EDUCATIONAL RESOURCE DEVELOPMENT

Department of Health Genomics Directorate

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ABSTRACT

Recent technological advances, such as the completion of the Human Genome Project, have received wide-spread publicity, however, there is often a lack of understanding of the underlying scientific concepts by the public.

To address this issue, the Genomics Directorate, Department of Health WA, collaborated with the Western Australian Branch of the Human Genetics Society of Australasia to develop the *Chromosomes and Abnormalities* education resource. This resource, intended for secondary school students, explains the essential components of cytogenetics, including descriptions of DNA, genes, metaphase chromosomes, mitosis and chromosome abnormalities. A practical karyotyping activity consolidates this knowledge by providing a visual depiction, which emphasises diploid number, chromosome structure, and the process involved in diagnosing a chromosome abnormality.

ACKNOWLEDGEMENTS

Chromosomes and Abnormalities was designed and produced in collaboration with cytogeneticists from King Edward Memorial Hospital (KEMH) and the Human Genetics Society of Australasia – WA branch. All proceeds from sale of this resource go to the HGSA (WA). Mark Lehman, President of the Science Teachers Association WA (STAWA), kindly allowed his Year 10 science class to be part of our end-user review process.

1. DESIGN OF CHROMOSOMES & ABNORMALITIES CD-ROM

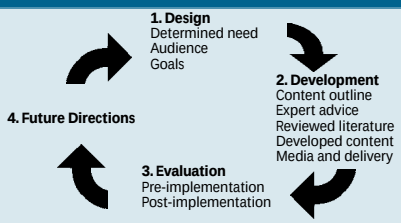

Figure 1. The Development Process

Determined the need for the teaching resource.
In 1998, teachers requested an educational resource as a result of a STAWA professional development workshop facilitated by Dr Ashleigh Murch, Cytogenetics Department, KEMH on behalf of the Genomics Directorate.

Analysed audience
Target audience: all science students from 15 to 17 years of age with a range of prior knowledge.

Defined goals
- Develop the knowledge and skills that students need to understand how DNA and chromosomes can determine the health of an individual.
- Develop an understanding of the diagnostic procedure used to determine chromosome abnormalities such as Down syndrome.
- Facilitate a greater genetic literacy, enabling students to participate in topical debates on genomics issues and make informed decisions about their own health.

2. DEVELOPMENT

Content outline
- 6 fact sheets: DNA, genes, human chromosomes, mitosis, karyotyping, chromosome abnormalities.
- Activities: Karyotyping activity, crossword puzzle, microscopy (2 slides with metaphase spreads).

Expert advice on content
The advice of text book authors and senior curriculum officers in the Department of Education and Curriculum Council were sought for advice and comment on content and development.

Reviewed literature
Current education resources (from WA, NSW and Victoria)
- Science Teachers' Association of Western Australia. Year 12 Human Biology Laboratory Manual. 2nd ed: STAWA, 2000.
- Allen R. Year 11 &12 Biology 2003. Student Resource and Activity Manual: Biozone Learning Media Australia, 2003.
- Newton T, Joyce A. Human Perspectives. 2nd ed. Sydney: McGraw-Hill Book Company, 1999.

Figure 2. Fluorescence in-situ hybridisation showing DiGeorge syndrome. One chromosome number 22 has 4 fluorescing regions, this indicates a normal chromosome. The other chromosome only fluoresces in 2 places, revealing a microdeletion of the long arm of chromosome 22.
Diagram courtesy of Applied Imaging International

References on methods of teaching genetics.

- Wood R. Taking the plunge into the gene pool: teaching and learning in genetics. Research in Science Education, 1993; 23:337-344.
- Teaching and Learning Reasoning in Genetics with Multiple External Representations. Australian Association of Research in Education AARE 2001 Conference, 2001, Fremantle, Western Australia. Curtin University of Technology.
- Marbach-Ad G. Attempting to break the code in student comprehension of genetic concepts. Journal of Biological Education. 2001, 35(4):183-189.
- Kirkpatrick G, Orivs K, Pittendrigh B. A teaching model for biotechnology and genomics education. Journal of Biological Education. 2002, 37(1):31-35.
- Lewis J, Leach J, Wood-Robinson C. Chromosomes: the missing link - young peoples understanding of mitosis, meiosis, and fertilisation. Journal of Biological Education. 2000, 34(4):189-199.
- Venville G, Treagust D. Exploring conceptual change in genetics using a multidimensional interpretive framework. Journal of Research in Science Teaching, 1998, 35(9):1031-1055.

Developed content

Selected media and delivery methods

3. EVALUATION

Pre-implementation
Expert review
- Reviewed by cytogeneticists from KEMH.
- A follow-up STAWA workshop was conducted in July 1999 at the WA Science Teachers Conference. 15 teachers attending the workshop provided feedback over the following months. Teachers were from both government and non-government schools in the metropolitan area.

End-user review
- 32 Year 10 students (15 years of age) from Padbury Senior High School in 2003.

Post-implementation
- An evaluation by teachers and students will be implemented towards the end of the school year, after the genetics component of the year 12 science curriculum has been implemented.

4. FUTURE DIRECTIONS

The resource may be further developed by designing an interactive computer-based karyotyping activity with accompanying worksheets. In addition, the suitability of *Chromosomes & Abnormalities* as a learning tool for first year life sciences students at university is currently being assessed. There are also plans to develop the series to include more advanced concepts such as mRNA, protein translation, inheritance and social issues related to genomics.

The picture of chromosomes in Figure 3 is called a karyotype. A karyotype is a diagram where the chromosomes have been arranged in order.

Karyotypes are produced using cells which were about to divide, because at this stage the chromosomes are the most condensed and visible.

Karyotypes are made when the cells are in the metaphase stage of mitosis.

Figure 3a. The chromosomes of a male as they would be seen at 100x magnification under a light microscope.

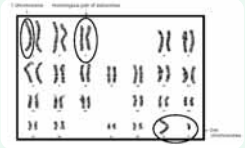

Figure 3b. The chromosomes of the same cell arranged into a karyotype with the chromosomes paired.