SUMMING-UP

1 Viruses

- In order to reproduce viruses are forced to infect a cell and are therefore called **obligate intracellular parasites**. Virus particles, called *virions,* consist of a protein envelope, the capsid, containing genetic material (DNA or RNA). A capsid can be enclosed by a membrane similar to that of a cell.
- Viruses that infect bacteria are called **phages**. Their reproductive cycle begins with the recognition of the bacterium by the viron. Then the virus injects its genetic material into the prokaryotic cell, which can then be transcribed by the bacterium and translated into proteins. In this case several copies of the virus are formed that destroy the host cell (**lytic cycle**). In other cases, the genetic material is integrated into the genome of the bacterium and duplicates with it (**lysogenic cycle**).

2 RNA viruses and prions

- Viruses that contain RNA have a different cycle than those that contain DNA. **RNA viruses** contain an enzyme (RNA replicase) that is able to produce copies of RNA from other RNA molecules that function as a template. In this case, the genetic material does not enter the cell nucleus.
- Instead, **retroviruses** have an enzyme (**reverse transcriptase**) that is capable of producing a molecule of DNA from RNA template molecules. Once produced, the DNA (cDNA) is incorporated within the nucleus of the host cell and the cycle proceeds in a similar manner to that described for viruses containing DNA.
- **Prions** are proteins that are modified in terms of their three-dimensional folding. They act as infectious agents that are capable of transmitting the modification to host proteins.

3 Genetics of bacteria

- Prokaryotes, while reproducing asexually, have three mechanisms for genetic recombination.
- The first is bacterial conjugation, which allows the passage of part of the genetic material from one bacterial cell to another. This is done through a conjugation tube that connects the cytoplasm of the two bacteria.
- Another mechanism of recombination is transformation that occurs when a bacterium acquires a DNA molecule present in the environment.
- The final mechanism is that of transduction, in which the passage of DNA from one bacterium to another occurs through a carrier, usually a viron.

4 Mobile genetic elements: plasmids and transposons

- There are some moving parts in cells that allow the passage of one or more genes from one end of a chromosome or genome to the other. **Plasmids** are small circular DNA molecules present in the cytoplasm of bacteria. They can be transmitted from one bacterium to another through the mechanism of conjugation. There are several types of plasmids.
- **Transposons** are mobile elements consisting of a gene that codes for a particular enzyme, **transposase**, which can act with a "cut and paste" or "copy and paste"

5 Recombinant DNA technology

- **Recombinant DNA technology** enables the transfer of a gene from one cell to another. If the cells belong to different species transgenic organisms can be created.
- This technology involves the use of **restriction enzymes**, capable of cutting DNA at specific points corresponding to particular base sequences (restriction sites).
- The fragments of DNA obtained are separated according to the length of the fragments by gel electrophoresis.
- Recombinant DNA technology is based on the fact that it is possible to insert a gene of interest into a plasmid, and through it into a bacterium. The integration of a gene within a DNA molecule is completed by the action of the **DNA ligase** enzyme.

6 DNA analysis techniques

- A technique that enables genes within a genome to be identified involves the use of a **hybridisation probe**. The DNA is denatured and the strands paired with other shorter strands, that are artificially prepared and contain chemical or radioactive markers.
- DNA analysis by the creation of **genetic imprints** (DNA fingerprinting or profiling) is widely used for the identification of individuals. It is usually preceded by the amplification of some particular sequence of DNA by the polymerase chain reaction (called **PCR**).
- Human DNA is very similar in all individuals and the creation of the genetic imprint exploits particular base sequences called **short tandem repeats** (STR) that have high individual variability.

SUMMING-UP

7 Genetic engineering in medicine

- Genetic engineering techniques have found applications in medicine: **transgenic bacteria** can be created and modified by inserting a plasmid, containing a human gene that encodes for a protein of interest, into their cytoplasm.
- Genetic engineering techniques can also be used in **gene silencing**, which exploits RNA interference mechanisms.
- Finally, there are promising **gene therapy** techniques that enable human genes to be inserted directly into other human cells.