WHO DO YOU THINK YOU ARE?

SCIENCE BASED CROSS-CURRICULUM ACTIVITIES
based on the investigations of Lisa Matisoo-Smith

Visit the Allan Wilson Centre at: www.allanwilsoncentre.ac.nz

ALLAN WILSON CENTRE
FOR MOLECULAR ECOLOGY AND EVOLUTION

INTRODUCING THE FAMILY TREE

- Introduce the concept of a 'family tree'. Do students know what it is and what it tells us? Do they know that a family tree can be thought of as a history of their family? *eg*
  - Who is in their family at present and how are they related?
  - Who was in their family and where were they born?
  - What children did they have …?
- Challenge students to start with their parents. Do they know where they were born? Do the students have grandparents that are still alive? Where were they born? How far back can they trace their family tree (history)?
- As a homework assignment have students enlist the help of family members to create a family tree. Share these as a class. What interesting things did they find out? *eg*
  - the countries that their ancestors came from.
  - when they came to New Zealand.

INHERITING TRAITS FROM PARENTS AND FAMILIES

- Introduce the idea that all human beings are similar and yet all humans are different. Can they think of ways that they are similar to other classmates? *eg same coloured hair or eyes*
  Can they think of ways that they are different from their classmates? *eg different height, different coloured skin …*
- Have any students ever been told by family members or friends that they are just the same or very much like another family member? In what way were they told they were 'just like …'? Was it their hair, their nose shape, their height, their ability to do something as well as a past/present family member, have the same interests …? Have students ever been told by someone they have inherited something from their father/mother/other family member such as musical ability or bright blue eyes?
- Can the students think of any characteristics (traits) that they have inherited from their parents and/or other family members? (A good definition of a trait is a characteristic or quality they get from their parents and/or family).

Science Curriculum Indications:

- Exploring the concept of family trees, traits and how and why we inherit these from our parents and families.
- Gaining a better understanding of our cell structure including DNA, chromosomes and genes and the roles they play in keeping our bodies alive and growing.
- Understanding that we carry our family history in our genes, how we inherit DNA messages from our genes and the effect of gene shuffling over many generations.
- Discovering how mitochondrial DNA is passed down between generations and the importance of this discovery in tracing family histories and the understanding of human evolution.

Yrs 5–10. Links to Social Sciences, Technology and English

- Can they think of physical traits they could inherit? *eg*
  - Eye colour, height, hair colour, foot size, nose shape …
- Can they think of behavioural traits they could inherit? *eg*
  - Being right or left handed, having perfect pitch in music, being neat and tidy or untidy, liking to argue …
- Did students know that there are also medical traits that can also be passed down to children? *eg*
  - An increased risk of getting a disease that many family members have had in the past.
- Did students know that the environment and the way they live can also play a large part in altering or changing the traits they have? Can students give examples of how their environment could change their physical, behavioural and medical traits? *eg*
  - Our hair colour is inherited but exposure to lots of sunlight (or hair dye) can easily change this colour.
  - Learning to respect other people's opinions could help us become less argumentative.
  - Eating healthy foods and exercise will make us less likely to get a serious medical condition.
- Share the following animal environmental change. 'A sheep dog has the trait of always wanting to round up sheep'. With training he can be made to only round up sheep when and how the owner wants this to be done.
- Play and discuss the following animation with the students to further illustrate the above points:
  http://learn.genetics.utah.edu/content/begin/tour/index.html
  Click on 'What is a Trait'. Have them speculate on how they would inherit these traits (record answers for later comparison).

CELLS, DNA, GENES & CHROMOSOMES

- Did students know that the human body is made up of cells? Have students conduct Google research to find out the estimated number of cells that make up the human body (estimated between 50 and 100 trillion cells).

CAN YOU TRACE YOUR FAMILY HISTORY?

- Play the 'What is a cell' (introductory video) at: *http://www.youtube.com/watch?v=gFuEo2ccTPA*
- What else can they find out about cells? Ensure that students understand that all humans, plants and animals are made up of cells, they come in thousands of shapes and sizes, and they all play different roles to keep our bodies working and healthy. One suitable site for student research is: *http://www.biology4kids.com/files/cell_main.html*
- Introduce the idea that in every one of the trillions of cells in the body there is a nucleus (a bit like a control centre) that contains Deoxyribo Nucleic Acid or DNA for short and most cells in the body have these DNA molecules that tell the cell what part it will play in keeping our bodies alive and growing. Did they know that DNA is the full set of instructions of how each human is made? The student task is to find out how DNA goes about this task.
- As a class and in groups, conduct detailed research into DNA, genes and chromosomes at the following websites, videos and interactives.
  - *http://youtu.be/rromYAt1Lfw (What is DNA)*
  - *http://youtu.be/4NegABEGTv4 (DNA and Genes Explained)*
  - *http://youtu.be/zwibgNGe4aY (DNA Simply Explained)*
  - *www.meddlingkids.org/2011/07/evolution-explained-for-kids-dna-and-traits (DNA and Traits for Kids)*
  - *http://www.genome.gov/25520880 (DNA)*
  - *http://learn.genetics.utah.edu/content/begin/tour/index.html*
- As part of the research process, have students/groups/class record all new discoveries on a chart. Did their discoveries include the following?
  - DNA is found in the nucleus of our body cells and contains instructions our body needs to live and grow.
  - DNA comes in the form of a twisted ladder (double helix).
  - the rungs of the ladder are built with a 4 letter DNA alphabet, A, C, T and G. A always combines with T and C always with G.
  - A single strand of DNA is made up of a string of letters which are divided up into groups to form DNA words.
  - These letter words can be divided up into more groups to form different DNA sentences.
  - These sentences are called genes and we can think of them as a code that our body understands and needs to make the different proteins that we need to live and grow.
  - The genes control the body cells and tells them what to do.
  - Because there are 20,000 – 25,000 genes per human being they have to be tightly packaged in storage units called chromosomes to fit into the nucleus of each cell.
  - Each human has 46 chromosome packages of genes 23 from their mother and 23 from their father.
  - Our sex is determined by chromosomes, X from our mother and either X or Y from our father. XX = female, XY = male.
  - Genes control how our bodies work, repair our body and decide the traits we have such as how we look etc.

WE ALL CARRY OUR HISTORY IN OUR GENES

- Revise idea that we get 23 chromosomes each from our mother and father and relate this concept to our parents and our grandparents and so on to help students understand that every member of different generations of the family also received 23 chromosomes each from their mothers' and fathers'. Do students think that if we can read this DNA we could find out something about the history of our family?
- Tell students that although we get 23 chromosomes from each parent, we don't know what combination of chromosomes we are going to get from each parent. Does this help students understand that although we may be similar to other family members, because the chromosomes get 'shuffled up', this makes us all unique and different human beings – similar but different. What effect do they think this would have over many generations? Would this make it harder to find out about our family's genetic history going back many generations?
- If the shuffling of our genes over many generations makes it difficult to track our history, how do we now find out about our family history (records such as birth certificates, marriage certificates, shipping records …)? Introduce the idea that this is called genealogy (whakapapa). Is any student family member interested in genealogy? What have they found out about their family? What would be the consequences for tracing the family tree if any of these records could not be found, were lost or destroyed? Introduce the concept of 'deep history' as a time beyond memory or any written records. Tell students that this is where DNA data is very useful for tracing human history.

HUMAN EVOLUTION AND MITOCHONDRIAL DNA

- Do students think there were always human beings on the Earth? If not, where do they think we came from (evolved)? Tell students that as far back as the 1960s it was generally agreed that our nearest living relatives on Earth were the apes. How do they think we discovered this (discuss idea of the fossil records and how fossil records are often incomplete)? How would they find out how long ago (*Homo sapiens*) evolved?
- Did they know that in 1987, one of New Zealand's most famous scientists, Allan Wilson, and two of his colleagues, used modern genetic science technologies to answer this question? Tell students that a new form of DNA called mitochondrial DNA had been discovered – a DNA that was found outside the nucleus of the cell (unlike nuclear DNA found in the nucleus).

WE ALL CARRY OUR HISTORY IN OUR GENES

Data project the following video animations and through discussion, help students investigate how mitochondrial DNA was used to answer how modern humans evolved at:
http://learn.genetics.utah.edu/content/extras/molgen/index.html

STUDENT INVESTIGATION FOCUS QUESTIONS

Introduction to Molecular Genealogy Section

- What does a family tree tell us?
- What record of our families do we carry in our bodies?
- What clues does our DNA provide us about our ancestors?
- Why is the written record sometimes not enough to be able to trace our families back over many generations?
- What advantages does combining the written record with DNA technology give us when tracing our ancestry?

Autosomal DNA Section

- What do we find in the nucleus of our cells?
- What do we inherit from our parents and how much?
- Where did your parents inherit their autosomal DNA from?
- In turn, where did their parents inherit their DNA from?
- How can autosomal DNA tell us about our genetic past?
- Why does this become less accurate the further back we go?

X and Y Chromosome Sections

- How are we able to use both our X and Y chromosomes to trace our ancestry back to previous generations?
- What happens to this accuracy the further back we go?

Mutation Section

- What is meant by a mutation and when does it happen?
- Because of mutations, what happens to DNA when it is copied and passed down through more and more generations?
- Why are we more likely to have similar DNA to close relatives than distant relatives?
- Can you explain the part that mutation has played in creating the differences between all the peoples of the world?
- What are we able to tell by looking closely at one particular section of our DNA?
- What has research into mitochondrial and Y DNA allowed us to find out about people all over the world?

WHAT ALLAN WILSON FOUND

- Tell students that because the mitochondrial DNA (mtDNA) didn't get shuffled, scientist Allan Wilson realised that as the exact copy is passed down by the mother to her children from generation to generation, this would be a good way to trace the genetic history of a person or a species. Explain that even with mtDNA, every so often a mutation would take place … … and when it did, it started a new branch of the big family tree. That is, it linked all of the descendants of that woman who had that mtDNA mutation. Tell students that by looking at all the particular mtDNA mutations he was able to draw a family tree for all living humans.

EXTRA FOR EXPERTS

- Introduce students to the concept of human phylogenetic relationships as a way of describing when species shared a common ancestor. Tell students that Allan Wilson's research shows that the common ancestor of modern human beings (*Homo sapiens*) came from Africa 150 – 200,000 years ago.
- Visit: *www.allanwilsoncentre.ac.nz* > select Teachers and Students and download the two 'Human Evolution' powerpoint presentations for class and group study to find out:
  - How humans evolved from ape-like ancestors in Africa to modern humans occupying every part of the globe.
  - How scientists study our evolutionary history, using evidence such as fossil remains and genetics to back their theories.
  - How these theories may change as new evidence is found
  - The contributions of a New Zealander, Allan Wilson, to our understanding of human evolution.
- Older students can recreate Allan Wilson's research at: *www.allanwilsoncentre.ac.nz* > select Teachers and Students > select Recreate the Research

CONCLUDING ACTIVITIES

- Tell students that using mtDNA mapping, researchers at Otago University led by Professor Lisa Matisoo-Smith have made some exciting new discoveries about four Rangitane tribal ancestors buried in a village on Wairau Bar, more than 700 years ago – the time that Māori first arrived in New Zealand. The researchers believe that this will help them trace where the 'first kiwis' came from. Download the full press release at: *www.starters.co.nz/download/get/-0001-ancestors/64.html*
- Discussion points include:
  - What was previously thought about the genetic diversity of our founding population?
  - What has this mtDNA mapping now told us?
  - What advances have allowed the researchers to make this exciting discovery?
  - What does the finding that three of the four individuals had no recent common maternal ancestor tell us?
  - Is it now possible to find out where our founding (Māori) population came from and how will we go about finding this out?
- Play the series of videos on evolution to the class found at: *www.pbs.org/wgbh/evolution/educators/teachstuds/svideos.html* including evolution of humans and why evolution is still controversial – especially in the USA. Have students find out how science tackles the claims that it didn't happen this way.
- Have students conduct research on evolutionary topics from the student library at: *www.pbs.org/wgbh/evolution/library/index.html* and present their findings to the class.