

STEM Works: Biotechnology - Biology-based Activities and Exhibits with a Biotech Career Focus

An outreach program of The Leonardo www.theleonardo.org



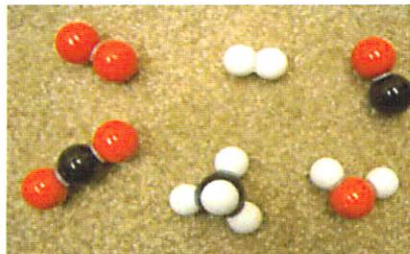
MOLECULES - Life's Building Blocks

Some 5 Billion years ago 92 elements (made by stars and supernova) coalesced into Planet Earth. You and all the stuff in and on the planet are made of those elements - star-stuff.. All 92 have their special place in the Periodic Table - the 'Mona Lisa' of Chemistry. Here's a simple version:

Periodic Table
of the Elements

1	2											10																			
3	4											18																			
11	12											18																			
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36														
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54														
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118

A key part of STEM is Chemistry, Biology uses Elements to produce Molecules (Chemists do that, too, but Biology figured it out 3 to 4 Billion years ago!). Here are the very simple Molecules which are the foundation of all Biology - of all Life:



- Activities at the Molecules exhibit included:
- making oxygen and hydrogen out of water --and putting them back together to make water again!
 - burning propane and forming water and carbon dioxide

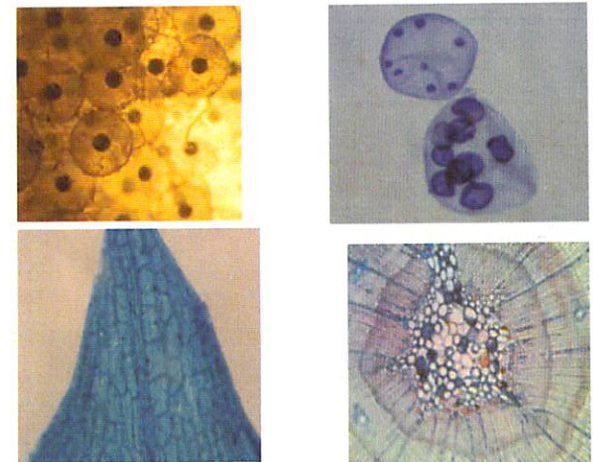
CELLS - Life's Basic Units

Cells are usually small - it takes microscopes to 'see' them (Molecules and Atoms are lots smaller, like 10,000 times smaller!). Cells are the basic units of all Life. There are simple ones and highly complex ones. There are very tiny cells and very large cells (did you have one - or two - for breakfast?).

Many Biotech careers involve cells: seeing and analyzing them, growing them, counting them, sorting them, and even killing the bad ones (like bad bacteria and cancer cells). Microbes are cells, bacteria are cells, you have lots of different kinds of cells. You are the creation of a fusion of an egg cell and a sperm cell.

Plant cells are very different from animal cells; bacteria are very different, too.

Here are a few of the (larger) cells you might have seen with the digital microscope (our little microscope isn't powerful enough to see most bacteria):



Careers, Jobs, You - and STEM

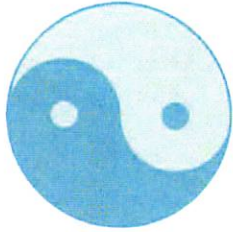
STEM is Science, Engineering, Technology, and Mathematics - the basis of much of our modern economy. As the diagram below shows, depending on your goals and needs, you can qualify for STEM-relevant jobs fresh out of high school, with some post high school Certificate training, with an Associates degree, or with a Bachelors degree. The more education, generally the better and more interesting the job - and the better salary! The most important factors are interest and curiosity.



Biotechnology is the Biology-based part of STEM. Biotech includes health and medicine, agriculture, pharmaceuticals, nutraceuticals, forestry,, environment, bio-energy, and a wide range of engineer or scientist assistant positions.

And you already know a lot of Biology - we all do. Our own cells and tissues, our breathing and respiration, our nutrition and movement.

The four STEM Works exhibits give you a hands on, personal, and interesting introduction to some of the basics of Biology - the rest is up to you. Let us know how we can help. For lots more information, go to: www.tinyurl.org/leospaces and click on Biology.



PHOTOSYNTHESIS - Using Carbon Dioxide

Life evolved several billion years ago. It really took off when early cells captured sunlight as energy to make molecules - the stuff needed for living things. Using CO₂ (Carbon dioxide) and H₂O (Water) photosynthetic cells make biochemicals - and throw away oxygen in the process.

Plants grow *from the air* - using the carbon in CO₂ as the major building block for all plant stuff - including the fuels you and the rest of the Animal Kingdom use as food. This is the Grand Balance of Planet Earth - our Grand Yin-Yang: Photosynthesis (Plants) and Respiration (You!).

Here's the process:



It's easy to see that plants produce Oxygen by looking at healthy green plants under water in bright light - see the tiny bubbles on the leaves and stems?



Activities at the Photosynthesis exhibit included:

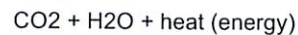
- Measuring YOUR CO₂ and O₂ with two cool sensors: inhale, exhale -- keep it up!
- Watching aquatic (aquarium) plants make oxygen - breath deeply.

RESPIRATION - Using Oxygen

You take in (inhale) Oxygen and you exhale CO₂ - that's Respiration. You use fuel as energy, 'burn' it (without fire) using Oxygen and make CO₂ and water - just like the propane burning activity in MOLECULES. Respiration IS combustion, except that Biology figured out how to do it without a match or flame.

Here's the process:

Fuel (made by plants) + O₂ -->



Respiration is the other half of the Grand Balance - the Grand Yang. Plants make Oxygen, we use it; we produce CO₂, plants use it. What a system - the great balance of Planet Earth. Oh, and Yes, you are like a Plant running backwards!

Another balance:

Energy IN = Energy OUT



You take Energy in as fuel (food), you use it to move: If you take in more than you use, guess what happens?!



Activities at the Respiration exhibit included:

- more O₂ and CO₂ detection - inhale, exhale -- deeply!
- Burn a peanut - how many Calories, how much energy?
- Visual pedometer - how many steps to 'burn' a peanut? A donut? A candy bar?



Back to YOU - Careers STEM: Biotechnology

Anatomy

surgical technician, physical therapist,
massage therapist

Biomanufacturing

Botany

forester, farmer, plant biotechnologist,
biofuels technician, algae culturist

Cell Biology

microscopist, cell biotechnologist, tissue culture,

Ecology

ecosystem management aide, landfill technician

Energy

biofuels, algae culture, human power

Genetics

molecular biotechnology, forensics technologist,
diagnostics technology

Marine Biology

oceanographic technician,

Microbiology

microbe biotechnologist, diagnostics technician,
microscopist

Paleontology

fossil technologist, museum aide

Pharmacy-Pharmaceutics

technicians and aides

Physiology

nursing assistant, nutrition aide, coach/trainer,
medical technician, dental technician

Zoology

veterinary assistant, wildlife biology, park ranger,
rancher, beekeeper

Resources: www.tinyurl.com/leospaces click Biology
www.theleonardo.org
www.utahfutures.org