GEEE! THE NEWS RELEASE JULY 6, 2004

The Provincial Museum launches *The GEEE! in GENOME*; a discovery of genes, their functions and controversies.

The Provincial Museum of Alberta presents a new exhibition explaining the relevance of genomics to nature and human life, and the controversy stemming from it in the areas of agriculture, endangered species, forensics and advances in medicine. ***Geee! in Genome*** is a national travelling exhibition that will be on display at the Museum from July 8 to October 11, 2004.

Genomics is the study of genes and their functions, and aims to decipher and understand the entire genetic information content of organisms.

Why?

Why are some people born with traits such as freckles or widow's peaks, while others are not? Can a better understanding of DNA help solve crimes, cure diseases or even bring back an extinct species? These questions are explored in the exhibit, along with controversial ethical issues such as genetically modified organisms (GMOs), genetic testing, gene therapy, therapeutic and reproductive cloning, GMO labeling and safety, DNA databanks and privacy issues. Electronic polling stations offer the public a chance to contribute their opinions on each of these topics.

The exhibition highlights the important contributions of Canadian scientists to the field, paying particular tribute to the late Nobel Prize winning chemist Dr. Michael Smith. Smith was committed to fostering young scientists and supporting women in science.

-30-

Media inquiries for interpretive tours may be directed to:

Todd Crawshaw
Communications Coordinator
Phone: (780) 453-9186
Fax: (780) 422-5681
Email: todd.crawshaw@gov.ab.ca

Julie Calderbank
Head, Marketing & Communications
Phone: (780) 453-9111
Fax: (780) 422-5681
Email: julie.calderbank@gov.ab.ca

Other media inquiries may be directed to:

Donna Coad
Communications Officer
Genome Prairie
Phone: (403) 503-5222
Fax: (403) 503-5225
Email: dmcoad@genomeprairie.ca

Janet Weichel Mckenzie
Communications
Canadian Institutes of Health Research
Phone: (613) 941-4563
Fax: (613) 954-6653
Email: jweichel@cihr.ca

Hosted by:

Alberta COMMUNITY DEVELOPMENT

THE PROVINCIAL MUSEUM OF ALBERTA

Geee! in Genome is produced by the **Canadian Museum of Nature** and presented nationally by **Genome Canada** in partnership with the **Canadian Institutes of Health Research** (CIHR). It is presented at The Provincial Museum of Alberta by Genome Prairie, in partnership with CIHR's Institutes of Gender and Health and Musculoskeletal Health and Arthritis.

Presented locally by:

GenomePrairie

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

Institute of Gender and Health / Institut de la santé des femmes et des hommes

Institute of Musculoskeletal Health and Arthritis / Institut de l'appareil locomoteur et de l'arthrite

Media partner:

EDMONTON JOURNAL

The Provincial Museum of Alberta is located at 12845-102 Avenue in Edmonton. For further information, phone (780) 453-9100 or visit www.pma.edmonton.ab.ca. Visit the **Canadian Museum of Nature** at www.nature.ca/genome.

GEEE! THE HIGHLIGHTS

- The 5,000 sq. ft. (465 sq. m) travelling exhibition consists of four main sections, each divided into self-contained modules that explore different aspects of genomics.

As you enter the exhibition you will be greeted with:

- an introduction to the exhibition,
- the ABCs of genomics and proteomics,
- applications of genomics, and
- the stars in the science of genomics, highlighting Dr. Michael Smith (Nobel Prize winner in 1993 from British Columbia).

"It is important to have a scientifically literate public because there are so many things in our lives driven by science and technology."

~ Dr. Michael Smith

GEEE! EDUCATIONAL ACTIVITIES

Through a series of educational activities, models and stations, you can explore the different aspects of genomics and proteomics and its applications. ***The GEEE! in Genome*** invites you to question and investigate relevant ethical issues regarding genomics.

GEEE! THE JOURNEY

As you enter the exhibition, images and specimens that highlight the extraordinary diversity of life on earth will tantalize you. Throughout these images, you will see the letters **A**, **T**, **C** and **G** — the chemical bases of DNA.

The message is simple, yet profound: with only four letters, or ***notes***, nature has created the many symphonies of life.

The GEEE! in Genome **is Canada's first exhibition on genomics - the study of genes and their functions - and is part of an extensive, innovative, multidimensional public education project.**

The GEEE! in Genome **is produced by the *Canadian Museum of Nature* and presented nationally by *Genome Canada*, in partnership with the *Canadian Institutes of Health Research***

Highlights of the exhibition are on the website www.nature.ca/genome.

THE GEEE! IN GENOME FORUMS

The Provincial Museum of Alberta and Genome Prairie will be hosting four forums on issues relating to genomics in late September, early October. Below is information on each of the forums. ***(Note: dates and topics are subject to change.)***

Genomics and the History of Life

Genomics research has revealed that all life on earth shares a common heritage. Organisms as diverse as bacteria, yeast, fruit flies and humans employ highly-conserved genes and regulatory pathways that govern birth, growth and death. This public forum will examine the basis of that evolutionary heritage and how the study of organisms, living or extinct, can provide insights into topics such as hereditary disease and human development.

Date: Wednesday, September 22nd
Time: 7pm to 9pm
Place: Calgary Science Centre
701 - 11 Street SW, Calgary

Genetic Testing: Promise and Peril

We are in the middle of a scientific revolution that has far reaching implications for human health, human lives and the very definition of what it means to be human. Genetic research enables us to isolate genetic predispositions within and between populations. Genetic testing enables us to identify and even correct hereditary illnesses. But, are you ready to find out what your genes might tell you about your future health? And if you know, who else should? Will this knowledge lead to genetic discrimination? Will parents now think of tinkering with their babies' genes to maximize their chances of success later in ife? Could human cloning ever be considered or justified? These are but a few many questions raised by the new genetic revolution. How can we control access to our personal information, and how will we deal with the ethical and moral issues that arise from this genetic revolution?

Date: Thursday, September 23rd
Time: 7pm to 9pm
Place: The Provincial Museum of Alberta
12845 - 102 Avenue

GMOs: What are they and should I be concerned?

What potential have GMOs to change our lives? But are genetically modified organisms safe for us and for our environment? What are some of the ethical issues involved? Can or should life be patented?

Date: Thursday, September 30th
Time: 7pm to 9pm
Place: The Provincial Museum of Alberta
12845 - 102 Avenue

Forensics

In the course of criminal investigations, law enforcement agencies now routinely look for matches of genetic material to assist with the identification of those responsile for performing criminal acts. But who should have access to your genetic information? Should you freely give your genetic information to authorities even if you are not involved in a criminal investigation? What government body should collect and hold this information or profiling as part of the public record?

Date: Thursday, October 7th
Time: 7pm to 9pm
Place: The Provincial Museum of Alberta
12845 - 102 Avenue

GEEE! WHAT IS A GENOME?

- A **genome** is all the genetic material contained in an organism, including its chromosomes, genes and DNA (deoxyribonucleic acid).
- Genes carry information for making all the proteins needed by an organism to function. These proteins determine, among other things, an organism's appearance, health and traits.
- DNA is made up of four chemical bases (represented by **A**, **T**, **C**, and **G**) that may be repeated millions of times throughout a genome. The human genome, for example, has 3.2 billion pairs of bases.
- The arrangement of these bases is extremely important, as it determines the kind of organism, whether a plant, animal or a fungus. It is the countless possible arrangements of these four bases that account for the huge diversity of life on earth.

- Researchers study not only the human genome, but also the genomes of all kinds of creatures, from microbes to animals such as mice and pigs. The more we learn about other genomes, the more we may discover about our own.

GEEE! WHAT ARE GENOMICS?

- Research in genomics has a number of different focuses. It may concentrate on sequencing an entire genome, one chromosome or a specific gene.
- Research may also be focused on the function of a gene or the interaction of several genes.
- Genomics research will let us grasp the language of life and understand, for example, the tiny genetic differences that determine the colour of an eye or the shape of a mouth.
- Some of what is learned from this research may help doctors prevent and treat diseases better. There may be applications and possibilities that we have not even conceived of yet.

The word 'genome' is a combination of 'gene' and 'chromosome'.

GEEE! THE HIGHLIGHTS

On your journey through the exhibition, you will discover:

- a musical analogy, woven throughout the exhibition to help explain genomics,
- historical and Canadian stars in the science of genomics, highlighting the late Nobel Prize-winning chemist, Dr. Michael Smith who was committed to fostering young scientists and supporting women in science,
- provocative considerations such as made-to-measure children, immortal pets and human lifespans of 150 years,
- astonishing genetic similarities between humans and other species,
- a hands-on ability to build a DNA model,
- a video game where you race against a cell to build a protein,
- a scanning game about foods containing genetically modified organisms (GMOs) in a grocery store,
- a DNA detective game to solve wildlife crimes and mysteries,
- an activity to analyze the traits in their own family tree,
- personal accounts of people who suffer from genetic disease,
- the impressive work of the genomics winners in the 2002 Canada-wide Science Fair,
- a film *How to Build a Human: Predictor* (35 minutes), and
- an activity area for public programming. Learn about dominant and recessive genes, then find out about natural clones and common myths around the subject of cloning. Learn how to extract your own DNA and build a chain of proteins.

GEEE! LEARN

Relevant ethical issues and questions are raised at every stage of the exhibition. You will be encouraged to record your opinions and view the opinions of others. The exhibition will help de-mystify the science of genomics, challenge misconceptions and encourage questions. You will be asked to ponder such controversial ethical issues as genetic testing, gene therapy, human cloning, GMO labelling and safety, DNA databanks and access to genetic information.

GEEE! RESEARCH AT THE MUSEUM

The Provincial Museum of Alberta is mandated to document the phenotypic (appearance) and genotypic (genetic makeup) diversity of the birds of the province.

Much variation in birds' appearance is localized in a narrow band along the eastern slopes of the Rocky Mountains of Alberta where boreal forest types encounter cordilleran forest ones. This area has been, and remains, the focus of much ornithological research at The Provincial Museum of Alberta. In it lay answers to various questions about the past history of the province, and the process by which new species of animals form and take independent evolutionary paths.

Dr. Jocelyn Hudon, Curator of Ornithology at the Museum, has been taking advantage of the opportunity afforded by this natural experiment, where gene complexes are broken wide open, to understand the origin and genetic basis of species-specific differences in birds' appearance. Notably, he has been scrutinizing variation and differentiation within two species pairs in the area, the Yellow-bellied (*Sphyrapicus varius*) and Red-naped Sapsuckers (*S. nuchalis*), and the eastern and western forms of the Northern Flicker (*Colaptes auratus*), the Yellow-shafted and Red-shafted Flickers respectively, which differ in many characteristics.

Dr. Hudon hopes someday to set up a molecular lab at the Museum to carry out sophisticated DNA analyses of hybrid individuals, but in the meantime, has been using the bird's outward appearance (the phenotype) of the differentiated forms to infer population makeup and degree of intermixing (hybridization) between the species in the hybrid zone, as well as monitor gene flow between them. As a result of this work, he has uncovered a very fluid genetic situation in the Sapsucker species pair, a "tug-of-war" of sorts between the genes from the two species.

Dr. Hudon recently unravelled the biochemical basis of the difference in shaft and moustache colours between the Yellow- and Red-shafted Flickers and has begun a study of the mendelian segregation (inheritance) of these and additional traits that distinguish the two forms in an area where they co-exist and hybridize in western Alberta. He is banding young Flickers at nests, identifying them with unique band colour combinations, and tracking the segregation of their characteristics over successive generations, collecting feather samples to be used for DNA analysis in the process. Dr. Hudon hopes to someday examine genetic linkage among the traits (quantitative trait loci, QTL) and between the traits and several identified polymorphic DNA markers (random amplified polymorphic DNA, RAPD) in the hopes, ultimately, to isolate the genes responsible for the differences in coloration. The advent of the genomic revolution now makes this goal a possibility.

~ Jocelyn Hudon
Curator of Ornithology
The Provincial Museum of Alberta

Hybrid Flicker

GEEE! DID YOU KNOW?

- The word 'genome' is a combination of 'gene' and 'chromosome'.
- April 2003 marked the 50th anniversary of the description of the double helix structure of DNA by James Watson and Francis Crick in 1953.
- If you unrolled the DNA contained in only one of your cells, it would be 1.8 metres long.
- In 1909, Wilhelm Johannsen, a Danish botanist, introduced the term 'gene', from a Greek word meaning 'to give birth to', to describe units of inheritance.
- Your genome contains 3.2 billion chemical letters.
- If the human genome were a book, it would be about the size of 800 dictionaries. All of this resides inside a microscopic nucleus that could easily fit on the head of a pin!
- You are more than 99.9% identical to your mother, the person sitting beside you on the bus and Albert Einstein.
- In the next 60 seconds, your body will produce enough new DNA that, if linked together, would stretch 100,000 km.
- A team led by Dr. Lap-Chee Tsui from the *Hospital for Sick Children* in Toronto discovered the defective gene and molecular defect responsible for cystic fibrosis. It is estimated that one in every 2,500 children born in Canada have cystic fibrosis.
- There are natural clones such as identical twins, plant bulbs, sea anemones and E.coli bacteria.
- Some people think that cloning may help save endangered species, or even reproduce those that have already disappeared.
- If you and your friend recited your genomes at the speed of one letter per second, it would take you more than eight minutes before you found a difference.

- It is impossible to clone a dinosaur, and the chances of cloning a Mammoth are pretty slim. Even if these extinct species were brought back to life, where would they live?
- Scientists have created genetically altered pigs that lack a gene involved in the rejection of transplanted organs. They could potentially be used to grow organs for human transplantation.
- Scientists report they have inserted a genetically modified virus into spinach cells. This virus produces a key component of what they think is a safer anthrax vaccine.
- It took nine years to identify the cystic fibrosis gene. Thanks to the microarray, it took only nine days to find one of the genes linked to Parkinson's disease.

GEEE! A TIMELINE

1869 DNA first isolated
1909 Word *gene* is coined
1952 Discovery that genes are made of DNA
1953 DNA double helix described
1961 mRNA isolated
1966 Genetic code cracked
1972 First animal gene clone
1981 First transgenic mice and fruit flies created
1983 First disease gene mapped (Huntington's disease)
1987 First human genetic map
1994 First genetically modified (GM) food appears on the market: Flavr Savr tomato
1996 Yeast genome sequenced
1996 First mammal cloned – Dolly the sheep
1997 E. coli genome sequenced
1998 Roundworm C. elegans genome sequenced
2000 Fruit fly genome sequenced
2000 Ninety percent of human genome sequenced
2003 Complete human genome sequenced

2004 The future is to be determined

GEEE! HISTORIC HIGHLIGHTS

The Pioneers

1886
The Father of Modern Genetics
Gregor Johann Mendel

Pioneering experiments in hybridization led him to conclude that discrete 'factors', now called genes, are responsible for the passing of characteristics to the offspring.

In 1866, based on the results of his investigation of the inheritance of 'factors' in pea plants, Mendel formulated the first and second laws of heredity.

1953
The Double Helix

With the help of chemist **Rosalind Franklin's** outstanding images of DNA X-ray diffraction, **James Watson**, an American geneticist and biophysicist, and **Francis Crick**, a British biophysicist, demonstrated that the DNA molecule is shaped like a double helix. In recognition of their discovery, Watson and Crick were awarded the Nobel Prize for Medicine in 1962.

1961
Messenger RNA Isolated

French biologists **François Jacob** and **Jacques Monod**, together with the help of French microbiologist **André Lwoff**, isolated messenger RNA, the molecule that takes information from DNA in the nucleus to the protein-making machinery in the cytoplasm of the cell. In recognition of their groundbreaking work, Jacob, Monod and Lwoff shared the Nobel Prize for Medicine in 1965.

1972
Genetic Engineering Pioneer

American Biochemist **Paul Berg** devised a method for cutting DNA molecules in specific places that corresponded to a particular sequence of DNA, or gene. This technique is known as **recombinant DNA** and is the primary method through which genetic engineering is practiced. For his pioneering work, Paul Berg was awarded the Nobel Prize for Chemistry in 1980.

1990-2000
The Genetic Decoders

In October 1990, an international team of scientists officially began the **Human Genome Project**. Their mission: mapping the entire human genome to show where genes are in relation to one another along the chromosome, and sequencing the entire human DNA by determining the order of **A**, **C**, **T** and **G**. The first rough map of the entire human genome was completed on June 26, 2000.

GEEE! THE Qs AND As

Who is involved in The Geee! in Genome?

The Geee! in Genome is an exhibition and national education project produced by the *Canadian Museum of Nature*, presented nationally by *Genome Canada* in partnership with the *Canadian Institutes of Health Research*. These organizations have a common desire to inform Canadians about genomics, a cutting-edge science in constant evolution. Their goal is to effectively communicate the results of genomics research to the public, thereby helping Canadians understand the relative risks and rewards of this type of research.

Where will the exhibition appear?

The exhibition premiered at the *Canadian Museum of Nature* in Ottawa in 2003. It will travel on a three-year national tour to nine other museums and science centres across Canada. It will return to the *Canadian Museum of Nature* in 2006 to be integrated into the new Nature of Humans Gallery.

The Geee! in Genome **is featured at:**

- *The Provincial Museum of Alberta: July 8, 2004 - October 11, 2004*
- *Ontario Science Centre: October 31, 2004 - January 9, 2005*
- *Centre des sciences, Quebec: January 24, 2005 - April 24, 2005*
- *Musée de la nature et des sciences, Quebec: April 2005 - June 2005*
- *Musée du Fjord, Quebec: September 11, 2005 - December 4, 2005*
- *Discovery Centre, Nova Scotia: December 2005 - March 2006*

Why is this exhibition timely?

Genomics is today what the Internet was at the beginning of the 1990s. That is to say, we're at the early stages of a very profound scientific revolution. It started with genetics and moved on quickly to genomics, has spread to proteomics (the study and applications of proteins) and functional genomics.

GEEE! THE Qs AND As *continued*

In what way will The GEEE! in GENOME exhibition influence the visitors?

- Breakthroughs related to DNA research appear in newspapers on an almost daily basis, introducing technical terms like genomics, proteomics and the Human Genome Project.
- While the genomics revolution promises to usher in an exciting new era of possibilities, many of us don't have the basic knowledge to understand its workings or evaluate its potential.
- The exhibition aims to help people understand what genomics is all about, and enable them to form informed opinions on issues that generate much media attention.

How does this exhibition address issues that Albertans face today, such as health care and GMOs?

- Already, issues such as cloning, stem cell research and GMOs are asking us to think hard about the "brave new world" to come. However, for many of us, reaching informed positions on such issues is difficult because genomics itself is complex and highly technical, often clouded in obscure scientific jargon. This exhibition aims to de-mystify these technologies and underscore their biological underpinnings. How do we as a society balance the scientific opportunities and potential health benefits with real or perceived ethical, legal and social issues?

What are more specific examples of how genomics could affect the delivery of health care?

- The genomics revolution will touch every aspect of our lives, but none more so than health care. That's because genomics will give us a whole new set of tools – new windows into the inner workings of our bodies. We will see a fundamental change in our approach to health care, with much greater emphasis being placed on prevention rather than on treatment. Genomics can also play a key role in the way drugs are developed. Today, clinical trials use a scattergun approach, involving tests on thousands of people. If pharmaceutical companies use genomics first to screen subjects, they will be able to target their tests towards those people most likely to benefit from new drugs. Gene therapy – using normal genes to replace or supplement a defective gene or to bolster immunity to disease – holds the potential to treat or even cure genetic and acquired diseases.

GEEE! THE Qs AND As *continued*

What are some of the ethical challenges facing genomics?

- This is a field of inquiry where scientific discovery is clearly outpacing our ability to deal with it. As a society, we need to reflect on what *can* scientifically be done, and what we believe *should* be done! Who will have access to our genetic information? How are we going to deal with possible surprises, like concealed genetic defects, that may come along the way? Is the developing world going to be left behind in the genomics revolution? Should genes be patented? Is genetically modified food safe? Are we going to be tempted to alter the genetic make-up of our children? These and related questions need to be debated before the full potential of these technologies are realized. For this to happen, people need to know what the issues are.

What can Albertans learn about the good aspects of genetic research through this exhibition?

The Geee! In Genome presents a rare opportunity to learn more about the scientific revolution that began 50 years ago with the discovery of the double helix, and that will shape our world for generations to come. It is nothing less than the discovery of the blueprint of our own bodies and that of all organisms around us. Today's scientists, including many Canadians, some of whom are highlighted in the exhibition, are on the verge of understanding how immunity to infectious diseases works, how to grow hardier and more productive crops, how to make forests resistant to disease and even how to develop new, cheaper sources of energy. But, this revolution will first have to be tempered by our willingness to espouse the new technologies and its possible repercussions.

What would you most want Albertans to learn about genomics from this exhibition?

That genomics in and of itself is not dangerous or a necessary evil, but a tremendous new tool in the scientific arsenal, with potential to prevent, detect and combat disease, engineer better crops and foods and create renewable sources of energy. However, since science is not in the business of telling what *should* be done, but rather, what *can* be done, people need to decide for themselves what will be acceptable and what will not. Welcome to the new, complex and confusing world of genomics.

GEEE! THE GMO QUESTIONS

GMOs in Agriculture

—items to consider

Agricultural products with a higher yield that are also insect and herbicide-resistant. Fruits and vegetables that grow in dry environments or are cold-resistant.

But:
What if insects developed immunity to pesticides?

GMOs in Food Production

—items to consider

Tomatoes that do not rot. Salmon that fatten up quickly. Pigs with less fat and better nutritional value.

But:
What if GM salmon escaped into the ocean?

GMOs in Forestry

—items to consider

Fast-growing trees whose ligneous fiber is of higher quality, less difficult to process and resistant to harmful insects, illnesses and environmental stresses.

But:
What if original species of trees ceased to exist?

GMOs in Health

—items to consider

Rice enriched with vitamin A. Bananas as vaccines. Sheep whose milk contains insulin. Alfalfa that produces hemoglobin.

But:
What if these medications had unexpected side effects?

GMOs in Environment

—items to consider

Fish that detect pollutants in the water. Plants that create biodegradable plastics. PCB-decomposing bacteria. Sugar beets that produce gas.

But:
Would you still need GMOs if you stopped polluting?

GMOs in Applied Research

—items to consider

Mice with human diseases to test vaccines and medication. Fruit flies to study the structure and function of genes. Fluorescent fish to understand human development.

But:
What if you could modify humans?

GEEE! A GLOSSARY (A TO C)

Here is just a sample of some relevant terms. To see all of the glossary visit www.nature.ca/genome and click on 'Glossary'.

The terms and descriptions provided in this glossary have been completed with the help of several sources:

- *National Human Genome Research Institute - Talking Glossary,*
- *Human Genome Project Information,*
- *PhRMA Genomics, and*
- *Word Central's Student Dictionary (Merriam Webster).*

A, T, C, G: Symbols for the bases adenine, thymine, cytosine and guanine.

A

Allele:
Alternate forms of a gene at a particular location on a chromosome. Different alleles produce variation in inherited traits such as hair colour and blood type. In an individual, one form of the allele (the dominant one) may be expressed more than another form (the recessive one).

Amino acid:
Different kinds of small molecules that link together in long chains to form proteins. Amino acids are often referred to as the 'building blocks' of proteins.

Antibody:
Antibodies help the body develop immunity to disease. Blood proteins are produced in response to a disease and help the body fight against the particular disease.

Autosome:
Any chromosome other than a sex chromosome; humans have 22 pairs of autosomes.

B

Bacteria:
Very small, single-celled life forms that can reproduce quickly. Bacteria are found throughout nature and can be beneficial or destructive.

Base:
A DNA nucleotide is made of a molecule of sugar, a molecule of phosphoric acid and a molecule called a base. The bases are the 'letters' that spell out the genetic code. In base pairing, adenine always pairs with thymine and guanine always pairs with cytosine.

Biotechnology:
The application of biological science; especially the use of genetic techniques to combine DNA from different sources into one organism in order to produce useful products, such as drugs.

C

Carrier:
A person who has one copy of the gene mutation for a recessive disorder is called a 'carrier'. Carriers are not affected by the disorder; however, they can pass on the mutated gene to their children. Children who inherit two such genes may be affected by the disorder.

Cell:
The basic unit of any living organism, a cell is a small, watery compartment filled with chemicals and a complete copy of the organism's genome.

Chromosome:
One of the threadlike packages of genes and other DNA in the nucleus of a cell. Different kinds of organisms have different numbers of chromosomes. Humans have 23 pairs of chromosomes - 46 in all (44 autosomes and two sex chromosomes). Each parent contributes one chromosome to each pair, so children get half of their chromosomes from their mother and half from their father.

GEEE! A GLOSSARY (C TO G)

C

Clone:
An exact copy of biological material such as a DNA segment (e.g., a gene or other region), a whole cell, or a complete organism.

Cloning:
Cloning creates a genetically identical copy of an animal or plant. Cloning is the process of making copies of a specific piece of DNA, usually a gene. When geneticists speak of cloning, they do not mean the process of making genetically identical copies of an entire organism.

Cytoplasm:
The viscous semi-liquid inside the membrane of a cell.

Cytosine:
One of the four bases in DNA that make up the letters A, T, C, G. Cytosine is the 'C'. Cytosine always pairs with guanine.

D

Deoxyribonucleic acid (DNA):
DNA is the chemical inside the nucleus of a cell that carries the genetic instructions for making living organisms. A long molecule, and usually packaged into chromosomes, DNA encodes genetic information in the form of a double helix held together by bonds between base pairs.

DNA fingerprinting:
In genetics, the identification of multiple specific alleles on a person's DNA to produce a unique identifier for that person.

DNA replication:
The process by which the DNA double helix unwinds and makes an exact copy of itself.

DNA sequencing:
Determining the exact order of the base pairs in a segment of DNA.

Dominant gene:
A gene that almost always results in a specific physical characteristic, for example, a disease, even though the patient's genome possesses only one copy. With a dominant gene, the chance of passing on the gene (and therefore the disease) to children is 50-50 in each pregnancy.

Double helix:
The structural arrangement of DNA, which looks something like an immensely long ladder twisted into a helix or coil. The sides of the 'ladder' are formed by a backbone of sugar and phosphate molecules, and the 'rungs' consist of nucleotide bases joined weakly in the middle by hydrogen bonds.

E

Embryo:
An animal in the early stage of development before birth (in humans, the embryo stage is the first three months following conception).

Enzyme:
A protein that encourages a biochemical reaction, usually speeding it up. Organisms could not function if they didn't have enzymes.

Ethical issues:
Questions that concern what is moral or right.

G

Gene:
The functional and physical units of heredity passed from parent to offspring, genes are pieces of DNA stored in the cell nucleus.

Gene therapy:
An evolving technique used to treat inherited diseases. The medical procedure involves replacing, manipulating or supplementing non-functional genes with healthy genes, in order to affect their function.

Genetics:
The field of science that looks at how traits are passed down from one generation to another through the genes.

GEEE! A GLOSSARY (G TO M)

G

Genetically modified organism (GMO):
An organism whose genetic make-up has been changed by any method, including natural processes, genetic engineering, cloning or mutagenesis.

Genetic engineering:
The artificial introduction of changes to the genes in a cell.

Genetic profile:
A collection of information about a person's genes.

Genome:
The complete package of genetic material for a living thing, a genome is one copy of the entire DNA in a cell of an organism (animal, plant or microbe) and includes both the chromosomes within the nucleus and the DNA in mitochondria.

Genomics:
The study of genes and their functions.

Germ cells:
The cells of the body involved in reproduction. Sperm of the male and eggs of the female are formed from germ cells.

Guanine:
One of the four bases in DNA that make up the letters A, T, C, and G, guanine is the 'G'. Guanine always pairs with cytosine.

H

Heredity:
The passing of certain traits from parents to their offspring. The process of heredity occurs through the genes.

Hormones:
Proteins produced by organs of the body that trigger activity in other locations.

Human Genome Project:
An international research project to map each human gene and to completely sequence human DNA.

I

Immune system:
A biological defence system that has evolved in vertebrates to protect them against the introduction of foreign material (such as pollen or invading micro-organisms) and to prevent the body from developing cancer.

Immunotherapy:
The concept of using the immune system to treat disease; for example, developing a vaccine against cancer. Immunotherapy may also refer to the therapy of diseases caused by the immune system (allergies, for example).

K

Karyotype:
The chromosomal complement of an individual, including the number of chromosomes and any abnormalities. The term is also used to refer to a photograph of an individual's chromosomes.

M

Microinjection:
Injection of tiny amounts of a substance into a microscopic body, such as a single cell.

Mitosis:
The process of nuclear division in cells that produces daughter cells that are genetically identical to each other and to the parent cell.

Molecule:
The smallest particle of a substance having all the characteristics of the substance.

Monogenic disorder:
A disorder, which is caused by mutations in just one gene (such as haemophilia), as opposed to polygenic disorders (such as hypertension) which involve the interaction of several genes.

Mutation:
A permanent structural alteration in DNA. In most cases, DNA changes either have no effect or cause harm, but occasionally a mutation can improve an organism's chance of surviving and passing the beneficial change on to its descendants.

GEEE! A GLOSSARY (M TO R)

M

Mutagenesis:
When a chemical or physical agent is used to cause permanent genetic alterations.

N

Nuchal translucency test:
The nuchal translucency test is used to determine if a woman is at high risk of having a baby with a chromosomal abnormality, such as Down Syndrome.

Nucleotide:
One of the structural components, or building blocks, of DNA and RNA. A nucleotide consists of a base plus a molecule of sugar and one of phosphoric acid.

Nucleus:
The largest, most prominent organelle in eukaryotic cells, the nucleus is a round or oval body that is surrounded by the nuclear envelope and contains the genetic information necessary for control of cell structure and function. It is the central cell structure that houses the chromosomes and is essential to such cell functions as growth, metabolism and reproduction.

O

Oncogene:
A gene that is capable of causing the transformation of normal cells into cancer cells.

Organelle:
A structure in a single-celled living thing that has a special task as an organ does in a many-celled living thing.

Organism:
An individual living thing that carries on the activities of life by means of organs which have separate functions but are dependent on each other: a living person, plant or animal.

P

Pharmacogenomics:
The science of understanding the correlation between an individual patient's genetic make-up (genotype) and their response to drug treatment.

Phenotype:
The observable traits or characteristics of an organism (e.g., hair colour, weight) or the presence or absence of a disease. Phenotypic traits are not necessarily genetic.

Plasmids:
A structure composed of DNA that is separate from the cell's genome. In bacteria, plasmids confer a variety of traits and can be exchanged between individuals - even those of different species. Plasmids can be manipulated in the laboratory to deliver specific genetic sequences into a cell.

Protein:
A large complex molecule made up of one or more chains of amino acids. Proteins perform a wide variety of activities in the cell.

Prokaryote:
Cell or organism lacking a membrane-bound, structurally discrete nucleus and other subcellular compartments. Bacteria are examples of prokaryotes.

Proteomics:
The study of the full set of proteins encoded by a genome.

R

Recessive:
A genetic disorder that appears only in individuals that have received two copies of a mutant gene, one from each parent.

Recombinant DNA:
A variety of techniques that molecular biologists use to manipulate DNA molecules to study the expression of a gene.

Recombination:
Recombinant DNA is produced when genetic information from more than one organism is recombined in a laboratory process into a hybrid molecule.

Replication:
The process by which DNA isduplicated before cell division.

GEEE! A GLOSSARY (R TO X)

R

Ribonucleic acid (RNA):
A chemical similar to a single strand of DNA. In RNA, the letter U, which stands for uracil, is substituted for 'T' in the genetic code. RNA delivers DNA's genetic message to the cytoplasm of a cell where proteins are made.

S

Sex chromosome:
A sex chromosome is one of the two chromosomes that specify an organism's genetic sex. Humans have two kinds of sex chromosomes, X and the other Y. Normal females possess two X-chromosomes and normal males one X and one Y.

Stem cell:
Undifferentiated, primitive cells in the bone marrow with the ability both to multiply and to differentiate into specific blood cells.

T

Thymine:
One of the four bases in DNA that make up the letters A, T, C, and G. Thymine always pairs with adenine.

Transgenic:
An experimentally-produced organism in which DNA has been artificially introduced and incorporated into the organism's germ line, usually by injecting the foreign DNA into the nucleus of a fertilized embryo.

U

Uracil:
Uracil is one of the four bases in RNA. Uracil replaces thymine, which is the fourth base in DNA. Like thymine, uracil always pairs with adenine.

V

Vector:
An agent, such as a virus or a small piece of DNA called a plasmid that carries a modified or foreign gene. When used in gene therapy, a vector delivers the desired gene to a target cell.

Virus:
Extremely small and simple life forms made merely of a protein shell and a genome. A virus reproduces by inserting its genome into the cells of other life forms. As those cells duplicate, so does the virus.

X

Xenotransplant:
Transplantation of tissue or organs between organisms of different species, genus or family. A common example is the use of pig heart valves in humans.

GEEE! THE MEDIA HEADLINES

June 1, 2004
Swedish team partners with Canada to work on worldwide leading-edge forestry genomics project

May 21, 2004
Montréal student wins top genomics award at Canada-Wide Science Fair 2004

May 20, 2004
Two McGill Professors recognized by Royal Society of Canada

May 13, 2004
Western Canadian Students Sweep Top 3 Awards in 2004 National Biotech Contest

April 13, 2004
Two University of Alberta teams awarded a total of $18 million to study organ transplant rejection mechanisms and small molecule metabolites as markers for disease

March 20, 2004
Canada's high-tech cancer fight: a pioneering Vancouver research centre probes ways to treat and, possibly, prevent cancer. Scientists are building on the discovery of the human genetic blueprint, reports Peter Calamai

March 14, 2004
Salmon served as fish-on-a-chip; DNA microarray records critical gene information; GRASP biologists shaking up world of aquaculture

February 17, 2004
Detection advance offers cancer at a glance

February 12, 2004
B.C. genome scientists pop the cork on wine project: Scientists join the quest for the perfect grape

February 6, 2004
Coming soon: customized diets that will help you fight cancer. Thanks to genome research, it could be only 10 years away

February 6, 2004
Religious urge genetic engineers to play card game of philosophical questions

February 1, 2004
Tough Issues in Genomics - GELS Comes to the Fore

Headlines courtesy Genome Canada website (genomecanada.ca)

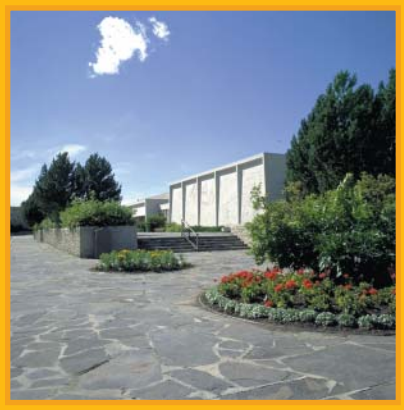
GEEE! THE MUSEUM DETAILS

ADMISSION:

Adult (18-64 years)	$10
Senior (65 and over)	$8
Student (with ID)	$8
Youth (7-17)	$5
Family (Two adults and children 7-17)	$28

HOURS:

Open daily from 9 am to 5 pm
Admission is half price on Saturdays and Sundays between 9 am & 11 am



MAMMOTH PASS:

Experience it!

Become a Mammoth Pass member — join us now and visit all year long at no additional charge! It's a wonderful way to spend quality time with the family. It's a great place to learn and increase your understanding and appreciation of Alberta's natural and cultural heritage and the world around you.

Your ***Mammoth Pass*** will pay for itself in just a few visits.

ANNUAL MAMMOTH PASS:

Adult (18-64 years)	$35
Senior (65 and over)	$30
Student (with ID)	$30
Youth (7-17)	$20
Family (Two adults and children 7-17)	$70
Grandparent (Two grandparents and children 7-17)	$60

THE MUSEUM SHOP

Be sure to visit *The Museum Shop* for all sorts of great gift ideas and specialty merchandise all about genomics. **You will find:**

- ***Geee! in Genome*** t-shirts
- DNA Wood Puzzle
- Zome tool DNA Build Kit
- Glow DNA Puzzle
- Human DNA Biology Kit
- A wide assortment of books for all ages, including the history of genetics, forensic science, and ethics

It's your stories …your heritage …your Museum!