

- DNA is transcribed to make RNA (mRNA, tRNA, and rRNA)
- Transcription begins when RNA polymerase binds to the promoter sequence
- Transcription proceeds in the 5' → 3' direction
- Transcription stops when it reaches the terminator sequence

19 **Transcription**20 **The Process of Transcription**21 **The Process of Transcription**22 **RNA Processing in Eukaryotes**23 **Translation**

- mRNA is translated in codons (three nucleotides)
- Translation of mRNA begins at the start codon: AUG
- Translation ends at nonsense codons: UAA, UAG, UGA

24 **The Genetic Code**

- 64 sense codons on mRNA encode the 20 amino acids
- The genetic code is degenerate
- tRNA carries the complementary anticodon

25 **The Genetic Code**26 **The Genetic Code**27 **Simultaneous Transcription & Translation**28 **The Process of Translation**29 **The Process of Translation**30 **The Process of Translation**31 **The Process of Translation**32 **The Process of Translation**33 **The Process of Translation**34 **The Process of Translation**35 **The Process of Translation**36 

- ✓ What is the role of the promoter, terminator, and mRNA in transcription? 8-4
- ✓ How does mRNA production in eukaryotes differ from the process in prokaryotes? 8-5

- ✓
- ✓
- ✓

37  **Regulation**

- Constitutive genes are expressed at a fixed rate
- Other genes are expressed only as needed
  - Repressible genes
  - Inducible genes
  - Catabolite repression

38  **Operon**

39  **Induction: process that turns on the transcription of a gene.**

40  **Induction**

41  **Repression: regulatory mechanism to meant to stop gene expression**

42  **Repression**

43  **Catabolite Repression: form of positive regulation designed to control intracellular molecular levels.**

44

- 1 ▪ Lactose present, no glucose
- 2 ▪ Lactose + glucose present

45

- ✓ What is an operon? 8-6
- ✓ What is the role of cAMP in catabolite repression? 8-7
- ✓

46  **Mutation**

- A change in the genetic material
- Mutations may be neutral, beneficial, or harmful
- Mutagen: Agent that causes mutations
- Spontaneous mutations: Occur in the absence of a mutagen

47  **Mutation**

- 1 ▪ Base substitution (point mutation)
  - Missense mutation
- 2 ▪ Change in one base
  - Result in change in amino acid

48  **Mutation**

- 1 ▪ Nonsense mutation
- 2 ▪ Results in a nonsense codon

49  **Mutation**

- 1 ▪ Frameshift mutation
- 2 ▪ Insertion or deletion of one or more nucleotide pairs

50  **The Frequency of Mutation**

- Spontaneous mutation rate = 1 in  $10^9$  replicated base pairs or 1 in  $10^6$  replicated genes

- Mutagens increase to  $10^{-5}$  or  $10^{-3}$  per replicated gene

51  **Chemical Mutagens**52  **Chemical Mutagens**53  **Radiation**

- Ionizing radiation (X rays and gamma rays) causes the formation of ions that can react with nucleotides and the deoxyribose-phosphate backbone

54  **Radiation**

- UV radiation causes thymine dimers
- 

55  **Repair**

- Photolyases separate thymine dimers
- Nucleotide excision repair

56  **Selection**

- Positive (direct) selection detects mutant cells because they grow or appear different
- Negative (indirect) selection detects mutant cells because they do not grow
  - Replica plating

57 

- ✓ How can a mutation be beneficial? 8-8
- ✓ How are mutations caused by chemicals? By radiation? 8-9
- ✓ How can mutations be repaired? 8-10
- ✓ How do mutagens affect the mutation rate? 8-11
- ✓ How would you isolate an antibiotic-resistant bacterium? An antibiotic-sensitive bacterium? 8-12

58  **Genetic Recombination**

- Vertical gene transfer: Occurs during reproduction between generations of cells.
- Horizontal gene transfer: The transfer of genes between cells of the same generation.

59  **Genetic Recombination**

- Exchange of genes between two DNA molecules
  - Crossing over occurs when two chromosomes break and rejoin

60  **Genetic Recombination**61  **Genetic Transformation**62  **Bacterial Conjugation**63  **Conjugation in *E. coli***64  **Conjugation in *E. coli***65  **Conjugation in *E. coli***66  **Transduction by a Bacteriophage**67  **Plasmids**

- Conjugative plasmid: Carries genes for sex pili and transfer of the plasmid
- Dissimilation plasmids: Encode enzymes for catabolism of unusual compounds
- R factors: Encode antibiotic resistance

68  **R Factor, a Type of Plasmid**69  **Transposons**

- Segments of DNA that can move from one region of DNA to another
- Contain insertion sequences for cutting and resealing DNA (transposase)
- Complex transposons carry other genes

70  **Transposons**71  **Transposons**72 

- ✓ Differentiate horizontal and vertical gene transfer. 8-14
- ✓ Compare conjugation between the following pairs:  $F^+ \times F^-$ ,  $Hfr \times F^-$ . 8-15
- ✓ What types of genes do plasmids carry? 8-16
- ✓
- ✓
- ✓
- ✓