



Lecture 2:

General Introduction

Course 281

Introduction to Molecular Biology

About the course

Why study molecular biology?

1.1 What is Genetics

- Genetics is the study of heredity.
- **What is heredity?**

The process by which characteristics are passed from parents to offspring so that all organisms, human beings included, resemble their ancestors.



Figure 1.8 Introduction to Genetics (© Garland Science 2012)

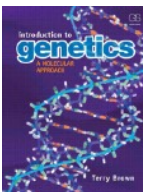
1.1 What is Genetics

- **What controls heredity?**

The central concept of genetics is that heredity is controlled by a vast number of factors, called:

Genes

, which are physical particles present inside living cells.

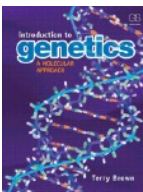


1.1 What is Genetics

Genes are units of biological information

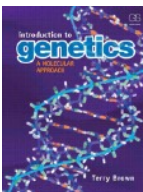
- Genes are units of biological information.
- The entire complement of genes in an organism contains the total amount of information needed to construct a living, functioning example of that organism.
- Genes are responsible for the visible characteristics (such as eye color) and for biochemical activities (physiology).

What happen if genes fail to work properly?



1.1 What is Genetics

- **Gene failure example:**
 - The human gene CFTR contains part of the biological information for transport of chloride ions into and out of cells.
 - If the CFTR gene is defective, then chloride transport breaks down, leading to inflammation and mucus accumulation in the lungs (a disease called cystic fibrosis).
 - By the genetic study of the underlying cause of cystic fibrosis that the CFTR gene (“cystic fibrosis transmembrane regulator”) was first discovered.



1.1 What is Genetics

- How is biological information stored in a genes?
- It was not until the 1950s when it was discovered that genes are made of DNA.
- How is the information stored in a molecule?

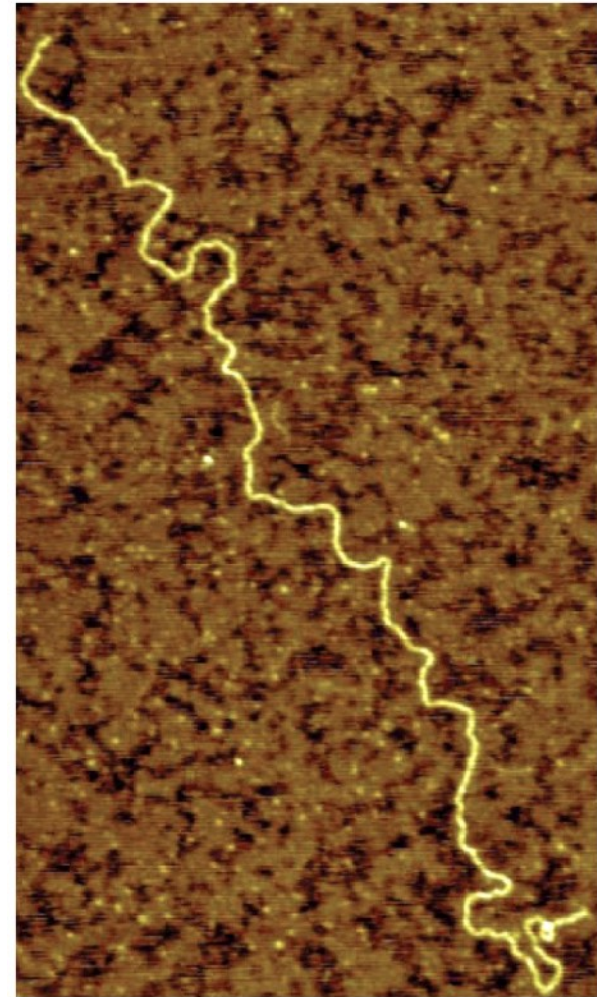


Figure 1.1 Introduction to Genetics (© Garland Science 2012)

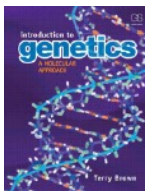
1.1 What is Genetics

DNA is made of a four letter language, which contains the information to make a living organism.

We will study this in details in future chapters

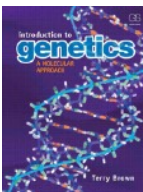
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Figure 1.2 Introduction to Genetics (© Garland Science 2012)



1.1 What is Genetics

- How the information in the gene is made available to the cell?
- The transfer of biological information from gene to cell is called **gene expression**.
- For all genes, the process begins with the transfer of information from a DNA molecule into an RNA molecule in a process called transcription.
- The gene's biological information, now contained in its RNA molecule, is used to direct the synthesis of a protein in a process called **translation**.



1.1 What is Genetics

We will study this in more details in the future

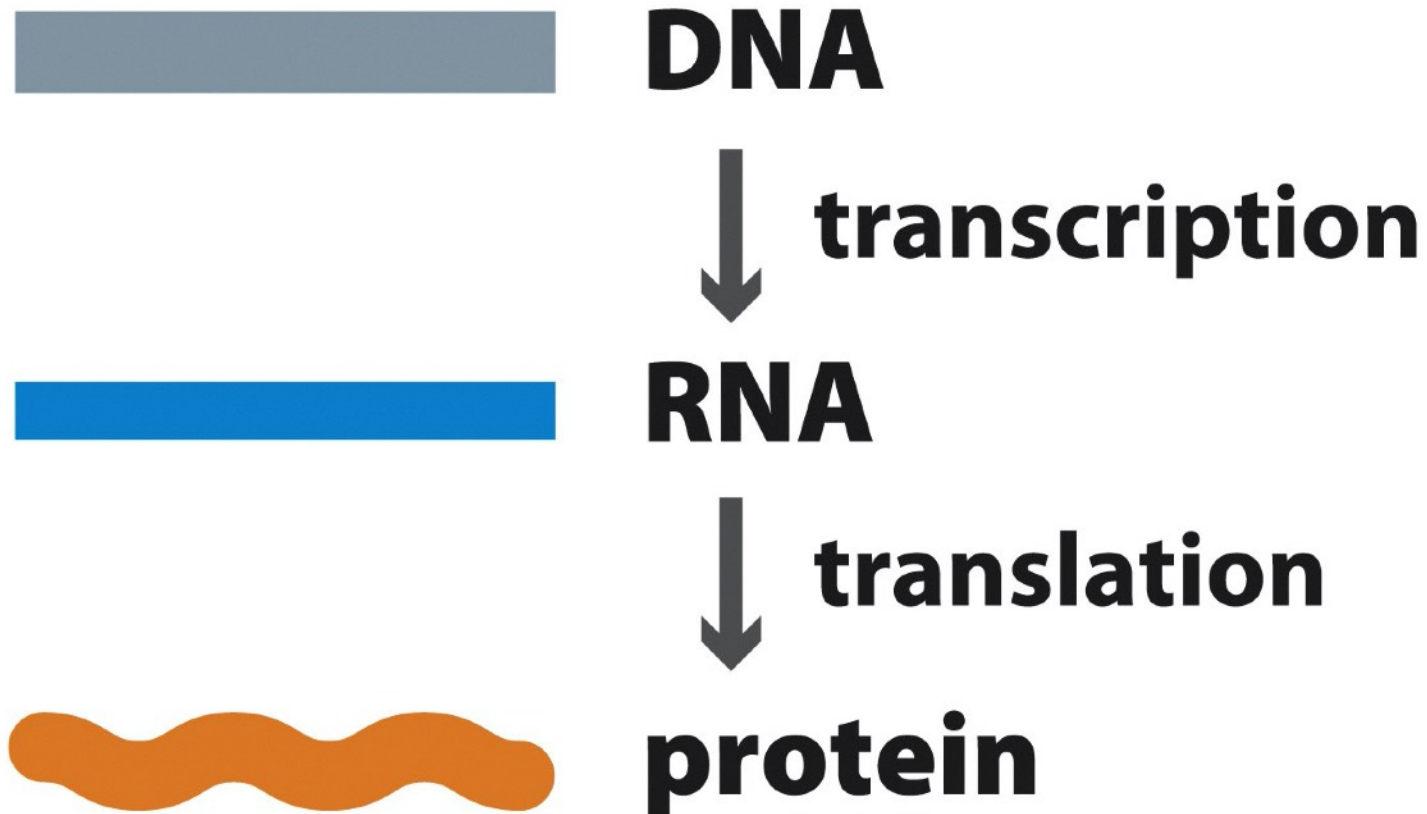
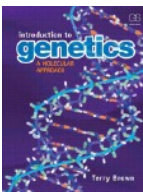


Figure 1.3 Introduction to Genetics (© Garland Science 2012)

1.1 What is Genetics

- The information carried in some genes is needed by the cell at all times (Always ON).
- Other genes have more specialized roles and are active at specific time (ON/OFF).



1.1 What is Genetics

- **Example:**
 - Many bacteria deal with sudden increases in temperature by switching ON genes whose protein products help to protect the cell from damage.

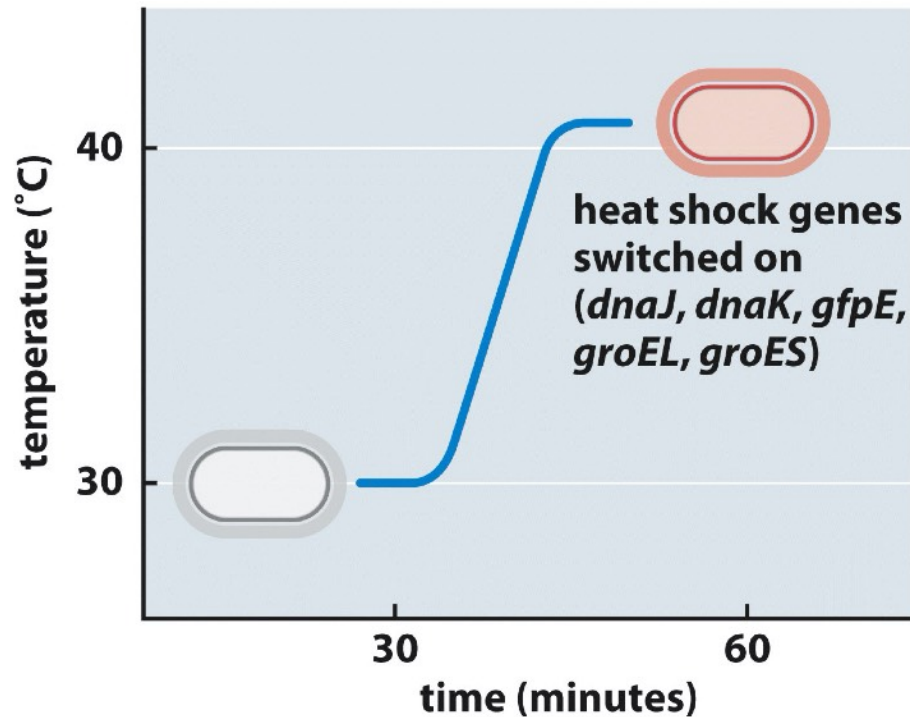


Figure 1.4 Introduction to Genetics (© Garland Science 2012)

1.1 What is Genetics

- Do genes act as units of inheritance only through sexual reproduction?
- Much more frequent type of reproduction is the division of a parent cell into two daughters.

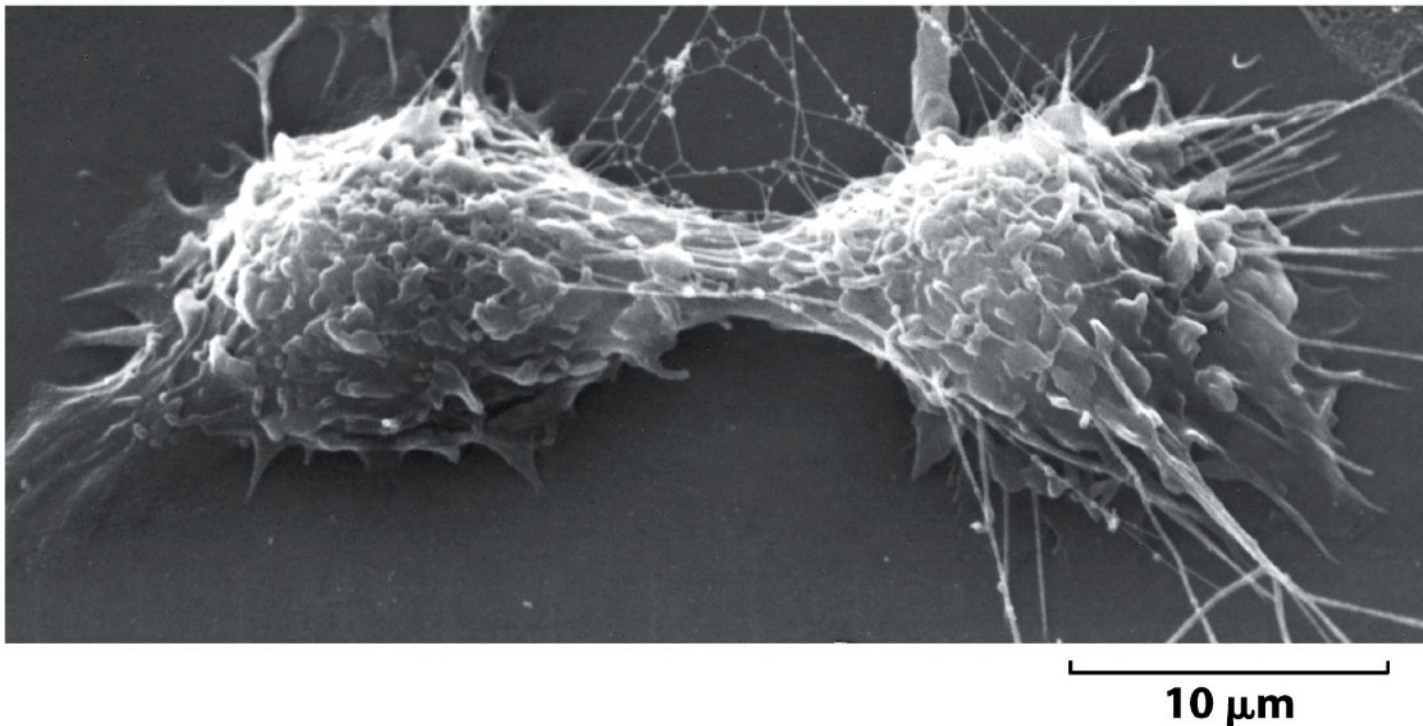
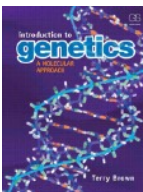


Figure 1.5 Introduction to Genetics (© Garland Science 2012)

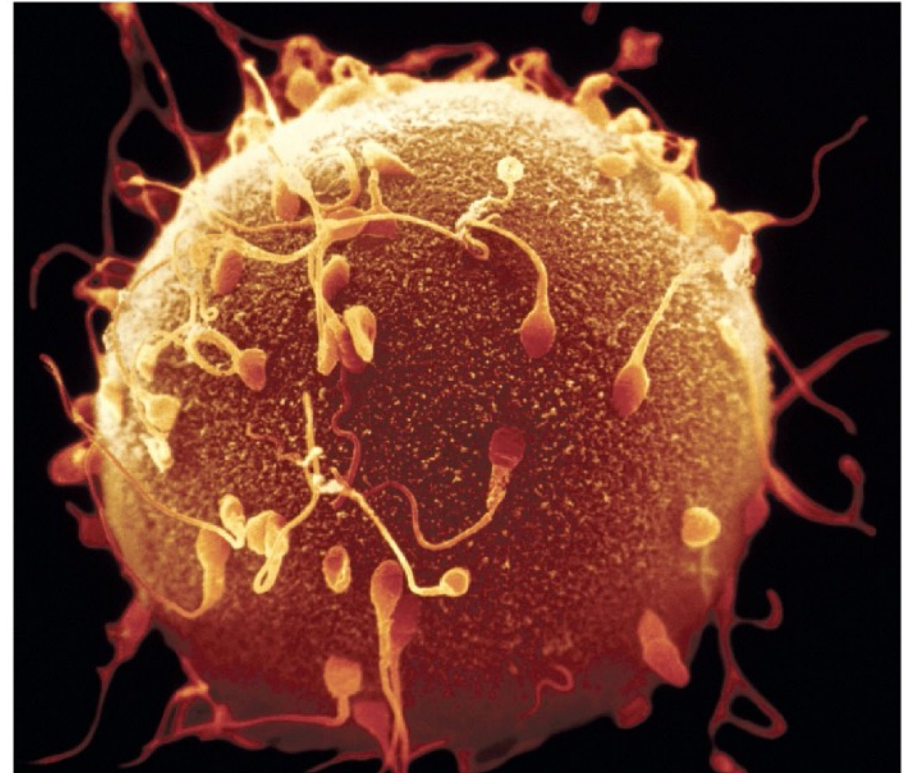
1.1 What is Genetics

- How many cell divisions happen in your lifetime?
 10^{17} (How many millions/billions?)
- What happens if errors take place in any of these 10^{17} divisions?
- Any error would be disastrous, as it would give rise to a lineage of cells that possessed an incomplete or altered complement of the organism's biological information.



1.1 What is Genetics

- Sexual reproduction is preceded by a specialized type of cell division that produces the male and female sex cells.
- One male and one female cell then fuse to give a fertilized egg, which then develops into a new version of the organism.



25 μm

Figure 1.6 Introduction to Genetics (© Garland Science 2012)

1.1 What is Genetics

- What is genetically unique about sexual reproduction?

Sexual reproduction provides an opportunity for DNA molecules to exchange segments by **recombination**.

We will study this later!

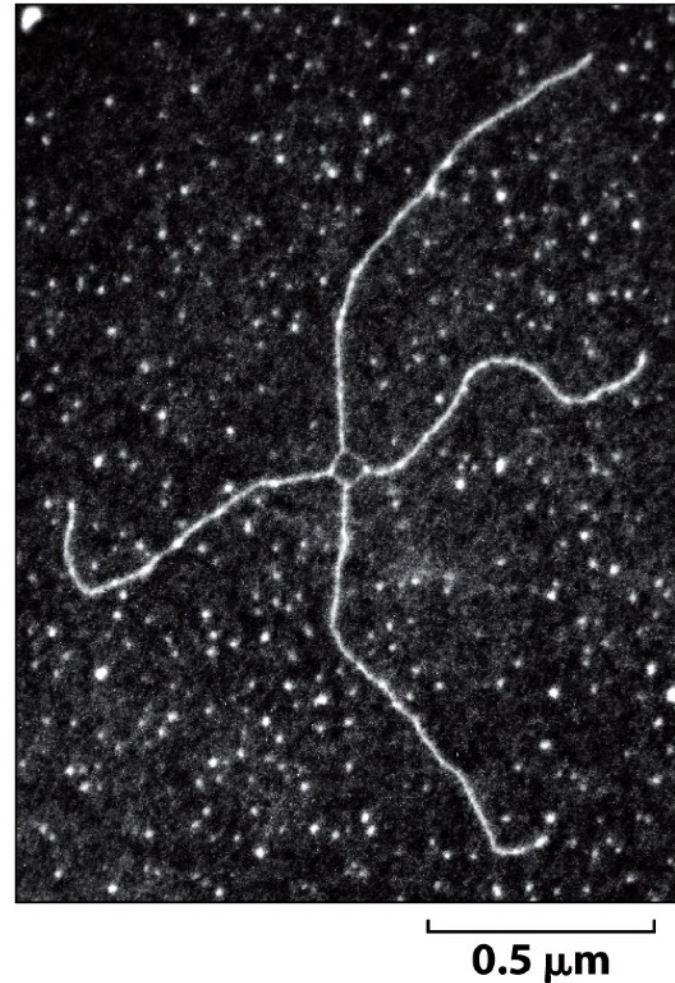


Figure 1.7 Introduction to Genetics (© Garland Science 2012)

1.1 What is Genetics

- How do genes change over time?
- DNA molecules can undergo structural alterations, called **mutations**.
- Many mutations are repaired by the cell soon after they occur, but a few slip through, which means that the DNA molecules that are passed to the offspring are not always precise copies of the parental molecules.



Figure 1.9 Introduction to Genetics (© Garland Science 2012)

1.2 GENETICS IN OUR MODERN WORLD

- The role of genes in development.
- How do genes control the pathway that begins with a fertilized egg cell and ends with an adult organism?

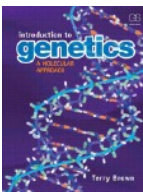
We can study this using
model organisms



Figure 1.10 Introduction to Genetics (© Garland Science 2012)

1.2 GENETICS IN OUR MODERN WORLD

- The human genome.
- Over 6000 inherited diseases are known, diseases that are caused by defects in the genome and which, like other genetic features, can be passed from parents to offspring.
- Understanding genetic diseases and devising ways of treating them (**gene therapy**).
- Genetics to catch criminals.



1.2 GENETICS IN OUR MODERN WORLD

- Genetics applications in industry and agriculture..
- The human insulin gene has been transferred to *Escherichia coli*, and these genetically engineered bacteria are now used as a cheap means of producing insulin for use by diabetics.



Figure 1.12 Introduction to Genetics (© Garland Science 2012)

1.2 GENETICS IN OUR MODERN WORLD

- Genetics applications in industry and agriculture..
- Genetic engineering is also being used to create improved crops, ones that give higher yields or have higher nutritional values (**Golden rice**).



Figure 1.13 Introduction to Genetics (© Garland Science 2012)