Diversity of Genomes

Prokaryotic Gene Families

Definition

- Prokaryotic gene families are groups of genes in bacteria and archaea that share similar sequences and often perform related functions.
- These genes arise from a common ancestral gene and may evolve over time to perform slightly different roles.

Characteristics of Prokaryotic Genomes

Prokaryotic genomes are:

- Small in size
- Compact (very little non-coding DNA)
- Usually circular DNA

Genes are:

- Closely packed
- Often organized into operons (groups of genes controlled together)

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Formation of Gene Families

Gene families are formed mainly through:

A. Gene Duplication

- A gene is copied within the genome
- Copies may mutate and acquire new functions

B. Horizontal Gene Transfer (HGT)

- Genes transferred between organisms (not inherited from parent)
- Major contributor to diversity in prokaryotes

C. Mutation and Divergence

- Small sequence changes accumulate over time
- Leads to functional variation

Types of Prokaryotic Gene Families

1. Paralogous Genes

- Genes within the same organism that evolved by duplication
- May perform different but related functions

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2. Orthologous Genes

- Genes in different species derived from a common ancestor
- Usually retain similar functions

Examples of Prokaryotic Gene Families

A. rRNA gene family

- Important for protein synthesis

B. Heat shock protein genes

- Help in stress response

C. Antibiotic resistance genes

- Provide survival advantage in presence of antibiotics

Eukaryotic Gene Families

Definition

- Eukaryotic gene families are groups of related genes in organisms such as plants, animals, and fungi that originate from a common ancestral gene and perform similar or diverse functions.

Characteristics of Eukaryotic Genomes

Eukaryotic genomes are:

- Large and complex
- Contain both coding (genes) and non-coding DNA

Gene Structure:

- Genes contain **introns** (non-coding regions)
- Coding regions are called **exons**
- Genes are separated by long intergenic regions

Formation of Gene Families

1. Gene Duplication

- Main method for forming gene families
- **Types:**
  - **Tandem duplication** – duplicated genes lie next to each other
  - **Whole genome duplication** – entire genome is duplicated

2. Mutation and Divergence

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- Duplicated genes change over time due to mutations
- Leads to new or specialized functions

3. Exon Shuffling

- Exons are rearranged between genes
- Produces proteins with new combinations of domains

4. Alternative Splicing

- One gene produces multiple protein variants
- Increases functional diversity

5. Recombination

- Exchange of genetic material creates variation

Types of Gene Relationships

A. Paralogs

- Genes within the same organism
- Evolve new or different functions

B. Orthologs

- Genes in different species
- Usually perform similar functions

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Types of Gene Families

1. Multigene Families

- Large groups of similar genes
- Often have related functions

2. Superfamilies

- Groups of distantly related gene families
- Share structural similarities

Examples

A. Globin Gene Family

- Includes hemoglobin and myoglobin
- Involved in oxygen transport

B. Homeobox (Hox) Genes

- Control development and body patterning

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C. Immunoglobulin Gene Family

- Involved in immune response

Features of Eukaryotic Gene Families

- Large and diverse
- High redundancy (many similar genes)
- Functional specialization
- Complex regulation of gene expression

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Genome Analysis

Introduction to Genome Analysis

- Genome analysis is the study of the complete genetic material (genome) of an organism using computational and experimental methods.
- It involves identifying, sequencing, and interpreting DNA to understand structure, function, and evolution.

What is a Genome?

The genome is:

- The complete set of DNA in an organism
- **Tissue Proteome** → proteins in a tissue

It includes:

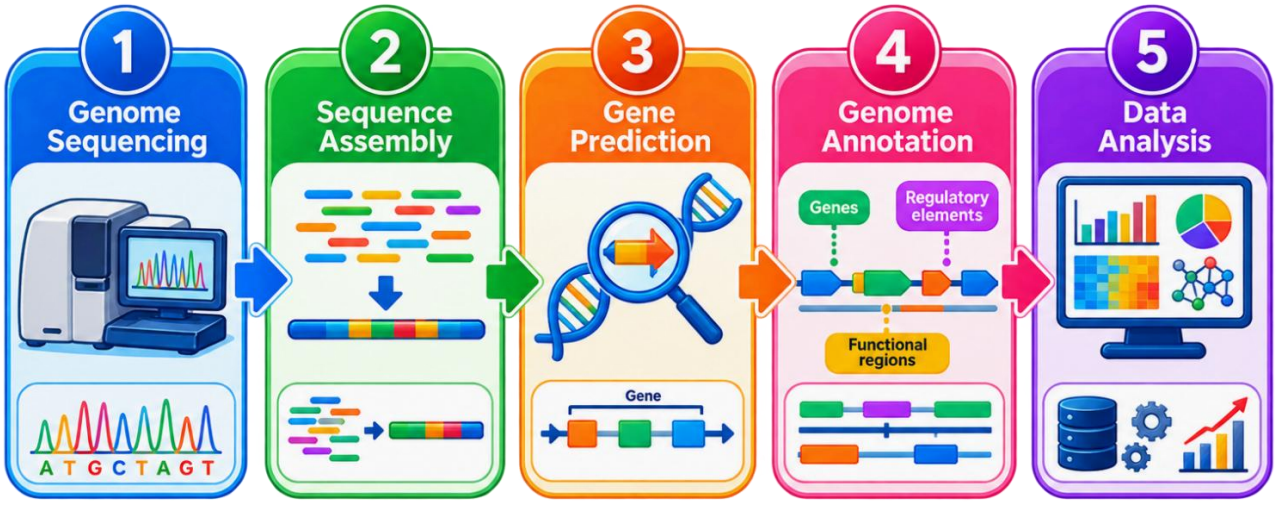
- **Genes** → coding regions (proteins or RNA)
- **Non-coding regions** → introns and intergenic regions
- **Regulatory elements** → promoters, enhancers
- **Repetitive sequences** → tandem repeats and transposable elements

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Objectives (Goals) of Genome Analysis

- Identify all genes in a genome
- Determine gene functions
- Understand genome organization
- Study genetic variations
- Analyze evolutionary relationships
- Detect disease-related genes

Steps in Genome Analysis



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