





Components

	NAME	DESCRIPTION	AUDIENCE
	<i>Protein molecules</i> teachers guide	This guide explains how to use a learning object to build students' understanding of the molecular structure of proteins.	teachers
	<i>What is a protein?</i> learning object	This interactive learning object explains what proteins are. It introduces students to amino acids and how they combine to form proteins.	students
	<i>Exploring proteins</i> worksheet	This worksheet may be used by students in conjunction with the learning object, <i>What is a protein?</i>	students
	<i>Genetic code reading</i> frame table data sheet	This table summarises the amino acid triplet code. Students may use this for the bingo activity that concludes the learning object, <i>What is a protein?</i>	students

Purpose

Students develop an understanding of the molecular structure of proteins and why they are important in our body.

Outcomes

Students understand that:

- proteins are essential molecules;
- proteins are made of chemically-bonded subunits called amino acids; and
- the order of amino acids in a protein is determined by a DNA sequence.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
Students work through the interactive learning object, <i>What is a protein?</i> Students explore types of protein molecules and learn that they are composed of amino acids.	individually or in pairs
Students answer questions on the worksheet, <i>Exploring proteins</i> .	individually
Students play bingo using the data sheet, <i>Genetic code reading frame table</i> .	individually or in pairs

Teachers notes

The learning object contains images of selected proteins from RCSB Protein Data Bank (www.rcsb.org). Students examine these images to observe that proteins are made of simpler units. Through the learning object, students learn that the simpler units are called amino acids, that they are chemically combined, and that their order is specifically determined by the nucleotide order in DNA.

At the end of the learning object, students play bingo to practise using a triplet code of nucleic acids to determine an amino acid. This may be done as a class activity.

Ask students to draw a 9-square grid (3 x 3) and then fill it in with names of amino acids. Codons are then called out (eg AUG) and students consult the genetic code reading frame table to determine what amino acid is being coded for. If this amino acid appears on their grid they cross it out. Three in a row, in any direction, is bingo.

Using Jmol

Images of protein molecules in the learning object *What is a protein?* are displayed using Jmol: an open-source Java viewer for chemical structures in 3D.

The following keyboard commands are used by Jmol to manipulate images. Note: The x-axis goes left to right across the screen, the y-axis up and down, and the z-axis is perpendicular.

rotate about x-axis	drag mouse up-down
rotate about y-axis	drag mouse left-right
rotate about z-axis	hold shift-key and drag mouse left-right
zoom in and out	hold shift-key and drag mouse up-down
move model in x-y plane	hold shift-key, double-click and hold mouse down while dragging (on Macintosh press Command and Option keys, drag mouse)
reset view	press shift key, double-click on background

More commands are available by right-clicking in a Jmol window (Macintosh: Control-click).

Acknowledgements

learning object, *What is a protein?*

Image of haemoglobin: Park, S.Y., Yokoyama, T., Shibayama, N., Shiro, Y., & Tame, J. R. (2006). 1.25 Å resolution crystal structures of human haemoglobin in the oxy, deoxy and carbonmonoxy forms. *J. Mol. Biol.* 360, 690-701, created with Jmol: an open-source Java viewer for chemical structures in 3D (jmol.sourceforge.net).

Image of myosin: Rayment, I., Rypniewski, W.R., Schmidt-Base, K., Smith R., Tomchick, D. R., Benning, M.M., Winkelmann, D. A., Wesenberg, G., & Holden, H.H. (1993). Three-dimensional structure of myosin subfragment-1: a molecular motor. *Science* 261, 50-58, created with Jmol: an open-source Java viewer for chemical structures in 3D (jmol.sourceforge.net).

Image of insulin: Timofeev, V.I., Chuprov-Netochin, R.N., Samigina, V.R., Bezulgov, V.V., Miroshnikov, K. A., & Kranova, I.P. (2010). X-ray investigation of gene-engineered human insulin crystallized from a solution containing polysialic acid. *Acta Crystallogr., Sect. F* 66, 259-263, created with Jmol: an open-source Java viewer for chemical structures in 3D (jmol.sourceforge.net).

Image of human growth hormone: Chantalat, L., Jones, N.D., Korber, F., Navaza, J., & Pavlovsky, A.G. (1995). The crystal structure of wild-type growth-hormone at 2.5 Å resolution. *Protein Pept. Lett.* 2, 333-340, created with Jmol: an open-source Java viewer for chemical structures in 3D (jmol.sourceforge.net).

Designed and developed by the Centre for Learning Technology, The University of Western Australia.
Production team: Anton Ball, Helen Billiald, Pauline Charman, Jan Dook, Alwyn Evans, Dan Hutton, Bec McKinney, Emma Pointon, Jodie Ween and Michael Wheatley. Thanks to Bob Fitzpatrick, Jenny Gull, Charmaine White and Wendy Sanderson.

Technical requirements

The learning object requires Adobe Flash Player version 8 or later (this is a free download from www.adobe.com). It can be placed on a web or file-server and run either locally or remotely in a web browser. The teachers guide, worksheet and data sheet require Adobe Reader (version 5 or later), which is a free download from www.adobe.com. The worksheet is also available in Microsoft Word format.

SPICE resources and copyright

All SPICE resources are available from the Centre for Learning Technology at The University of Western Australia (UWA). Selected SPICE resources are available through the websites of Australian State and Territory Education Authorities.

Copyright of SPICE Resources belongs to The University of Western Australia unless otherwise indicated.

Teachers and students at Australian schools are granted permission to reproduce, edit, recompile and include in derivative works the resources subject to conditions detailed at spice.wa.edu.au/usage.

All questions involving copyright and use should be directed to SPICE at UWA.

Web: spice.wa.edu.au
Email: spice@uwa.edu.au
Phone: (08) 6488 3917

Centre for Learning Technology (M016)
The University of Western Australia
35 Stirling Highway
Crawley WA 6009

Associated SPICE resources

Proteins 2: Protein molecules may be used in conjunction with related SPICE resources to teach the topic of proteins.

DESCRIPTION	LEARNING PURPOSE
<p><i>Proteins (overview)</i></p> <p>This learning pathway shows how a number of SPICE resources can be combined to teach the topic of proteins.</p>	
<p><i>Proteins 1: The importance of proteins</i></p> <p>A video highlights the essential role played by proteins in living organisms.</p>	Engage
<p><i>Proteins 2: Looking at proteins</i></p> <p>Students complete a practical activity to isolate and visualise proteins in tissue samples, using gel electrophoresis.</p>	Explore
<p><i>Proteins 3: Protein molecules</i></p> <p>Students work through an interactive learning object that explains the molecular structure of proteins.</p>	Explain
<p><i>Proteins 4: Making proteins</i></p> <p>Students work through an interactive learning object that explains how proteins are made by living organisms. A fact sheet summarises the main stages of transcription and translation.</p>	Explain
<p><i>Proteins 5: Defective proteins</i></p> <p>What happens when the process of protein formation goes wrong? A case study about Kuro disease explains some implications.</p>	Elaborate