NATIONAL VETERINARY LABORATORY

P.O. Box 239, 1Tice Road
Franklin Lakes, NJ 07417
877-NVL-LABS (877-685-5227)
www.natvetlab.com

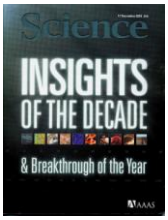
NEWSLETTER

Science's Major Accomplishments of the First Decade of the 21st Century©

Evelyn E. Zuckerman, Editor **Winter 2011** **Vol. 10, Number 1**

In This Issue:

The winter 2011 issue of the NVL Newsletter will be our 37th edition over 8 years of the past decade. In this issue we will look back at the major scientific accomplishments of the past decade 2000-2010, the first decade of the 21st century. The Science magazine editors (Science Vol. 330, No. 6011, December 17, 2010) have selected and expertly reviewed the 10 most important scientific accomplishments of the decade. We will summarize the journal's selections for the major science accomplishments of the past decade.



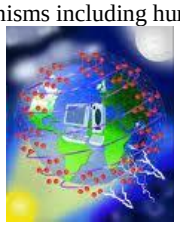
The editors selected: 1) the dark genome, 2) precision cosmology, 3) ancient DNA, 4) water on Mars, 5) reprogramming cells, 6) the microbiome, 7) exoplanets, 8) inflammation, 9) metamaterials, and 10) climate change research.

The Decade- Millennium Y2K:

Who can forget the fears and trepidations at the coming of the new millennium, the year 2000 (Y2K) with all the predictions of the computer catastrophes due to the incomplete coding of the year in the operating systems of most computers? Luckily the dire predictions never materialized.

The Internet:

During the decade the internet became an essential part of most people's lives and is now used for commerce, scientific investigations, education, and recreation. The use of the internet has allowed shared computer use by scientists and non-scientists to sequence the genomes of numerous organisms including humans.



However, it should be noted that accurate and inaccurate information is readily available on the internet and society must try to ensure that the most accurate information predominates.

1) The dark genome:

The human genome was published in 2001 and, at that time, the current knowledge was that DNA (genes) were the instruction for building proteins whereas RNA was the messenger for carrying these messages to the cell's protein factories where they were translated into action. Between the genes lay long stretches of "junk DNA," the dark genome, which was thought to be useless and inert.

During the decade the "junk DNA" was shown to exert important regulatory functions on the protein coding genes and is important when mutated in disease states. RNA coded by the "junk DNA" was also shown to regulate the expression of genes in health and diseases. It is obvious that the past decade has radically changed our concepts of how the genome functions.

2) Precision cosmology:

These concepts are too abstract to discuss in detail here but scientists are now beginning to understand the origin of the universe after the "big bang."

3) Ancient DNA:

Until recently the knowledge of ancient life relied on the study of stones and bones. During the past decade scientists were able to study "biomolecules" such as ancient DNA and collagen.

We now know the color of dinosaur feathers and how woolly mammoths withstood the cold. In 2008 a team of scientists bought mammoth hair on eBay and sequenced the entire DNA genome, the first genome of an extinct animal. In 2010 a group identified a previously unknown species of human by its DNA alone. Sequencing ancient DNA may have practical implications in that the DNA may be used to help save threatened animals, such as polar bears, by introducing genetic diversity back into these animals.

4) Water on Mars:

During the decade, Mars orbiters and rovers discovered long-lived seas or lakes on ancient Mars which may indicate some form of life.

Scientists theorize that meteorites from Mars, dislodged by asteroid impacts, made it to earth. "Mars was wet enough early enough and long enough; if it turns out to harbor life as we know it (bacteria), then life on earth could well have started here (Mars)."

5) Reprogramming cells:

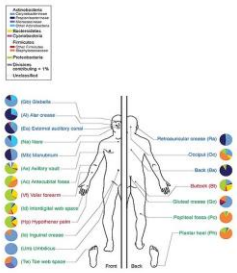
During the past decade scientists have, by manipulating cells to overexpress a few genes, been able to transform skin and blood cells into induced pluripotent stem cells that are able to become any number of cells in the body.

Some genes can make skin cells differentiate into neurons or blood cells. Using these techniques, cell lines have been prepared from patients with rare, hard-to-study diseases. The ultimate hope is to be able to grow genetically identical replacement cells and tissue and perhaps, even complete functional organ replacements.

6) The microbiome:

The microbiome is defined as the total collection of organisms, found in humans or animals, that include bacteria (the majority), yeast, single-cell eukaryotes, helminth parasites and viruses, the later including viruses that infect the cellular microbiome organisms (e.g., bacteriophages, the

viruses of bacteria). Total microbial cells found in association with humans may exceed the total number of cells making up the human body by a factor of 10 to 1. Few microbes make us sick; most just call the human body home. In fact, there is ample evidence that some commensal viruses stimulate the immune system to make the body more able to defend against certain bacterial invaders. As we know from the "probiotic" commercials on TV, certain harmless bacteria help us to maintain intestinal health and to digest our food more effectively. The total number of genes associated with the human (or animal) microbiome could exceed the total number of genes by a factor of 100-to-1. Many of these organisms have not been successfully cultured, identified, or otherwise characterized.



Anatomical variations in the microbiome

While pathogenic microbes can invade and grow within other organisms and cause disease and death, human and animal bodies contain trillions of microorganisms, living together with the body's cells, usually in harmony. Because of their small size however, microorganisms make up only about one to two percent of the body's mass. The operations and effects of these intricate systems of health-preserving microbes, along with their destructive disease-causing counterparts, are surprisingly little understood. In December 2008, the National Institutes of Health (NIH) launched the Human Microbiome Project to explore the roles these systems play. Part of the NIH's Roadmap for Medical Research, the Human Microbiome Project will distribute a total of $115 million to researchers over five years. Initially, researchers will sequence 600 microbial genomes, completing a collection that will then total 1,000 genomes. Researchers will take samples of the microbial communities from several human body regions including digestive tract, mouth, skin and female urogenital tract.

The NIH funding for the Microbiome Project is for the human microbiome but the findings will doubtlessly be relevant to animals as well since humans share many of the same microorganisms with animals. However, imagine the microorganisms to be found in pigs living by foraging in the sewers around the world, or those found in fish taken from polluted rivers. The elucidation of the oral microbiome of humans compared to cats may explain why cats often develop severe gingivitis and stomatitis due to their *Bartonella* infections whereas humans do not. Maybe the "other" microorganisms of the microbiome in the mouth of cats complement *Bartonella* to induce the inflammatory process. In this regard, the Nobel laureate Joshua Lederberg stated "We should think of each host and its parasites as a superorganism…"

7) Exoplanets:

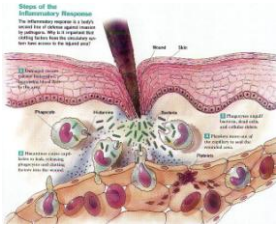
A planet is a celestial body (like the earth) other than a comet, meteor, or satellite that revolves around a sun. In 1584 Giordano Bruno stated "There are countless suns and countless earths all rotating around their suns in exactly the same way as the seven planets of our system." Little did it matter that he was correct in his observations. Society back then was even more hostile to scientific thought than now since Bruno spent 7 years in a dungeon and then was burned at the stake in Rome.

During the past decade scientists have found hundreds of planets outside of our solar system and called them "exoplanets." In 2000 there were 26 known exoplanets whereas, by the end of the decade, there numbered 505 and still counting. Scientists expect to find several Earth-like exoplanets which may be suitable for life as we know it.

8) Inflammation:

Inflammation gained much attention from scientists and the general public during the past decade. Large circulation popular publications such as Time Magazine (2004) produced entire issues devoted to inflammation as the sole or as a contributing factor for such conditions as heart disease, Alzheimer's disease and cancer. In veterinary medicine, infections with bacteria such as *Borrellia*, *Bartonella* and *Ehrlichia* were shown to produce clinical disease by inducing chronic inflammation.

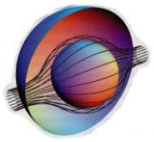
The inflammatory process can be divided into acute and chronic. Acute inflammation was thought to be a beneficial process that rebuilt tissue damaged by trauma or infection. Although still true, when inflammation becomes a chronic process it has been shown to be a major factor causing diseases that will kill most animals including humans. Evidence now points to chronic inflammation as a driving force in all animals, including humans, for cancer, diabetes, Alzheimer's and other neurological diseases, atherosclerosis, and chronic infectious diseases such as Lyme disease and bartonellosis.



Acute inflammation due to a splinter

9) Metamaterials

Metamaterials work by steering light and other electromagnetic waves and thus make it possible to steer light around objects creating an artificial blind spot.



Reproduced from Science 330:1622, 2010.

The physics behind this field are beyond the scope of this newsletter but the hope is that metamaterials will be able to benefit mankind.

10) Climate change research:

The headline in Science stated "Climatologists Feel the Heat as Science Meets Politics. In 2007 the United Nations Intergovernmental Panel on Climate Change (IPCC) reached a solid scientific consensus: "Warming was 'unequivocal,' it was very likely due mostly to human beings, and natural processes were very unlikely to blunt its strength."

Climate change iconic pictures

However, despite this overwhelming scientific world consensus, the United States refused to sign the Kyoto Protocol, an emission-limiting treaty that 187 countries had already ratified 3 years earlier. Many climate experts now think that mankind will have to adapt to a warming planet since there likely will be no political will to mitigate emissions in the near future. Due to the warming of the earth, which will displace both wild animals and humans and probably result in closer co-habitation, veterinarians may see an increase in existing diseases or see new diseases develop. In this regard, most new "emerging" human diseases of the past decade have emerged from animals. Increased temperatures may increase flea and tick populations and thus increase *Bartonella* infections of cats, dogs and people.

Veterinary Medicine:

What have been the major veterinary medical accomplishments of the first decade of the 21st century? As author of our Newsletters, Dr. Hardy chooses the following: 1) declaration of the elimination of Rinderpest from the earth, 2) the continual spread of chronic wasting disease (prion disease) in wild cervids, 3) cloning of Fido and Miss Kitty, 4) introduction of the FIV vaccine, 5) appearance of the canine flu virus, 6) development of stem cell therapy, 7) sequencing the dog genome, 8) women out-number men in veterinary medicine, 9) *Bartonella* comes of age, 10) One Health Initiative embraced by the AVMA.

Tasha, the Boxer whose genome was the first dog's genome to be assembled in 2005.