7.2 Nuclear matter

A tiny organelle in the cytoplasm of eukaryotic cells contains the blueprint of life and determines how cells will develop. All eukaryotic cells have a nucleus — at least at the start of their lives. In some cells, such as red blood cells, the nucleus deteriorates and is broken down.

Carrying the message

The nucleus is usually difficult to see and needs to be stained to become visible under a light microscope. Only by using an electron microscope do the details of the cell and the nucleus become clear. The nucleus is separated from the rest of the cell by the nuclear membrane, which has many tiny pores or openings that connect at various places with the endoplasmic reticulum. The pores allow the transportation of materials into and out of the nucleus.

In prokaryotes, the DNA is more loosely located in an area of the cell and is not contained in a membrane.

The DNA molecule looks like a double helix. Its structure was discovered by Watson and Crick in 1953. It carries the code for making all the parts of all the different kinds of cell. The code also programs the way cells behave and how they carry out their functions, such as transmitting nerve impulses, supplying energy, contracting or carrying out photosynthesis. In this way, the nucleus is the control centre of the cell.

Captivating chromosomes

When the cell is about to divide, the lengths of DNA shorten and coil to form chromosomes. With suitable staining, the chromosomes become visible. At other times in the life cycle of the cell, the chromosomes are not visible as the coils are unwound and the DNA is spread throughout the nucleus. Each chromosome appears to be made of two strands, or chromatids, held together by a centromere. During cell division, the chromosomes divide into single strands. One chromatid from each pair becomes part of the new cell formed by the cell division. Later, when the DNA molecule replicates itself, the chromatids become double stranded again. Exact replication of the DNA ensures that instructions (characteristics) are passed on unchanged.

Every kind of living thing has its own particular number of chromosomes in each body cell, normally occurring in matched pairs. A human cell, whether it is a white blood cell or a cell from the cheek lining or the kidney, will have 23 pairs or 46 chromosomes in total. One of the pairs, known as the sex chromosomes (which contain information for sexual characteristics), does not match in males. There is a longer X chromosome and a shorter Y chromosome. In females there are two X chromosomes. The non-sex chromosomes are called autosomes.
Number of chromosomes in body cells (non-sex cells) of some living things

<table>
<thead>
<tr>
<th>Species of living thing</th>
<th>Number of chromosomes in each body cell</th>
<th>Species of living thing</th>
<th>Number of chromosomes in each body cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>chimpanzee</td>
<td>48</td>
<td>tomato</td>
<td>24</td>
</tr>
<tr>
<td>Euglena (unicellular organism)</td>
<td>90</td>
<td>cabbage</td>
<td>18</td>
</tr>
<tr>
<td>fruit-fly</td>
<td>8</td>
<td>frog</td>
<td>26</td>
</tr>
<tr>
<td>human</td>
<td>46</td>
<td>housefly</td>
<td>12</td>
</tr>
<tr>
<td>koala</td>
<td>16</td>
<td>pig</td>
<td>40</td>
</tr>
<tr>
<td>onion</td>
<td>16</td>
<td>platypus</td>
<td>52</td>
</tr>
<tr>
<td>shrimp</td>
<td>254</td>
<td>rice</td>
<td>24</td>
</tr>
<tr>
<td>sugarcane</td>
<td>80</td>
<td>sheep</td>
<td>54</td>
</tr>
</tbody>
</table>

Your kind of karyotype?

Chromosome pairs differ from each other in various ways, such as in size, shape and banding. This helps them to be distinguished from each other. **Karyotyping** chromosomes is the process of sorting chromosomes into their matched pairs. Cells about to divide are treated and stained, mounted on slides for viewing and photographed. The photographs are cut up and rearranged. Karyotyping is an important technique used in investigating chromosomal disorders.

**Activities**

**Using data**

1. Convert the information given in the table above into a bar graph showing the number of pairs of chromosomes in eight different organisms.
2. Which species' body cells have:
   (a) the highest total number of chromosomes?
   (b) the smallest total number of chromosomes?
3. Do you think that the number of chromosomes reflects the intelligence of an organism? Explain your answer.

**Remember**

1. Why is the nucleus often referred to as the control centre of a cell?
2. Where is the nucleic material located in prokaryotic cells such as bacteria?
3. Suggest a function for the many tiny pores in the nuclear membrane.
4. Why are cells stained?
5. What is a chromosome?
7. How many pairs of chromosomes does each body cell of a human contain?
8. What is the difference between sex chromosomes and autosomes?
9. What is the process of karyotyping and why is it important?

**Think**

1. If each cell nucleus has about one metre of DNA, how does the DNA fit in?
2. Why can karyotyping be carried out only on cells about to divide?
3. How can karyotyping determine whether the cell is from a male or a female person?

**Create**

Using a variety of materials, including pipe cleaners of different colours and lengths, make a model of a nucleus with a set of four pairs of chromosomes.

(a) How many chromosomes are there altogether?
(b) Are they all alike?
(c) What structure will each chromosome have?
(d) Devise a 'container' representing the cell for your nucleus.