

















Teacher's guide to Genetic Molecules

Like all programs in the Hands On Genetics series, the Genetic Molecules program is designed to help the student understand principles that have been presented in class. Students will get most out of the program if they have been exposed to the molecule names and to the molecular processes before tackling the program. However the program is structured so that it will provide any necessary level of help for students who have little or no previous knowledge.

For example, the first stage of the program introduces the names and structures of the four DNA bases, Adenine, Cytosine, Guanine and Thymine. The student is first asked to re-arrange the letters to make the names of the bases. If they cannot do this, they may click on a **Hint** button, which fills in the base names one letter at a time, until they can recognise the names.

<div style="border: 1px solid blue; padding: 2px; display: inline-block;">C</div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div>	  <div style="border: 1px solid orange; padding: 2px; display: inline-block; margin: 0 5px;">  </div> 
d n t i u	
<div style="border: 1px solid blue; padding: 2px; display: inline-block;">T</div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div>	<div style="border: 1px solid orange; padding: 2px; display: inline-block; margin: 0 5px;">  </div>   
i n h e i e y n h y e	
<div style="border: 1px solid blue; padding: 2px; display: inline-block;">A</div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div>	   <div style="border: 1px solid orange; padding: 2px; display: inline-block; margin: 0 5px;">  </div>
e a i n m e o n s	
<div style="border: 1px solid blue; padding: 2px; display: inline-block;">G</div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div> <div style="border: 1px solid blue; width: 20px; height: 15px; display: inline-block; margin: 0 5px;"></div>	 <div style="border: 1px solid orange; padding: 2px; display: inline-block; margin: 0 5px;">  </div>  

Purines:

Pyrimidines:

The student is then asked to classify the bases as Purines or Pyrimidines. Bases are initially presented in a way which does not make it clear which is a 'real' base and which is not (the real bases are outlined in boxes in the above diagram). If the student does not know which is which, a hint may be taken which shows the real bases.

Altogether, the genetic molecules program divides the study of DNA, RNA and proteins into seven stages, of which the above is the first:

- (1) Identify DNA bases
- (2) Make DNA nucleotides
- (3) Single strand of DNA
- (4) DNA synthesis
- (5) Make RNA nucleotides
- (6) Transcription
- (7) Translation

These stages are best run in sequence. This can be done just by clicking the **Next** button at the end of each stage, without recourse to menus. Students should therefore need no particular instruction in the use of the program. They will probably discover by themselves that the program also has the flexibility to jump around to different stages, using the **GoTo** menu.

Information menu:

A lot of detailed information is shown in screens which are accessible from the **Information** menu. These are listed below, with a brief description of each screen:

Overview: This is a special screen, which the student is asked to make up. It contains the names **DNA, RNA, protein, replication, transcription** and **translation**, and the student is asked to put these into boxes which make up a logical order.

Purines and pyrimidines: Summarises the information to complete the first stage of the program. This screen is inaccessible while students are doing the first stage. With this exception, however, all screens are available at all times. Furthermore each of the screens can be accessed at the time when it is most relevant from an **Info** button which appears in the Instruction window.

Number of phosphates: The basic building block in the program is a nucleotide, with a single phosphate molecule attached to a sugar and base. In reality, bases occur in a form with three phosphates, which is illustrated in this screen.

5' and 3': These terms, which describe the directionality of DNA, are explained. Students at this level do not need to understand these terms, or even to know that DNA is directional, but it is important that the information be available for the better students who will sometimes see the terms and want to understand them.

Double stranded DNA: Explains the hydrogen bonding of two single strands to form the double strand.

The double helix: In the program, all nucleic acids are pictured as linear molecules. The helical nature of double-stranded DNA is noted here.

Double-stranded DNA replication: Stage (4) of the program deals with the synthesis of a new DNA strand using an old one as a template. Many students will realise that this is only

half of the process, since both DNA strands of a double helix need to be replicated. The complete process is pictured here.

Base and nucleotide names: Summarises the nomenclature of all DNA and RNA bases with and without sugar and phosphate molecules.

DNA and RNA polymerase: The enzymes responsible for DNA replication and RNA transcription are not involved directly in the program, and this screen briefly describes their role.

The ribosome: A description of the simplified ribosome as pictured in the program.

Transfer RNA: Shows both 'uncharged' and 'charged' forms of transfer RNA.

Termination factors: A brief description of the protein factors responsible for terminating the translation process.

Amino acids: Shows the names and structures of all 20 amino acids.

Peptide bond: A brief description of the way in which amino acids are joined to make a polypeptide.

Genetic code: The 64 codons and their associated amino acids and termination factors.

Types of RNA: Messenger RNA and transfer RNA play important parts in the program. This screen is a reminder that there are other types of RNA, including ribosomal RNA which is the most abundant RNA.

Number of tRNAs: The program simplifies the translation process, by assuming that each codon has a unique tRNA equivalent. In reality there are many less tRNA molecules, which is dealt with briefly here.

Students should be cautioned that they do not need to learn the information in these screens. The basic concepts of molecular biology can all be revised or learned by going through the stages of the program. The information screens are for those students who would like to understand the processes in more depth.