

Introduction to genetics and scientific inquiry

A brief history of modern genetics

Before 1860

- **Development of microscopy**
- **Elucidation of cell theory**
- **Publication of “The origin of species” by Charles Darwin in 1859**

1860 - 1940

- **Publication of Mendel’s work in 1866**
- **Discovery of chromosomes and their behavior and rediscovery of Mendel’s work in 1900**

1940 - Present

- **Discovery that deoxyribonucleic acid (DNA) is the basic genetic material**
- **DNA structure was elucidated**
- **Era of molecular genetics (recombinant DNA technology)**

DNA and Genes

Required properties of a genetic material

1. Control the synthesis of the enzymes and proteins within a cell or organism

The growth, development, and functioning of a cell are controlled by the proteins within it, primarily its enzymes. Thus, the nature of a cell's phenotype is controlled by the protein synthesis within that cell. The genetic material must determine the presence and effective amounts of the enzymes in a cell.

DNA and Genes

Required properties of a genetic material

2. Self-replicate with high fidelity yet show a low level of mutation

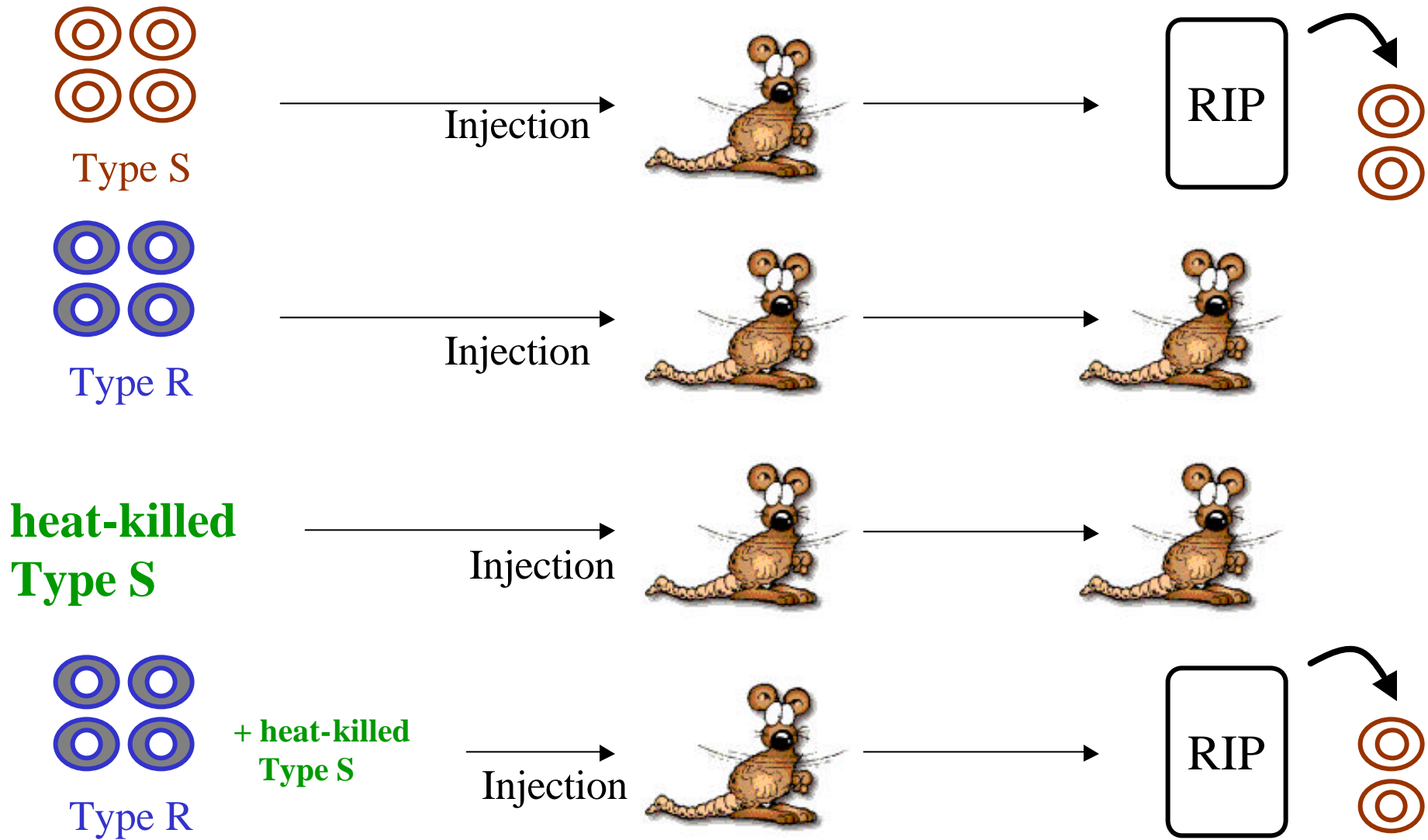
The genetic material must be capable of directing the replication of itself precisely so that every daughter cell receives an exact copy. Some **mutability, or the ability to change**, is also required because we know that the genetic material has changed, or evolved, in the history of life on earth. However, the fidelity has to be high to maintain the functioning of enzymes. In life the fidelity of the replication process is so great that the error rate is only about one in a billion.

DNA and Genes

Required properties of a genetic material

3. Must be located in the chromosomes

It has been known that genes, the discrete functional units of genetic material, are located in chromosomes within the nuclei of eukaryotic cells. Thus, the genetic material in eukaryotes must be a part of the chromosomes.



Griffith's experiment with *Streptococcus*. S-type cells will kill mice as will heat-killed S-type cells injected with live R-type cells. S-type cells are recovered from dead mice in both cases.

DNA and Genes

Griffith's experiment with *Streptococcus pneumoniae*

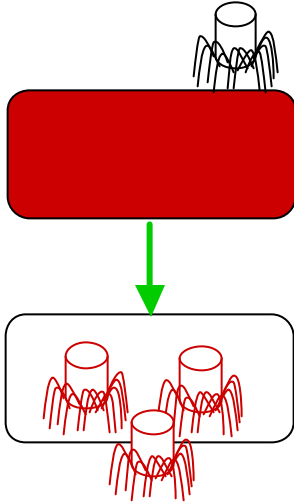
1. S-type cells will kill mice
 2. Heat-killed S-type cells injected with live R-type cells also kill mice
 3. S-type cells are recovered from dead mice in both cases
- Heat-killed bacteria of one type can “transform” living bacterial of a different type

DNA and Genes

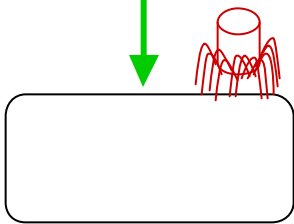
Is the genetic material DNA or protein?

1. DNA can be labeled with ^{32}P while protein is labeled with ^{35}S .
2. Genetic material must be passed on to the next generation.
3. Viruses infect cells to make more of themselves.
4. In viruses the genetic material is copied many times and passed on to all the new viruses.

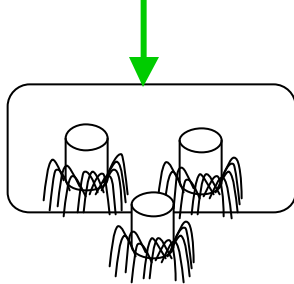
Bacterium in ^{35}S medium



Progeny phage with ^{35}S -labeled protein and unlabeled DNA

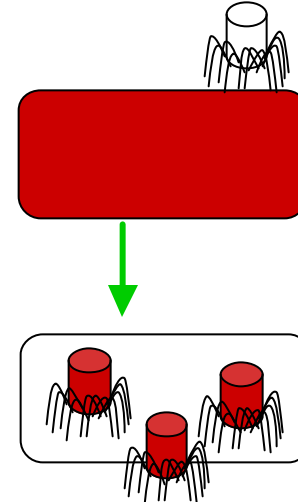


Labeled protein stays outside, unlabeled DNA enters cell

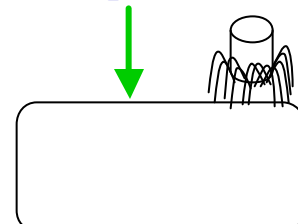


Progeny phage virtually unlabeled

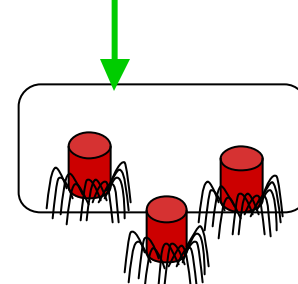
Bacterium in ^{32}P medium



Progeny phage with unlabeled protein and ^{32}P -labeled DNA



Unlabeled protein stays outside, labeled DNA enters cell



Progeny phage strongly labeled

Unlabeled phage infects cell

Labeled phage progeny released

Labeled phage infects unlabeled bacteria

DNA and Genes

The Hershey and Chase experiments using ^{35}S -labeled and ^{32}P -labeled bacteriophage

1. The nucleic acid labeled (^{32}P) enters the bacteria during infection
 2. The protein labeled (^{35}S) does not enter the bacteria during infection
- Genetic material of phage needed to reproduce must be carried on nucleic acids

