Innovación, Creatividad, Fecundividad, Descubrimiento, y Revelación

Aha! It is at your fingertips
and always in your imagination,
wherever you go!

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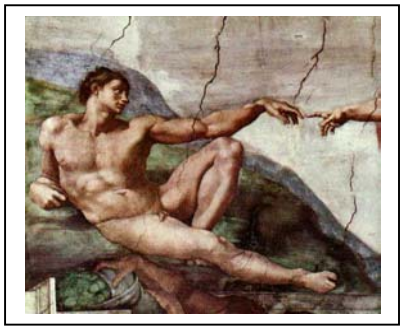
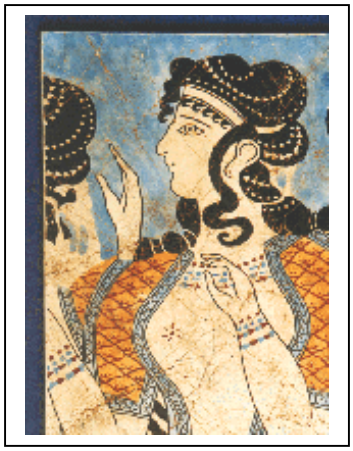
This article has five words in its title, all sharing similar meanings. Each is an aspect of what it means to be an innovator and inventor in the sciences or in many other walks of life. Here we will concentrate about things that are in science and of interest to young people as yourselves, things you may choose to explore, not only to learn the facts but to do something creative and new.

First of all, you must throw away all the preconceptions anyone has ever told you about science being necessarily difficult, boring, or something that will make you unpopular with your friends! If you are (and I am sure you really are) bright and inquisitive and with a lively spirit, then this will not be diminished if you spend some time reading, thinking, and even doing an experiment or two. You should also realize that science and art are not so far apart in real life, and in fact some famous people were masters in both activities - we just know them sometimes more for one thing or another - Leonardo da Vinci and Michelangelo from long ago, and Beatrice Wood from the last century.



Now, when you begin to realize that doing creative and innovative scientific exploration shares something in common with art and even with games, then you are on your way to even having some fun and you can start to think "what if" more often.

You see, when you think about those five words in the title, they all have the standard meanings, right out of the dictionary. But beyond that there is something deeper, and we can even learn something about our modern culture's use of words from looking at their ancient uses and histories. Innovation, creativity, discovery, all have to do fundamentally with fertility and birth and the revealing that goes on in birth and the life of a child growing up - only now we are talking about ideas, concepts, and a lot of "what ifs" that go on when someone is trying out a new kind of chemistry experiment, or a new way to grow cells or test a medicine on animals, or a new way to write software for a robot.



Our minds are constantly being fed with all sorts of stimuli and inputs that we don't even think about consciously, and we have all sorts of strange associations going on inside our brains, which occasionally in our modern world we remember and call them dreams, or daydreams. This is part of innovation and discovery! It is part of the fecundity inside our minds that is always going on, just like the dreams we have that we never remember. And when the dreaming comes in direct contact with the conscious, directed thoughts about solving particular problems, something that you have been given as a task to do, then that is where we stop being machines and show off our humanness, by daring to suggest and try something that was never tried before.

Innovation. Daring to bend the rules of the way things were always taught or shown or seen. Of course within some types of bounds and rules of common sense, but then, even there you have to allow that what you think is the edge of common sense may still be something you have to walk past, push a little, and you will discover that a whole new way of looking at a problem is - Born - and then that new way of thinking starts to govern what you are going to do and try in the course of your experiment.

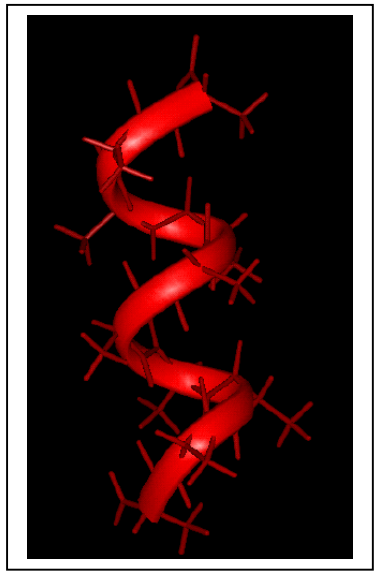
Another thing that you have to remember, and it is sometimes hard to realize but it is true - innovation and creativity and discovery come only because we as humans are always making mistakes! Invention and even survival come from mutations and "mistakes" in the way we do things - departures from the norm, the usual, the mechanical or instinctive way. If all we did is follow raw instinct, we would never invent, we would not discover, not build, and we would be probably extinct as a species long ago!

Instead, our brains are designed for being inexact and fuzzy in almost every kind of neural processing, and this is what helps us to classify and to recognize things that are themselves, as images, or sounds, or smells - or ideas and concepts - fuzzy and "rough around the edges." Just think about it awhile - for instance, how you ever came up with a shortcut to solving any problem, or a new recipe in the kitchen, or a new song on the guitar, or a new tactic you like to try in futbal. And then look at a baby starting to walk and think about how all those mistakes and falling over are not just accidents but experiments in finding what are the boundaries and limits for motion.

And so it goes on in life - we are exploring the bounds, the limits, and when we test to go beyond, that is part of innovation. When we stop doing that, we become complacent, maybe a little less bother to our peers or parents, but also less creative! But of course we have to use our accumulated knowledge and experience and memory to be able to judge where the boundaries are, or we will be apt to make big and wasteful, even costly mistakes.

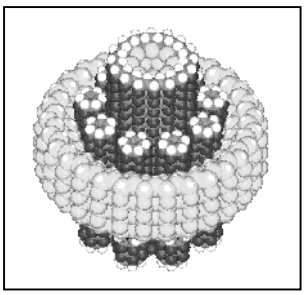
Well, having said all that, let's think of what could be some innovative experiments you can do that will help you to understand more about both the scientific subject and also your own creative inquiring spirit. You're probably thinking, this will be complicated, because almost always it seems you need special equipment and facilities to do the "really cool stuff." in science. I hope by the end of reading this you will see that that is not necessarily the case!

Let's talk about two things in science that seem miles apart. Biodiversity of species and the brand new field of nanotechnology that promises to revolutionize everything from computers to medicine to bridges to space travel. We live here in a country known for its diversity of species. Not just a lot but one of the densest concentrations of variety in insects and plants on the planet. How do they get to be that way? Well, of course there is the genetic model and we know about DNA and chromosomes. But and it is the various interactions proteins that results, ultimately, and smells and movements. To almost any single species of of doing a project to study how its close relatives, or how it is you might want to be daring about that species that is perhaps in the way it or shares itself as a host or acts else. You could look for just that species. Or you could study everything you can about molecular levels really makes gives it some special property or wings, the stronger eyes, the stronger poison. And then

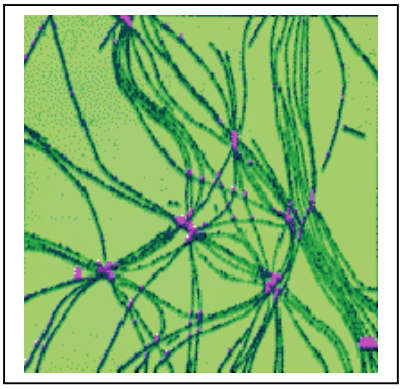


that give you only the code of so many thousands of in the structures and colors begin with you could pick animal or plan life and think that species is different from similar for that matter. But and look for something new different from anything else, reproduces, or moves, or eats, as a parasite to something behaviors that are special to go a big step further and what on the cellular and this species different and or behavior - the longer legs protective coloring, the again you might make a project for yourself to come up with a model, on paper or on the computer or something you could make like a sculpture, showing Your Idea, Your Creative Innovation, as to how there could be an artificial device that behaves like this creature. A robot that works like an insect. How would you get it to be really small? How might you get it to move and even smell like the real thing? You'll be surprised to know that this kind of science and engineering has been going on already for years, especially in Japan where microrobots have been studied and built, based on insects, for over fifteen years, and in the USA a scientist in Ohio actually filmed insects and horses, too, for hours and hours, and then he and his students successfully built one of the first six-legged robots.

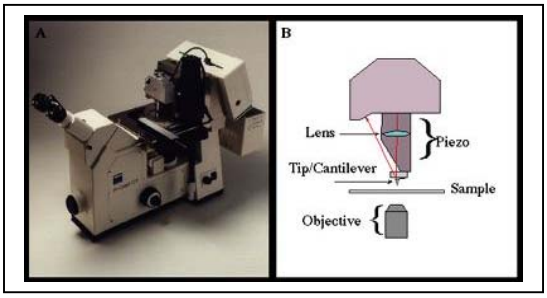
Now this is also a form of bioprospecting, and you've probably heard that word before, and if you haven't you should visit InBio or their web site (see below) and get acquainted with this special form of innovative exploration being pioneered right here by Costa Rican chemists and biologists.



Well now, if you really get into thinking about how to build an artificial butterfly or cucaracha (yucch! - pick something else, please!), then you just might want to learn about all this nanotechnology. Because when it comes down to it, your body, like that of the insects and the flowers they visit, is made of many tiny molecular machines, not just the enzymes and proteins and DNA but lots more, and because scientists love to come up with new names, this gets called nanotech and the tiny machines are nanobots. Nano, of course, means 1/1000 of a micro, so we are talking about 1/1,000,000 of 1mm and that is smaller than my good eyes can see!



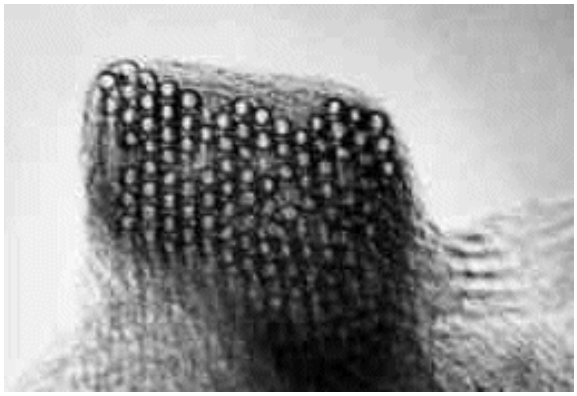
"Nano" also spells "innovation" because the whole field exists because of people making trials and guesses beyond the bounds, "outside the box." The first Atomic Force Microscope, which lets you "see" images of atoms by manipulating a tiny cantilever with interatomic forces, was invented in the 1980's by folks who said, "We know the limits with using light in regular microscopes, and we know how to do things with electron microscopes, but that doesn't let us do the things we want to do, including maybe being about to move atoms around like peas with a fork!" And thus the field of Scanning Probe Microscopy was born, gave Gunther Binnig and Heinrich Rohrer the Noble Prize in Physics (1986), and ushered in a revolution in almost every field of science. You wouldn't have a Pentium PC without it, and probably many other common household electronics like even cell phones.



Another fellow in Iowa thought, there ought to be as better way for working with seeing the surface of living cells and also what is going on inside them at the same time, and he broke the confines of standard thinking, and came up with a cool combination microscope that lets you see structures inside and how they change the surface on the outside, a powerful tool for biologists and medical researchers.

So as you can see from some of the pictures with this article, and from some of the links at the end that point you in the direction of exciting exploration and discovery, the famous physicist Richard Feynman was quite right when in 1956 he declared, "There's plenty of room at the bottom," meaning that one could conceivably build machines and even computers out of molecules and atoms like they were Lego building blocks. People didn't understand him back them, except a few, and it took about forty years before the ideas really caught on. Now NASA is thinking of building microrobots to explore on Mars out of strings that are thinner than the circuit lines in today's Pentium chips, that are made themselves out of simple carbon in a very simple process.

Discovered in 1992 by someone willing to think about "what if" you did it a different way that no one else had every tried.



Now you can't easily go create an experiment in your classroom or at home with nanotubes or nanomachines. But you can surely do some cool things on the computer including the construction of models that just might be possible to build out of molecules. This is something you can do through some of the links provided below. And then some one or two of you might start to wonder about how you can bring the nanotubes back up to the level of Giants like bacteria and cells and insects. Can you think of a way to put a drug into a tiny tube made of thousands of carbon atoms so that this drug will find only certain spots in the body and help treat infections, or cancer, or else seek out and find dangerous biotoxins or environmental poisons? Can you think of a way that microstrings of these nanotubes can be used to neutralize dangerous pests without the need for harmful chemicals that poison people and everything else that is good and alive as well? Can you think of a way to make an artificial virus out of molecular "spare parts" that might go into the body and fight off real killer viruses like ebola or smallpox?

If you can imagine, then you are starting to innovate and create. You just have to start putting it into a good and focused form and direction, and then start collecting the data, learning more about the bounds of what can and what should be, turning your Dream into a working hypothesis, finding a few ways to test it, and then you are on your way. And wherever you go, remember that you are always following your Dream, and never to give up on it!

Useful Links for Future Explorations:

Innovation and Creativity

http://dmoz.org/Science/Social_Sciences/Psychology/Creativity/
Like it says, with lots and lots of interesting links to essays and projects

http://kids.patentcafe.com/magazine/archives.asp
Articles by kids of different ages describing their scientific inventions

http://www.inventored.org/k-12/girlsinvent.html
More about child inventors, especially girls, and lots about different school projects

Da Vinci, Beatrice Wood, and Remarkable Women and Men in Science and Art

http://www.astr.ua.edu/4000WS/4000WS.html
4000 years of women in science - and you thought they were all staying in the village wile the men went off to battle!

http://www.mos.org/leonardo/
The quintessential Renaissance Man - just because it is not 15th century Italy does not mean there is not a need for more quibtessential Renaissance People - we need them more than ever and it can be You

http://www.beatricewood.com/intromenu.htm
The Beatrice Wood Studio - she pioneered special glazing and worked at her kiln up to age 104.

http://www.nobel.se/physics/laureates/1903/marie-curie-bio.html
Marie Curie, who opened up the path for much of modern medical technology

http://www.i-a-s.de/IAS/htm/frpinakothek.htm
Michelangelo and many others

http://womenshistory.about.com/cs/artists/
Some important women artists - not scientists also, but oinnovators in paint and other media

Biodiversity

www.biophotos.com
See what a local entomologist-artist does with his 1,000,000 specimen collections!

www.bioplanet.com/links.html
Vast resource on all sorts of bioscience especially with protein and genetic studies

www.inbio.ac.cr
InBio Institute right in San Jose (Heredia)

http://www.molec.com/gallery/index.html
Diversity at the molecular scale, an impressive image collection

www.biodiversity.org, www.biodiv.org, www.biodiversity.uno.edu
Three powerhouse resources for learning and discovery

Nanotechnology

http://www.foresight.org/Nanomedicine/Gallery/
Exactly what it sounds like. An impressive and provocative collection of images into a nanofuture.
www.di.com
Digital Instruments, makes of scanning probe microscopes, with a wonderful image library
http://itri.loyola.edu/nanobase/
Entry point to a vast collection of nanotech scientific information
http://www.pa.msu.edu/cmp/csc/NTSite/nanopage.html
All about nanotubes
http://www.cmp-cientifica.com/cientifica/
An important nanosite from Madrid, Spain
http://www.nano.sussex.ac.uk/gallery/
Another impressive gallery, and loads of technical information and links with it

About the Author:
Martin Dudziak is a physicist and mathematician who grew up in the United States, studied and taught and worked in many places around the world, served briefly as a scientist with Intel Corporation here in Costa Rica, and is currently developing a company based upon among other things nanotechnology and artificial intelligence. He resides near San Jose.

