

**DESCRIPTION OF TOPICS FOR 12 (OR MORE) SCIENCE SHOWS**  
**By John Bachar**  
**“SCIENCE IN THE PUBLIC INTEREST”**  
**“CONVERSATIONS ON BASIC AND CURRENT TOPICS IN SCIENCE”**

The well-known evolutionary biologist, Richard Dawkins, in his book “A Devil’s Chaplain: Reflections on Hope, Lies, Science, and Love”, included in Chapter 7.1 – “Good And Bad Reasons For Believing” -- an open letter to his daughter (written when she was ten) which said in pertinent part:

Next time somebody tells you something that sounds important, think to yourself: "Is this the kind of thing that people probably know because of evidence? Or is it the kind of thing that people only believe because of tradition, authority, or revelation?" And, next time somebody tells you that something is true, why not say to them: "What kind of evidence is there for that?" And if they can't give you a good answer, I hope you'll think very carefully before you believe a word they say.

Your loving  
Daddy

### **1. Averages and Distributions**

The concept of an “average” and a “distribution” is pervasive in all of science as well as in economics, finance, engineering, and countless other fields. In order to understand what takes place in these as well as other areas of knowledge, one must know the precise definition of these two concepts. Many examples will be explained in which averages and distributions are inherent. Consider this scenario: Three different societies, together with a three-year history of the average incomes in each, will be presented. For all of these years, the average income in each of the three is \$60,000. Which of these three would you prefer to inhabit? Or consider this: two different geographical regions (both exquisitely beautiful) have an average daily temperature of 75 degrees. In which would you choose to live? The program will analyze these questions and your choices, and will explain how to use averages and distributions in your daily life for your benefit and for a deeper understanding and appreciation of science as well as countless other areas that impact continually on your life.

### **2. Scientific Method**

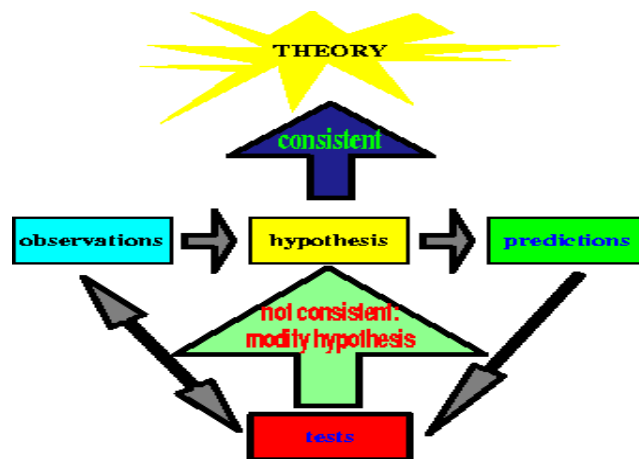
The word science derives from the Latin word, “**scientia**”, meaning “**having knowledge**”. In the most general sense, science is defined as the acquisition of knowledge accumulated by systematic study; it is organized by general principles, and is made up of an orderly system of facts that have been learned from observation, study and experiments. The definition of science is very broad, indeed: you’ve heard of the science of physics and chemistry, but you’ve also heard of the science of cooking, the science of eating and dining, the science of hitting or throwing a baseball, the science of skiing or skating, the science of boxing, the science of climbing, library science, social science, political science, and even the science of lying!

Over many hundreds of years, there has evolved the bedrock of scientific inquiry and discovery, most notably in the “basic” sciences (physics, chemistry and biology, for example), but also in many other fields..

Here is a simple outline of the steps involved in the scientific method:

1. Observe some aspect of the universe.
2. Invent a tentative description, called a hypothesis, that is consistent with what you have observed.
3. Use the hypothesis to make predictions.
4. Test those predictions by experiments or further observations and modify the hypothesis in the light of your results.
5. Repeat steps 3 and 4 until there are no discrepancies between theory and experiment and/or observation.

Here is a diagram of the basic procedures in the scientific method:



In this program, many examples will be given of scientific facts discovered with the use of the scientific method.

### 3. Random Sampling

Suppose that there is a large finite population of elements (persons, bacteria, whatever) and a subset of the population (those voting for option A on a ballot, or those bacteria having left-handed helical tails, etc.) whose fraction,  $p$ , we wish to determine. It is generally impractical or impossible to count directly the number of elements in this subset, and then divide by the number of elements in the whole population, in order to calculate the value of  $p$ . It turns out that by an appropriate choice of a random sample (meaning, every element in the population has an equal chance of being selected) of sufficient size selected from the whole population, one can estimate  $p$  as accurately as one pleases and with as high a confidence probability as one pleases.

The theory for how this can be done is based on a fundamental theorem in mathematical probability theory -- the “**deMoivre-Laplace Limit Theorem**” -- due to the French-born mathematicians Abraham de Moivre (1667 – 1754) and Pierre-Simon Laplace (1749 – 1827). If  $n$  denotes the size of a sample that is to be taken randomly (and one after another with replacement after each selection) from the whole population, if  $k$  denotes the number within the sample found to have the desired property “S” (say, voting for option A on a ballot), and if  $p$  is the actual fraction of the whole finite population having property S, then  $k/n$  is the fraction of the sample having property S. The de Moivre-Laplace Limit Theorem allows the determination of the smallest  $n$  such that  $k/n$  (the sample preference) is "close to  $p$ " with a "high probability". To give an example, suppose we consider a California election. Assume the “whole population” is the set of “registered voters”. We wish to determine the smallest random sample size,  $n$ , such that there is a 95.17% probability that the sample preference is within 2% of the preference of the entire set of registered voters. The theory says that the sample size must be at least 2,500.

Instead of sampling the whole population as a single entity, it is often useful to partition the population into a finite number of sets and then to randomly sample each set in the partition independently. The theory of “Stratified Random Sampling” enables one to do this in such a way that one can determine the preference of the whole population.

The program will analyze all of these matters.

#### **4. Evolutionary Biology and Intelligent Design**

**Evolution** (the transformation over a long period of time from one species into another) is a fact that is as well established as any other fact in the world of science. The **theory of evolution** is the explanation for how that transformation occurs. An **evolutionist** accepts the Darwinian argument that natural selection and environmental factors combine to explain the diversity of life we see on earth. Although fossil evidence sufficiently demonstrates the fact of evolution, even more compelling evidence today comes from DNA testing of species (“**evolutionary biology**”). In the future, most of our additional knowledge of evolution will come from what we can learn from DNA. To call evolution a "theory" says nothing about its ability to accurately explain facts observed in the world. The sun-centered solar system of Copernicus and Galileo is a theory. Evolution is the central theory of biology. It is a powerful tool for explaining the presence of millions of fossils and other evidence (such as the fact that over 98% of the DNA of chimpanzees and humans is identical) about the origin of life forms. Biologists believe that life on earth has developed through the process of evolution, starting with single-cell organisms. There are disputes about evolution just as there are disputes about almost any theory. For example, most--but not all--biologists believe that evolution has not worked evenly throughout history: they believe that there have been periods of rapid evolutionary change followed by long periods of relatively little evolutionary change.

An “**intelligent design**” (ID) proponent rejects the theory of evolution and, more generally, the notion that natural law and chance alone can explain the diversity of life on earth. Instead, the ID proponent argues--often from statistics--that the diversity of life is the result of a purposeful scheme of some higher power (who may or may not be the God of the Bible). The concept of intelligent design evolved from “**creationism**”. A

**“creationist”** is a person who rejects the theory of evolution and believes instead that a Divine Being put each species on earth here.

The continuing controversy between evolutionary biology (or Darwinian evolution) and intelligent design (or creationism) has a long and bitterly fought history.

All of these matters will be explored in depth in this program. In it, you will learn about evolutionary biology, intelligent design, and the never-ending controversy!

### **5. Stem Cell Research**

A stem cell is a special kind of cell that has a unique capacity to renew itself and to give rise to specialized cell types. Although most cells of the body, such as heart cells or skin cells, are committed to conduct a specific function, a stem cell is uncommitted and remains uncommitted, until it receives a signal to develop into a specialized cell. Their proliferative capacity combined with the ability to become specialized makes stem cells unique. Researchers have for years looked for ways to use stem cells to replace cells and tissues that are damaged or diseased.

There are different types of stem cells. Embryonic cells - technically called totipotent - can produce all types of tissue. This is the very early stage of a recently fertilized egg and has only about 8 cells (morula). Inner cells - pluripotent - can become almost all types of cells and are taken from an early embryo stage. Adult stem cells are typically called multipotent cells that, like bone marrow cells, can produce a wide range of different blood cells. Embryonic stem cells are “harvested” or collected from the very early stages of a fertilized egg called a blastocyst. Adult stem cells are collected from a limited number of cell types in the body. Umbilical cord stem cells are collected from the cells of the umbilical cord of a recently born baby. Some of these cells are slightly undeveloped and so can turn into other types of cells (multipotent).

There exists a widespread controversy over stem cell research, which emanates from the techniques used in the creation and usage of stem cells. In particular, research using embryonic stem cells has proven to be an immensely sensitive topic. This is because, with the present state of technology, starting a stem cell 'line' requires the destruction of a human embryo and/or therapeutic cloning. Opponents of the research argue that this practice is a slippery slope to reproductive cloning and tantamount to the objectification of a potential human being. Contrarily, medical researchers in the field argue that it is necessary to pursue embryonic stem cell research because the resultant technologies are expected to have significant medical potential. The ensuing debate has prompted national and international authorities to seek suitable regulatory frameworks and highlighted the fact that stem cell research represents a moral, social and ethical minefield.

The program will give up-to-date exposition of this enormously important topic.

### **6. World Fossil Energy Depletion and Sustainable, Renewable Energy Sources**

There are only one trillion barrels of petroleum reserves left on Earth, and the world consumes over 30 billion barrels annually (2004 World Oil Journal), leaving about 34 years to exhaustion. Very little new reserves are being found: less than one new barrel is found for every four used. World oil output has already peaked.

There are 7,000 trillion cubic feet (2004 World Oil Journal) of natural gas reserves on Earth, and the 2010 projected world consumption (Energy Information Agency) is 111 trillion cubic feet, leaving less than 63 years to exhaustion.

British Petroleum, in its annual report 2005, estimated at 2004 end, there were 909,064 million tons of proved coal reserves worldwide, or 164 years reserve to production ratio.

Burning coal for energy usage contributes heavily to carbon dioxide emissions (and hence to global warming), as does petroleum and natural gas.

The world population is now 6.5 billion (2006) and UN demographers project that in about 28 years, the population will double to a frightening 13 billion! This phenomenon, of course, will accelerate the time to exhaustion of all three of these fossil energy sources.

As dismal as these facts indicate, there are solutions for sustainable, renewable energy sources (mostly solar). The program will describe current research on non-fossil, renewable energy sources together with the prospects for avoiding the impending world catastrophe.

## **7. Fareless Urban Mass Transit**

In the previous program on World fossil energy depletion, we learned that only one trillion barrels of petroleum reserves are left on Earth, and less than one new barrel is found for every four used. With over 30 billion barrels consumed annually worldwide (2004) and rapidly increasing, there is less than 34 years left. THEN IT'S ALL GONE! Of the 48 petroleum-producing countries, only 15 can supply their own internal needs; the remaining 33 must supplement their internal needs with imports. The US domestic reserve supply is only 22 billion barrels (it imports over 60% of its annual consumption), and if there were no imports, US oil would run out in less than THREE YEARS (7.4 billion barrels consumed annually – 25% of the annual world consumption)! The US transportation sector alone consumes two-thirds annually (4.9 billion barrels), and the US fleet of 235 million highway vehicles (2004) uses 3.9 billion (53 percent of annual US consumption).

Clearly, a sustainable energy source must soon be found to replace the impending worldwide petroleum exhaustion. Undoubtedly it will be solar, but MUCH TIME is needed to develop the technology for this transition. The most effective means for buying time is by drastically reducing the use of petroleum in the transportation sector. Since most (over 90%) of highway vehicle petroleum use is in urban regions, it follows that the solution is the implementation of very extensive urban mass transit systems. Even if there were an INFINITE supply of petroleum, it is critical that urban mass transit must be used to eliminate our ubiquitous urban traffic quagmire (24/7 gridlock virtually everywhere in the US, and especially in California and the LA region). Urban mass transit is the only logical method that can vastly reduce urban highway petroleum usage, thereby simultaneously buying critical time for solar technology development and for eliminating the traffic quagmire,.

The implementation of the FARELESS URBAN MASS TRANSIT SYSTEM (FUMTS) solves the aforementioned problems. This system provides an optimum model for any large urban region. FUMTS can reduce traffic volume in the six-county Southern

California region [SCR] by 90%, can save 3.2 billion barrels of petroleum annually in the USA, and can reduce motorists' costs by 90%! **No fares will be charged to any user.** FUMTS will be financed by a net-wealth tax on the upper 1% of the appropriate adult population, so that 99% of the citizens will bear no cost.

The program will reveal the surprising details of the FARELESS URBAN MASS TRANSIT SYSTEM.

## 8. Nuclear Energy

From John McCarthy, Professor Emeritus at Stanford University:

### *Details on nuclear energy*

Nuclear power can come from the fission of uranium, plutonium or thorium or the fusion of hydrogen into helium. Today it is almost all uranium. The basic energy fact is that the fission of an atom of uranium produces 10 million times the energy produced by the combustion of an atom of carbon from coal. Natural uranium is almost entirely a mixture of two isotopes, U-235 and U-238. U-235 can fission in a reactor, and U-238 can't to a significant extent. Natural uranium is 99.3 percent U-238 and 0.7 percent U-235. Most nuclear power plants today use enriched uranium in which the concentration of U-235 is increased from 0.7 percent U-235 to (nowadays) about 4 to 5 percent U-235. This is done in an expensive separation plant of which there are several kinds. The U-238 "tails" are left over for eventual use in "breeder reactors". The Canadian CANDU reactors don't require enriched fuel, but since they use expensive heavy water instead of ordinary water, their energy cost is about the same.

In 1993 there were 109 licensed power reactors in the U.S. and about 400 in the world. They generate about 20 percent of the U.S. electricity. (There are also a large number of naval power reactors.) The expansion of nuclear power depends substantially on politics, and this politics has come out differently in different countries. Very likely, after some time, the countries whose policies turn out badly will copy the countries whose policies turn out well.

For how long will nuclear power be available? Present reactors that use only the U-235 in natural uranium are very likely good for some hundreds of years. Bernard Cohen has shown that with breeder reactors, we can have plenty of energy for some billions of years. Cohen's argument is based on using uranium from seawater. Other people have pointed out that there is more energy in the uranium impurity in coal than could come from burning the coal. There is also plenty of uranium in granite. None of these sources is likely to be used in the next thousand years, because there is plenty of much more cheaply extracted uranium in conventional uranium ores.

A power reactor contains a core with a large number of fuel rods. Each rod is full of pellets of uranium oxide. An atom of U-235 fissions when it absorbs a neutron. The fission produces two fission fragments and other particles that fly off at high velocity. When they stop the kinetic energy is converted to heat - 10 million times as much heat as is produced by burning an atom of the carbon in coal. Besides the fission fragments several neutrons are produced. Most of these neutrons are absorbed by something other than U-235, but in the steady-state operation of the reactor exactly one is absorbed by another U-235 atom causing another fission. The steam withdrawn and run through the turbines controls the power level of the reactor. Control rods that absorb neutrons can

also be moved in and out to control the nuclear reaction. The power level that can be used is limited to avoid letting the fuel rods get too hot. The heat from the fuel rods is absorbed by water which is used to generate steam to drive the turbines that generate the electricity. A large plant generates about a million kilowatts of electricity - some more, some less.

After about two years, enough of the U-235 has been converted to fission products and the fission products have built up enough so that the fuel rods must be removed and replaced by new ones. What to do with the spent fuel rods is what causes most of the fuss concerning nuclear power.

#### ***Derails about the plutonium that is produced***

Besides fission products, spent fuel rods contain some plutonium produced by the U-238 in the reactor absorbing a neutron. This plutonium and leftover uranium can be separated in a reprocessing plant and used as reactor fuel. The Japanese had their spent fuel rods reprocessed in Europe and shipped the plutonium back home for use in reactors. This is what Greenpeace was fussing about. In terms of nuclear fuel, about 1/4 as much plutonium is produced as the U-235 that was in the fuel rods in the first place. Thus running a reactor for four years produces enough plutonium to run it for one more year provided the plutonium is extracted and put into new fuel rods.

#### ***Nuclear waste***

After the fuel has been in the reactor for about 18 months, much of the uranium has already fissioned and a considerable quantity of fission products have built up in the fuel. The reactor is then refueled by replacing about one-third of the fuel rods. This generally takes one or two months. {2002 note: Entergy Nuclear, an enthusiastic buyer and operator of American nuclear power plants has been reducing this time for their plants. They refueled their River Bend plant in Louisiana in 17 days and expect to reduce their average refueling outage time to two-three weeks.] Canadian CANDU reactors replace fuel continuously.

When fuel rods are removed from the reactor they contain large quantities of highly radioactive fission products and are generating heat at a high rate. They are then put in a large tank of water about the size of a swimming pool. There they become less radioactive as the more highly radioactive isotopes decay and also generate less and less heat. The longer the spent fuel is stored, the easier it will be to handle, but many reactors have been holding spent fuel so long that their tanks are getting full. They must either send the rods off or build more tanks.

The fuel rods should then be chemically reprocessed. Reprocessing removes any leftover uranium and the plutonium that has been formed. The U.S. shut down its reprocessing plant during the 1970s and hasn't replaced it. European reprocessing plants (Belgium, France, Russia, UK) continue to operate, and the Japanese are building their own - in the meantime sending their spent fuel to Europe for reprocessing. The French plant they use sends their plutonium back to Japan, where the Japanese plan to use it as reactor fuel.

The fission products are then put in a form for long term storage. A large reactor produces about 1.5 tonnes of fission products per year. The fission products are originally in a mixture with other substances, so reprocessing is required to get it down to a 1.5 tonnes. [If the waste is incorporated into a glass, the total weight is 15 tonne. If the

density is 3.0 times water, that means the volume of the waste is 0.5 cubic meters, and the volume of the waste glass is about 5 cubic meters [from Prof. Bernard Cohen]. Many schemes for long-term storage have been devised, but lawsuits and politics have prevented any of them from being implemented in the United States.

The French have decided on a scheme, but I don't know if they have put it into operation. Because the fission products become less radioactive with time, the longer you wait, the easier the task becomes. The Canadians are reviewing a plan for storing waste deep underground in the Pre-Cambrian "Canadian Shield".

The U.S. plan is to store the waste in Nevada in the same area as has been used for underground nuclear tests. This plan is still tied up in long-term indecision. A big step forward was taken in 2002 when the President signed a bill to over-rule the objections of the State of Nevada.

The nuclear experts for this program will make it well worthwhile for you to listen.

### **9. Evidence and Reasons for the Rise and Fall of Societies**

The world-famous biologist, Edward O. Wilson, says the following about Jared Diamond, author of the Pulitzer Prize-winning book, *Guns, Germs, and Steel: The Fates of Human Societies*:

“No scientist brings more experience from the laboratory and field, none thinks more deeply about social issues or addresses them with greater clarity, than Jared Diamond as illustrated by *Guns, Germs, and Steel*. In this remarkably readable book he shows how history and biology can enrich one another to produce a deeper understanding of the human condition.”

Diamond is a master of many scientific fields of inquiry (as diverse as archaeology and epidemiology, for example) that he employs to illuminate how and why the human societies of different continents followed widely divergent pathways of development over the past 13,000 years.

In his next and most recent book, *Collapse: How Societies Choose to Fail or Succeed*, Diamond probes the following question: What caused some of the great civilizations of the past to collapse into ruin, and what can we learn from their fates? He details the forces that lead to collapse and shows us what we must do to avert the current prospect of global ecological collapse.

Jared Diamond is a professor of geography and of environmental health sciences at UCLA. He began his scientific career in physiology and expanded into evolutionary biology and biogeography. He has received a plethora of awards and prizes for his extensive scientific accomplishments.

The program will explore Jared Diamond's fascinating exposition of these two works that so brilliantly expands our understanding of history and the human condition.

### **10. Global Warming**

Global warming refers to the observed increases in the average temperature of the Earth's atmosphere and oceans in recent decades.

The scientific opinion on climate change is that the average global temperature has risen  $0.6 \pm 0.2$  °C over the 20th century, and that it is very likely that "Most of the

warming observed over the past 50 years is attributable to human activities". The increased volumes of carbon dioxide and other greenhouse gases (GHGs) released by the burning of fossil fuels, land clearing and agriculture, and other human activities, are the primary sources of the human-induced component of warming. Some scientists, who point out that evidence of human-attributable climate change is inaccurate, call the significance of the human component of global warming into question.

Various prominent bodies have commented on global warming, most notably the Intergovernmental Panel on Climate Change (IPCC). National and international scientific groups have issued statements both detailing and summarizing the current state of scientific knowledge on the earth's climate. Scientific organizations that have made position statements on climate change include:

- Intergovernmental Panel on Climate Change
- American Meteorological Society Statement
- American Geophysical Union position statement on greenhouse gases and climate change
- Climate Change Science: An Analysis of Some Key Questions, National Academy of Sciences, Commission on Geosciences, Environment and Resources, (Washington, DC: National Academy Press, 2001).
- Joint statement on the Science of Climate Change, issued by sixteen national academies of science from around the world.
- A position paper of the Stratigraphy Commission of the Geological Society of London.
- Policy Statement on Climate Variability and Change by the American Association of State Climatologists (AASC)

Another factor involved in global warming is the phenomenon of global dimming. Global dimming is the gradual reduction in the amount of global hemispherical irradiance (or total solar irradiance) at the Earth's surface, observed since the beginning of systematic measurements in 1950s. The effect varies by location, but worldwide it is of the order of a 5% reduction over the three decades from 1960–1990. This trend has reversed during the past decade. Global dimming creates a cooling effect that may have partially masked the effect of greenhouse gases on global warming.

The global warming controversy is an ongoing dispute about the effects of humans on the global climate and what, if any, policies should be followed to avoid future effects. Although not fully settled, the current scientific opinion on climate change is that recent warming is largely human-caused.

This program is a must for everyone because global warming may have devastating consequences, not only for humans, but also for all living things. Expert guests will give a description and scientific explanation of global warming and what we can do about it.

## **11. DNA, the Human Genome Project, Genealogy, Evolutionary Biology, Treatment of Disease by Gene Alteration**

Deoxyribonucleic acid (DNA) is a nucleic acid—usually in the form of a double helix—that contains the genetic instructions specifying the biological development of all

cellular forms of life, and most viruses. DNA is a long polymer of nucleotides (a polynucleotide) and encodes the sequence of the amino acid residues in proteins using the genetic code, a triplet code of nucleotides.

DNA is often referred to as the molecule of heredity as it is responsible for the genetic propagation of most inherited traits. In humans, these traits can range from hair color to disease susceptibility. During cell division, DNA is replicated and can be transmitted to offspring during reproduction. Lineage studies can be done based on the facts that the mitochondrial DNA only comes from the mother, and the male Y chromosome only comes from the father.

Every person's DNA, their genome, is inherited from both parents. A mother's mitochondrial DNA, together with twenty-three chromosomes from each parent, combine to form the genome of a zygote: the fertilized egg. As a result, with certain exceptions such as red blood cells, most human cells contain 23 pairs of chromosomes, together with mitochondrial DNA inherited from the mother.

Because DNA collects mutations over time, which are then passed down from parent to offspring, it contains information about processes that have occurred in the past. By comparing different DNA sequences, geneticists can attempt to infer the history of organisms.

If DNA sequences from different species are compared, then the resulting family tree, or phylogeny can be used to study the evolution of these species. This field of phylogenetics is a powerful tool in evolutionary biology. If DNA sequences within a species are compared, population geneticists can glean information on the history of particular populations. This can be used in studies ranging from ecological genetics to anthropology (for example, DNA evidence is also being used to try to identify the Ten Lost Tribes of Israel).

DNA has also been used to look at fairly recent issues of family relationships, such as establishing some manner of familial relationship between the descendants of Sally Hemings and the family of Thomas Jefferson. This usage is closely related to the use of DNA in criminal investigations detailed above. Indeed, some criminal investigations have been solved when DNA from crime scenes has fortuitously matched relatives of the guilty individual.

**The analysis of similarities between DNA sequences from different organisms is also opening new avenues in the study of the theory of evolution.** In many cases, evolutionary questions can now be framed in terms of molecular biology; indeed, many major evolutionary milestones can be related to the molecular level. Many questions about the similarities and differences between humans and our closest relatives (the primates) are expected to be answered by the data from the Human Genome Project.

A genome is all the DNA contained in an organism, including its genes. The U.S. Human Genome Project began formally in 1990, and was a 13-year effort coordinated by the U.S. Department of Energy and the National Institutes of Health. The project originally was planned to last 15 years, but rapid technological advances accelerated the completion date to 2003. The Project goals were to

- identify all the approximately 20,000-25,000 genes in human DNA,
- determine the sequences of the 3 billion chemical base pairs that make up human DNA,

- store this information in databases,
- improve tools for data analysis,
- transfer related technologies to the private sector, and
- address the ethical, legal, and social issues (ELSI) that may arise from the project.

Knowledge about the effects of DNA variations among individuals can lead to revolutionary new ways to diagnose, treat, and someday prevent the thousands of disorders that affect us. Besides providing clues to understanding human biology, learning about nonhuman organisms' DNA sequences can lead to an understanding of their natural capabilities that can be applied toward solving challenges in health care, agriculture, energy production, environmental remediation, and carbon sequestration.

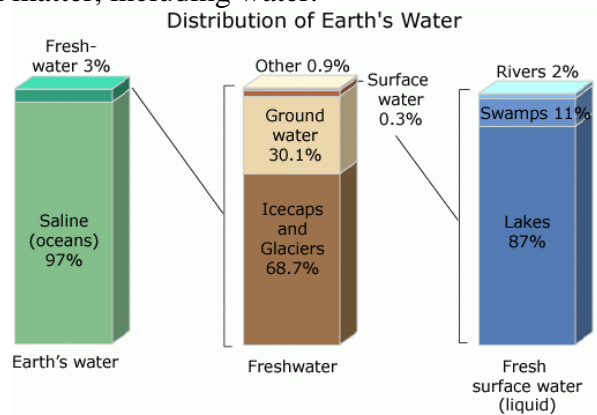
Leading experts will explain everyone needs to know about DNA, the Human Genome Project, genealogy, evolutionary biology, and the treatment of disease by gene alteration.

## 12. World Fresh Water Supply, Food Production, and Famine

**Water Resources of Earth.** Over 70% of our Earth's surface is covered by water. Although water is seemingly abundant, the real issue is the amount of fresh water available:

- 97.5% of all water on Earth is salt water, leaving only 2.5% as fresh water
- Nearly 70% of that fresh water is frozen in the icecaps of Antarctica and Greenland; most of the remainder is present as soil moisture, or lies in deep underground aquifers as groundwater not accessible to human use.
- < 1% of the world's fresh water (~0.007% of all water on earth) is accessible for direct human uses. This is the water found in lakes, rivers, reservoirs and those underground sources that are shallow enough to be tapped at an affordable cost. Only this amount is regularly renewed by rain and snowfall, and is therefore available on a sustainable basis.

Water is continually moving around, through, and above the Earth as water vapor, liquid water, and ice. In fact, water is continually changing its form. The Earth is pretty much a "closed system," like a terrarium. That means that the Earth neither, as a whole, gains nor loses much matter, including water.



About one-third of the world's population lives in countries with moderate to high water stress. The problems are most acute in Africa and West Asia but lack of water is already a major constraint to industrial and socio-economic growth in many other areas, including China, India and Indonesia. If present consumption patterns continue, two out of every three persons on Earth will live in water-stressed conditions by the year 2025. The declining state of the world's freshwater resources, in terms of quantity and quality, may prove to be the dominant issue on the environment and development agenda of the 21st century. Over the next 20 years, the average global supply of water per person is expected to drop by one-third. By the middle of the 21st century, 2 billion to 7 billion people will be severely short of water.

Glaciers store about 75% of the world's freshwater, and if all land ice melted the seas would rise about 70 meters (about 230 feet). During the last ice age (when glaciers covered more land area than today) the sea level was about 400 feet lower than it is today. At that time, glaciers covered almost one-third of the land.

It is estimated that the worldwide water distribution is 70% for irrigation use, 15% for industrial use, 15% for household purposes, and the remaining amount for recreation and environmental use.

***Food Supply of Earth.*** Of the world's total land area of 150 million km<sup>2</sup> (16 X the area of the US), much is not suitable for agriculture. Arable land comprises 10% of the total. Permanent crops are 1%; meadows and pastures, 24%; forest and woodland, 31%. The remaining 34% is land surface that supports little or no vegetation: Antarctica, deserts, mine sites, urban areas. Nearly all of the world's productive land is already exploited. Most of the unexploited land is either too steep, too wet, too dry, or too cold for agriculture. In Asia, nearly 80% of potentially arable land is now under cultivation.

Most arable land already is farmed, and the land area under agriculture had slightly declined. Improved agricultural methods that increase yields while minimizing environmental impacts hold the greatest promise for increasing world food supplies. At present, humans use or co-opt a substantial fraction of the world's terrestrial net primary production, raising doubts about our ability to greatly increase food supply to humans.

***Famine.*** Today, famine strikes African countries the hardest, but with ongoing wars, internal struggles, and economic instability, famine continues to be a worldwide problem with millions of individuals suffering. The Famine Early Warning Systems Network labeled Niger with emergency status in July of 2005, as well as Chad, Ethiopia, South Sudan, Somalia and Zimbabwe. In January 2006, the United Nations Food and Agriculture Organization warned that 11 million people in Somalia, Kenya, Djibouti and Ethiopia were in danger of starvation due to the combination of severe drought and military conflicts.

Many believe that the Green Revolution is still the answer to famine. The Green Revolution began in the 20th century with hybrid strains of high-yielding crops. Not only does this contribute to a larger amount of the crop, but it can also stabilize production. Some criticize the process, stating that these new high-yielding crops require more chemical fertilizers and pesticides, which can harm the environment. However, it may be an option for developing nations suffering from famine, and these crops can be bred as to adapt to the conditions of the country. These high-yielding crops make it technically

possible to feed the world and eliminate famine. They can be developed to provide optimal nutrition, and a well-nourished, well-developed population would emerge. Some say that the problems of famine and ill nourishment are the results of ethical dilemmas over using the technologies we have, as well as cultural and class differences.

Experts will discuss all of these matters and will also address the following questions: Is the world food supply keeping pace with population growth? What are the means of increasing the world's food supply? How much can we increase the world's food supply? What are the limits to the world's food supply? What steps can be taken to permanently remove the scourge of famine and malnutrition?

### **13. Nuclear Disarmament**

### **14. Biological Diversity Diminution**

### **15. Disease Detection and Control (Epidemics, Pandemics)**

### **16. Advances in Astrophysics: Dark Matter, Black Holes, Expansion and Age of the Universe**