# Teaching ideas for Topic 7: Nucleic acids (HL)

Some students find the biochemistry of this short but intense topic challenging, particularly if they are not studying Chemistry with HL Biology. Modelling the molecules, replication and protein synthesis can be helpful.

## Ideas for the lesson

• Invite students to compare the process of editing a piece of writing with the importance of single copy and repetitive sequences of DNA and the removal of introns before translation.

• Pairing exercises in which students must distinguish between terms that are easily confused can be helpful in understanding and fixing terminology in the mind. Examples might include:

– **introns** and **exons**

– **5' end** and **3' end** of a DNA molecule

– **transcription** and **translation**

**– sense** and **antisense**

– **nucleosome** and **polysome**

• There are some good animations at [**www.freesciencelectures.com**](http://www.freesciencelectures.com) (search for ‘DNA replication’).

• Protein structure provides an excellent opportunity for 3D modelling of structure, either using commercially available kits or as computer simulations. Students can distinguish visually between globular and fibrous proteins.

• Provide students with a table of mRNA codons and their equivalent bases (Table **3.1** in the student’s book) and ask them to produce a protein from a given sequence of DNA, to reinforce their knowledge of transcription and translation.

• Students can research examples of the effect of environment on gene expression in cells and organisms. Starting with fur colour in hares or cats, and effect of hormones on baldness, they can discover many other examples for themselves and present them to the class.

• The importance of non-coding DNA in replication and in applications such as DNA profiling is interesting and an engaging topic to discuss. Articles at [**www.lncrnablog.com**](http://www.lncrnablog.com) (search for ‘non-coding DNA’) and elsewhere can be useful. The application is shown well in a video called ‘Catching killers: DNA profiling’, available at [**www.smithsonianchannel.com**](http://www.smithsonianchannel.com).

• Changes in methylation patterns of DNA and the consequences for transcription and gene expression are a new development worthy of exploration and consideration. [**www.nature.com/nrg**](http://www.nature.com/nrg)has scholarly articles on this subject to use as a resource (search for ‘DNA methylation’).

## Practical activities

• Practical work involving enzymes can be used in conjunction with Topic **2**, *Molecular biology*. This could include the use of catalase from vegetable or animal sources (such as liver) to catalyse the breakdown of hydrogen peroxide. Descriptions of suitable experiments can be found at [**www.nuffieldfoundation.org/practical-biology**](http://www.nuffieldfoundation.org/practical-biology)(search for‘catalase and hydrogen peroxide’).

• Electron micrographs of polysomes in prokaryotes and eukaryotes can be used in teaching about the importance of these structures and the difference between translation in the two types of cell.

• Crude samples of DNA can be isolated in the laboratory (Practical **1**) and are a useful starting point for discussions of DNA profiling, repeated sequences and much more.

## ICT

• Students can model the 3D structure of proteins and DNA using computer simulations.

• Molecular visualisation software can be used to examine the structure of DNA and protein within a nucleosome.

• The structure of ribosomes and tRNA can also be analysed using molecular visualisation software.

• The following are links to online tools that are probably more sophisticated than will be needed in school, but provide students with the chance to see just some of the many such tools available to researchers.

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| **Name** | **URL** | **Description** |
| ncRNA | [**http://software.ncrna.org**](http://software.ncrna.org) | a portal site for web servers and software tools for sequence/structure analyses of non-coding RNAs |
| iSeeRNA | [**http://sunlab.lihs.cuhk.edu.hk/iSeeRNA**](http://sunlab.lihs.cuhk.edu.hk/iSeeRNA) | identification of long intergenic non-coding RNA transcripts from RNA-Seq data |
| HUGO Gene Nomenclature Committee (HGNA) | [**www.genenames.org**](http://www.genenames.org) | standardised nomenclature for all human genes |
| CoRAL | [**http://wanglab.pcbi.upenn.edu/coral/**](http://wanglab.pcbi.upenn.edu/coral/) | predicting non-coding RNAs from small RNA-sequencing data |

## Common problems

• Students often struggle with the names of the enzymes involved in DNA replication. Asking them to compile an ordered sequential list or table with name, function and location can help.

• The many factors that influence gene expression can also prove troublesome to students. It may be useful to summarise and collate these for students.

## Theory of knowledge (TOK)

• Students can discuss the relationship between the lock-and-key hypothesis and the induced fit hypothesis for enzyme action and consider why there was such a long time period between the proposals of the two.

• ‘Nature versus nurture’ can be discussed in determining an individual’s characteristics. The contribution of science to such discussions is important.

• Comparison of the techniques of studying photographs and building models of DNA at the time of Watson and Crick’s discoveries can be contrasted with the use of computers to locate genes within genomes today and provide material to discuss the developments in research that are due to technological advances.