

Traveling downstream from the KSC campus and Brickyard Pond:  
Main Stem

R1

The life and death of a pion and a muon are captured in a [bubble chamber](#), where gas glows brightly along the tracks of the particles. [Pions](#) and [muons](#) were first seen in [cosmic rays](#), the rain of high-energy particles from outer space. Muons were discovered 60 years ago by Carl Anderson and Seth Neddermeyer of [Caltech](#). Muons live for about 2.2 microseconds, and often survive to ground level, before [changing into electrons](#) and invisible [neutrinos](#). In 1947, ten years after the muon discovery, [Cecil Powell's](#) group at [Bristol University](#) discovered that the muons are produced by other particles - pions - which live for only a few hundredths of a microsecond. In this image, pions fly out from a collision in the streamer chamber. One of the pions makes the looping track to the right, before it decays into a muon, which then curls anticlockwise four times, and eventually changes into an electron which moves off towards the upper right.

[Source](http://hepweb.rl.ac.uk/ppUKpics/POW/pr_971015.html): [http://hepweb.rl.ac.uk/ppUKpics/POW/pr\\_971015.html](http://hepweb.rl.ac.uk/ppUKpics/POW/pr_971015.html)

**Photo Credit:** [CERN Photo](http://info.web.cern.ch/info/Press/PhotoDatabase/) (<http://info.web.cern.ch/info/Press/PhotoDatabase/>)

R2

Inserted in Delphi event record is a Feynman Diagram

In order to visualize and describe quantum electrodynamical interactions, physicist Richard P. Feynman introduced an ingenious schematic form of drawing now called a Feynman diagram. In such a diagram, all particles are represented by lines, with straight lines representing fermions and wavy lines representing bosons (except for the Higgs boson, which is usually represented by a dashed line, and gluons, which are usually represented by loops).

The diagram illustrated in the work represents the interaction of two electrons. Each electron is represented by a straight line, which exchange a (virtual) photon and then repel one other.

**Photo Credit:**

R3

DELPHI , Run 108629 Evt: 8412

DELPHI is the acronym for DEtector for Lepton, Photon and Hadron Identification. DELPHI is a Particle Physics experiment at the CERN laboratory in Geneva, Switzerland. It studies the products of electron-positron collisions at the LEP circular accelerator, working at the highest energies in the world.

[Source](http://hepweb.rl.ac.uk/ppUKpics/POW/pr_000329.html): [http://hepweb.rl.ac.uk/ppUKpics/POW/pr\\_000329.html](http://hepweb.rl.ac.uk/ppUKpics/POW/pr_000329.html)

[Info](http://delphiwww.cern.ch/offline/physics/pubdet2.html): <http://delphiwww.cern.ch/offline/physics/pubdet2.html>

**Photo Credit:** [CERN Photo](http://info.web.cern.ch/info/Press/PhotoDatabase/) (<http://info.web.cern.ch/info/Press/PhotoDatabase/>)

R4

Production of particle in the first CERN liquid hydrogen bubble chamber .

[Source](http://livefromcern.web.cern.ch/livefromcern/antimatter/history/historypictures/bub-event-half.jpg&imgrefurl=http://livefromcern.web.cern.ch/livefromcern/antimatter/history/AM-history02.html&h=511&w=765&sz=98): <http://livefromcern.web.cern.ch/livefromcern/antimatter/history/historypictures/bub-event-half.jpg&imgrefurl=http://livefromcern.web.cern.ch/livefromcern/antimatter/history/AM-history02.html&h=511&w=765&sz=98>

**Photo Credit:** [CERN Photo](http://info.web.cern.ch/info/Press/PhotoDatabase/) (<http://info.web.cern.ch/info/Press/PhotoDatabase/>)

R5

Astronomers at the Space Telescope Science Institute today (3/9/04) unveiled the deepest portrait of the visible universe ever achieved by humankind. Called the Hubble Ultra Deep Field (HUDF), the million-second-long exposure reveals the first galaxies to emerge from the so-called "dark ages," the time shortly after the big bang when the first stars reheated the cold, dark universe. The new image should offer new insights into what types of objects reheated the universe long ago.

Source : <http://hubblesite.org/newscenter/newsdesk/archive/releases/2004/07/text/>

**Photo Credit: NASA**

B1

Bank: "coalescing matter textures and imaginary tool for detecting the unknown (actually an impression of a chalk-line tool – the straight line is a core concept in mathematics which provides the framework for theoretical science)

R6

A black hole is an object with a concentration of mass great enough that the force of gravity prevents anything from escaping from it except through quantum tunneling behavior. The gravitational field is so strong that the escape velocity near it exceeds the speed of light. This implies that nothing, not even light, can escape its gravity, hence the word "black." The term "black hole" is widespread, even though it does not refer to a hole in the usual sense, but rather a region of space from which nothing can return.

Info : [http://en.wikipedia.org/wiki/Black\\_hole](http://en.wikipedia.org/wiki/Black_hole)

**Diagram by the artist**

R7

Image of the Eagle Nebula by NASA's Hubble Space Telescope

The picture was taken on April 1, 1995 with the Hubble Space Telescope Wide Field and Planetary Camera 2. These eerie, dark pillar-like structures are columns of cool interstellar hydrogen gas and dust that are also incubators for new stars. The pillars protrude from the interior wall of a dark molecular cloud like stalagmites from the floor of a cavern. They are part of the "Eagle Nebula" (also called M16 -- the 16th object in Charles Messier's 18th century catalog of "fuzzy" objects that aren't comets), a nearby star-forming region 7,000 light-years away in the constellation Serpens. Ultraviolet light is responsible for illuminating the convoluted surfaces of the columns and the ghostly streamers of gas boiling away from their surfaces, producing the dramatic visual effects that highlight the three dimensional nature of the clouds. The tallest pillar (left) is about a light-year long from base to tip. As the pillars themselves are slowly eroded away by the ultraviolet light, small globules of even denser gas buried within the pillars are uncovered. These globules have been dubbed "EGGs." EGGs is an acronym for "Evaporating Gaseous Globules," but it is also a word that describes what these objects are. Forming inside at least some of the EGGs are embryonic stars, stars that abruptly stop growing when the EGGs are uncovered and they are separated from the larger reservoir of gas from which they were drawing mass. Eventually, the stars themselves emerge from the EGGs as the EGGs themselves succumb to photoevaporation.

Source:

<http://grin.hq.nasa.gov/IMAGES/LARGE/GPN2000000987.jpg&imgrefurl=http://grin.hq.nasa.gov/BROWS E/HSTI.html&h=1973&w=1993&sz=1481&tbnid=nn0t84H6yvAJ:&tbnh=148&tbnw=150&start=48&prev=/i mages%3Fq%3Dhubble%2Bimages%2Bdeep%2Bspace%2B%2522nasa%2522%26start%3D40%26img sz%3Dxxlarge%26svnum%3D50%26hl%3Den%26lr%3D%26sa%3DN>

**Photo Credit: NASA**

B4

Prism: tool for studying light. Bends light according to wavelength (related to the color spectrum in the mural)

R8  
Sequence of crystal glazes (the crystallization of matter)

R9  
Pyrite Sun

A pyrite sun or dollar forms between tightly spaced layers of shale where the aggregate is forced to grow in a laterally compressed, radiating manner. Under normal conditions, pyrite would form cubes or pyritohedrons.

[Info: http://en.wikipedia.org/wiki/Crystal\\_habit](http://en.wikipedia.org/wiki/Crystal_habit)

**Courtesy Kim Lenz**

R10  
Black dot diagram based on the Laue diffraction pattern from a crystal of the plant enzyme Rubisco (ribulose biphosphate carboxylase/oxygenase). Rubisco is thought to be the most abundant protein in nature. Found in all plants it fixes carbon dioxide during photosynthesis.

R11  
Slice of a meteorite. A meteorite is a relatively small extra-terrestrial body that reaches the Earth's surface. While in space these bodies are called meteoroids and are called meteors after entering Earth's atmosphere, but before reaching the surface. These are "small" asteroids, approximately boulder-sized or less. Upon entering the atmosphere, air drag and friction cause the body to heat up and emit light, thus forming a fireball or shooting star.

[Info: http://en.wikipedia.org/wiki/Meteorite](http://en.wikipedia.org/wiki/Meteorite)

**Courtesy of Pete Nielson, Keene State College Geology Professor**

R12  
Drift of the continents from Pangaea to present.

Pangaea (Greek for "all lands") is the name Alfred Wegener used to refer to the supercontinent that existed during the Mesozoic era, before the process of plate tectonics separated the component continents.

[Info: http://en.wikipedia.org/wiki/Pangaea](http://en.wikipedia.org/wiki/Pangaea)

B7  
Plumb bob: gravitational pull

B8  
Sky map, an imaginary sphere around the earth for plotting the position of stars as seen from the earth (the small sphere in the center)

R13  
Water Molecules

An important feature of water is its polar nature. The water molecule forms an angle, with hydrogen atoms at the tips and oxygen at the vertex. Since oxygen has a higher electronegativity than hydrogen, the side of the molecule with the oxygen atom has a partial negative charge. A molecule with such a charge difference is called a dipole. The charge differences cause water molecules to be attracted to each other (the relatively positive areas being attracted to the relatively negative areas) and to other polar molecules. This attraction is known as hydrogen bonding, and explains many of the properties of water.

[Info: http://en.wikipedia.org/wiki/Water\\_%28molecule%29#Dipolar\\_nature\\_of\\_water](http://en.wikipedia.org/wiki/Water_%28molecule%29#Dipolar_nature_of_water)

**Photo Credit: Sarah Ashworth**

T1

A sequence suggestive of mud, water, and clay

T2

**Did life originally spring from clay?**

**By Alvin Powell**

Harvard News Office

Harvard researchers demonstrated how the first living cells may have formed in a series of experiments that indicate that clay can be an important catalyst for life. While the research is a far cry from proving that humans sprang from clay, as some creation myths assert, it does provide a possible mechanism for explaining how life initially arose from nonliving molecules. Researchers at the Howard Hughes Medical Institute and Massachusetts General Hospital showed that the presence of clay aids naturally occurring reactions that result in the formation of fatty sacks called vesicles, similar to what scientists expect the first living cells to have looked like. Further, the clay helps RNA form. The RNA can stick to the clay and move with it into the vesicles. This provides a method for RNA's critical genetic information to move inside a primitive cell, Harvard Medical School Professor of Genetics Jack Szostak said he and colleagues Martin Hanczyc and Shelly Fujikawa aren't suggesting they've hit on the exact method by which life initially arose. Still, he said, there are exciting parallels, including the fact that the clay aids in the creation of both the vesicles and the genetic material that would be needed to create a primitive cell.

[Source: http://www.news.harvard.edu/gazette/2003/11.06/01-liveclay.html](http://www.news.harvard.edu/gazette/2003/11.06/01-liveclay.html)

**Photo Credit: Photo Science Library**

T3

Transfer RNA molecule

Computer artwork of the double helix of tRNA (transfer ribonucleic acid), formed by spiralling paired strands of sugar phosphates, linked by nucleotide base pairs. Transfer RNA carries amino acid groups to ribosomes for protein synthesis. Protein synthesis is controlled by DNA (deoxyribonucleic acid, not seen) in the nucleus of a cell.

**Photo Credit: ALFRED PASIEKA//PHOTO RESEARCHERS, INC.**

T4

Morphological diversity found in a natural microbial community.

[Source:](http://doegenomestolife.org/gallery_batch/bergeys_web.jpg&imgrefurl=http://doegenomestolife.org/science/microbialfunction.shtml&h=161&w=150&sz=13&tbnid=lx8p2y09JFUJ:&tbnh=91&tbnw=85&start=6&prev=/images%3Fq%3DBergeys%26svnum%3D50%26hl%3Den%26lr%3D%26sa%3DG)

[http://doegenomestolife.org/gallery\\_batch/bergeys\\_web.jpg&imgrefurl=http://doegenomestolife.org/science/microbialfunction.shtml&h=161&w=150&sz=13&tbnid=lx8p2y09JFUJ:&tbnh=91&tbnw=85&start=6&prev=/images%3Fq%3DBergeys%26svnum%3D50%26hl%3Den%26lr%3D%26sa%3DG](http://doegenomestolife.org/gallery_batch/bergeys_web.jpg&imgrefurl=http://doegenomestolife.org/science/microbialfunction.shtml&h=161&w=150&sz=13&tbnid=lx8p2y09JFUJ:&tbnh=91&tbnw=85&start=6&prev=/images%3Fq%3DBergeys%26svnum%3D50%26hl%3Den%26lr%3D%26sa%3DG)

**Photo Credit: Frank Dazzo, Center for Microbial Ecology, Michigan State University**

R14

Diagram of the formation of eddies in a current

B10

Satellite detecting some type of matter

B11

## R15 a,b,c

Volvox colonies maturing

Volvox is one of the best known genera of green algae, and is the culmination of the evolution of spherical colonies. Each Volvox is composed of on the order of a thousand cells, each a biflagellate similar to Chlamydomonas, interconnected and arranged in a hollow sphere (a Coenobia), with a distinct anterior and posterior.

[Info:](http://en.wikipedia.org/wiki/Volvox) <http://en.wikipedia.org/wiki/Volvox>

**Photo Credit: Wim van Egmond**

## P1

Desmid alga, Closterium acerosum

Light micrograph of the freshwater green algae Closterium acerosum, an elongated, canoe-shaped desmid, seen here with filaments of Desmidium sp. (right). The remaining material visible here is decomposing organic matter. Magnification: x60 at 35mm size.

**Photo Credit: SIDNEY MOULDS / SCIENCE PHOTO LIBRARY**

## R16 a,b,c,d,e

Meiotic Sequence: Prophase I

Prophase I (the prophase of meiosis I) is the longest phase. In this phase, chromosomes shorten and become visible as single threadlike structures. Beaded appearances, if any, are due to the alternation of densely stained chromomeres in comparison with non-staining areas. Chromomeres are regions where the chromosomal material is tightly coiled.

Prophase I is subdivided into different stages:

Leptotene (a,b,c): chromosomes condense, the axial element of the synaptonemal complex (a protein lattice that keeps homologous chromosomes together) is formed.

Zygotene (d): The synaptonemal complex is formed (central and lateral elements) pairing homologous chromosomes, 1% of DNA that wasn't replicated during the S phase replicates.

Pachytene (e): starts right after the synaptonemal complex is fully formed (when synapsis ends), crossing over occurs.

Diplotene: synaptonemal complex disassembles (homologous chromosomes are kept together by recombination nodules), there is cellular growth and genetic transcription (and so chromosomes are seen less condensed)

Diakinesis: chromosomes condense again, Chiasmata (visual evidence of crossing over) can be seen.

[Info:](http://en.wikipedia.org/wiki/Meiosis#ProphaseI) <http://en.wikipedia.org/wiki/Meiosis#ProphaseI>

**Photo Credit: Dr. Denise Zickler, Institut Genetique et Microbiologie, U. Paris-Sud, Orsay, France**

## R17 a,b,c,d,e

Radiolaria sequence: progressive evolution of form

Radiolaria are amoeboid protozoa that produce intricate mineral skeletons, typically with a central capsule dividing the cell into inner and outer portions, called endoplasm and ectoplasm. They are found as plankton throughout the ocean, and their shells are important fossils found from the Cambrian onwards.

[Source:](http://www.microscopy-uk.org.uk/mag/artjun99/bdradio.html) <http://www.microscopy-uk.org.uk/mag/artjun99/bdradio.html>

[Info:](http://en.wikipedia.org/wiki/Radiolaria) <http://en.wikipedia.org/wiki/Radiolaria>

**Photo Credit: Wim van Egmond**

B12

Suggestion of simple life forms; some bacteria form chains.

B13

Bank: chain impression:

P2 & P3

Human stem cells

Stem cells are primal, undifferentiated cells which have the unique potential to produce any kind of cell in the body. Many medical researchers believe stem cells have the potential to revolutionize medicine, enabling doctors to repair specific tissues or to grow organs.

[Info: http://en.wikipedia.org/wiki/Stem\\_cell](http://en.wikipedia.org/wiki/Stem_cell)

**Photo Credit: Doug Melton, Melton Lab of Molecular Embryology, Harvard University**

R18

Starfish larvae

Sea stars or starfish are animals belonging to phylum Echinodermata, class Asterozoa. The names sea star and starfish are also used for the closely related brittle stars, which make up the class Ophiurozoa. They exhibit a superficially radial symmetry, typically with five or more "arms" protruding from a central body (pentaradial symmetry). In fact, their evolutionary ancestors are believed to have had bilateral symmetry, and sea stars do have some remnant of this body structure.

[Info: http://en.wikipedia.org/wiki/Starfish](http://en.wikipedia.org/wiki/Starfish)

**Photo Credit: Wim van Egmond**

B18

Hand lens

B19

Fossil crinoid crown

Crinoids, also known as "sea lilies" or "feather-stars", are marine animals that make up the class Crinozoa of the echinoderms (phylum Echinodermata). They live both in shallow water and in depths as great as 6000 meters. Crinoids are characterized by a mouth on the top surface that is surrounded by feeding arms. Although the basic echinoderm pattern of five-fold symmetry can be recognized, most crinoids have many more than five arms.

[Info: http://en.wikipedia.org/wiki/Crinoid](http://en.wikipedia.org/wiki/Crinoid)

**Complements Geology Department, Keene State College**

R20

R21

R22

R23

R24

R25

R26

Diatoms

Diatoms are the most common of the eukaryotic algae. They belong among the heterokonts along with the golden and brown algae, as shown by the pigmentation of the chloroplasts and the structure of the

gametes, although these have lost the mastigonemes found in other such groups. Most diatoms are single cells and live between two silicate shells collectively called a frustule or a test, one overlapping the other like the two halves of a petri dish.

[Info: http://en.wikipedia.org/wiki/Diatoms](http://en.wikipedia.org/wiki/Diatoms)

**Photo Credit:**

T5

Human red blood cells

Oxide colorants in an acid medium migrate through an alkaline clay slip to suggest cellular forms that progress from blue to red as do blood cells during capillary oxygen exchange.

**Photo Credit: Photo Science Library**

TB3

The shape of this tributary is suggestive of an animal. There is an hypodermic needle in thigh of animal.

R27 a,b,c,d,e

Desmid division

Desmids are the *Desmidiaceae* class of green algae, comprise around 40 genera and more than 10000 species, found mostly but not exclusively in freshwater. Most are unicellular, and are divided into two compartments separated by a narrow bridge or isthmus. Desmids assume a variety of highly symmetrical and generally attractive shapes, which provide the basis for their classification.

[Info: http://en.wikipedia.org/wiki/Desmid](http://en.wikipedia.org/wiki/Desmid)

**Photo Credit: Wim van Egmond**

R28

R29

Fan-shaped diatoms

Diatoms are the most common of the eukaryotic algae. They belong among the *heterokonts* along with the golden and brown algae, as shown by the pigmentation of the chloroplasts and the structure of the gametes, although these have lost the mastigonemes found in other such groups. Most diatoms are single cells and live between two silicate shells collectively called a frustule or a test, one overlapping the other like the two halves of a petri dish.

[Info: http://en.wikipedia.org/wiki/Diatoms](http://en.wikipedia.org/wiki/Diatoms)

**Photo Credit: Wim van Egmond**

R30

Gastropod

The gastropods, or univalves, are the largest and most successful class of mollusks, with 60,000-75,000 species, and second largest class of animals, with over 100,000 species, comprising the snails and slugs as well as a vast number of marine and freshwater species. They typically have a well-defined head with two or four sensory tentacles, and a ventral foot, which gives them their name (Greek gaster, stomach, and poda, feet).

[Info: http://en.wikipedia.org/wiki/Gastropod](http://en.wikipedia.org/wiki/Gastropod)

**Photo Credit: Wim van Egmond**

B19

Suggestion of bird fossil

B20

Suggestion of bird or shell fossil print

R31

**Lembadion protozoan.** Coloured scanning electron micrograph (SEM) of a Lembadion bullinum protozoan (single-celled animal). It is a ciliate protozoan, normally having numerous fine hairs (cilia) around its mouth (green), although these have been removed here. It lives in fresh water and eats other small organisms. Protozoa such as this are being used in biotechnology research at Axiva (part of Aventis) in Frankfurt, Germany. They are being studied to see if they can be used to make useful biologically active chemicals such as enzymes, polyunsaturated fatty acids (PUFAs) and antibiotics.

**Photo Credit: VOLKER STEGER / CHRISTIAN BARDELE / SCIENCE, PHOTO LIBRARY**

R32 (Background to R33 a-d)

Quantum Wave

In this image, a quantum wave builds up in a resonant cavity between the straight and curved walls, when waves are arriving from below. Most of the wave energy is reflected back, but a surprisingly large fraction of it gets through the tiny hole if the wavelength is just right to make the cavity resonant. Prof. Robert Westervelt and his research group invented the "Westervelt resonator" around 1995 at Harvard University, for the purpose of investigating electron waves. In this picture you see various aspects of waves all acting together: reflection, diffraction, and resonance. The whole device is just a few microns across, or smaller than a bacterium.

Source: <http://www.ericjhellergallery.com/index.pl?page=image;iid=35>

**Photo Credit: Eric Heller**

R33 a,b,c,d,e

Five ways of visualizing a simple molecule

**Rendered by Pymol**

R34

Silicon atoms

A scanning tunneling microscope image of silicon atoms deposited onto a silicon crystal. The size of the image is about 150 Angstroms.

**Photo Credit: Brian Swartzentruber**

B21

Calipers

B22

Mysterious form

B23

Mysterious plantlike form

B24

B25

Surface eruptions

B26 Instrument suggestive of monitoring surface pressure

R35 Silica vein intruding into sedimentary layers

**Courtesy Nancy Selvage**

B27 Spiral shell impressions arranged in a Fibonacci Spiral

A logarithmic spiral, equiangular spiral or growth spiral is a special kind of spiral curve that often appears in nature. One can construct approximate logarithmic spirals using Fibonacci numbers or the golden mean. Fibonacci sequences have been noted to appear in the branching patterns of leaves in grasses and flowers, branching in bushes and trees, the arrangement of tines on a pine cone, seeds on a raspberry and the like.

[Info:](http://en.wikipedia.org/wiki/Golden_spiral) [http://en.wikipedia.org/wiki/Golden\\_spiral](http://en.wikipedia.org/wiki/Golden_spiral)

[Info:](http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat.html#spiral) <http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat.html#spiral>

[Info:](http://en.wikipedia.org/wiki/Fibonacci_number) [http://en.wikipedia.org/wiki/Fibonacci\\_number](http://en.wikipedia.org/wiki/Fibonacci_number)

B28 Fossil; Phylum Brachiopoda (Lower Cambrian to present)

Fossil brachiopod with marginal spines (used for dating sedimentary rock).

B29 Sea urchin casts and impression

Sea urchins are spiny sea creatures found in oceans all over the world. (The name sea urchin means sea hedgehog, hedgehog being one meaning of the word urchin). Their shell, which biologists call the test, is globular in shape, and covered with spines. The size of the test in adults is typically in the range of 3 to 10 cm.

[Info:](http://en.wikipedia.org/wiki/Sea_urchin) [http://en.wikipedia.org/wiki/Sea\\_urchin](http://en.wikipedia.org/wiki/Sea_urchin)

R36 Fractal image: Rainbow Eddy

A fractal is a geometric object which is rough or irregular on all scales of length, and so which appears to be 'broken up' in a radical way. Some of the best examples can be divided into parts, each of which is similar to the original object. Fractals are said to possess infinite detail, and they may actually have a self-similar structure that occurs at different levels of magnification.

[Source:](http://www.fractalus.com/gallery/image/rainbow-eddy/?gallery=3) <http://www.fractalus.com/gallery/image/rainbow-eddy/?gallery=3>

[Info:](http://en.wikipedia.org/wiki/Fractal) <http://en.wikipedia.org/wiki/Fractal>

**Photo Credit: Damien M. Jones**

R37 This image results from a simplified version of a mathematical "map", which is like each house in a development having a unique "sister" house. There is a funny address book, which just says for each house what its sister house is that it must send letters to. Each house receives letters from just one other house and sends them to just one house. Either house can be itself, which is very rare, or the sending and receiving houses could be the same house, which is also rare. Typically the letter goes on a long journey, which either closes on itself in a simple way or fills a whole region of houses. Suppose a letter is sent from a house to its sister house. The sister sends it on to its sister, etc. All sister houses are somewhere in the same development. Now, it is not obvious (and not true in general) that the letter will reach all the houses in the development. Eventually however it must come back to the house where it

originated, even if it has to go to every other house first. Even the same address book, or map, can differ wildly as to how many houses are reached from a given house. If there were 1000 houses in the development, some houses would reach only a few others before the letter came back, and others could reach 100 or 500. What you see here is the result of sending about 500 "letters" in a development of about 5 million houses.

[Source:](http://www.ericjhellergallery.com/index.pl?page=image;iid=1) <http://www.ericjhellergallery.com/index.pl?page=image;iid=1>

**Photo Credit: Eric Heller**

R38

Banded Iron Formation

Banded Iron Formations are a distinctive type of rock often found in old sedimentary rocks. The structures consist of repeated thin layers of iron oxides, either magnetite or hematite, with bands of shale and chert. Some of the oldest known rock formations dated around 3,000,000,000 years before present, 3000MA, include banded iron layers, and the banded layers are a common feature in sediments for much of the Earth's early history. Banded iron beds are less common after 1800MA although some are known that are much younger.

[Info:](http://en.wikipedia.org/wiki/Banded_iron_formation) [http://en.wikipedia.org/wiki/Banded\\_iron\\_formation](http://en.wikipedia.org/wiki/Banded_iron_formation)

**Courtesy Geology Department, Keene State College**

R39

Reynold's Number Formula

The Reynolds number is the most important dimensionless number in fluid dynamics and provides a criterion for determining dynamic similarity. Where two similar objects in perhaps different fluids with possibly different flowrates have similar fluid flow around them, they are said to be dynamically similar.

[Info:](http://en.wikipedia.org/wiki/Reynolds_number) [http://en.wikipedia.org/wiki/Reynolds\\_number](http://en.wikipedia.org/wiki/Reynolds_number)

**Photo Credit:**

P4a

Somatotropin growth hormone

Computer graphic of a molecule of the protein somatotropin, the human growth hormone. It is produced by the anterior lobe of the pituitary gland. Somatotropin causes growth in all or most parts of the body by affecting many metabolic functions, especially the production of proteins. It is a large molecule, being formed of 191 amino acids and having a molecular weight of 22,005. Its production is regulated by the brain's hypothalamus. Over-production causes gigantism and acromegaly, whilst a deficiency leads to dwarfism.

**Photo Credit: ALFRED PASIEKA / SCIENCE PHOTO LIBRARY**

P4b

Stonefly nymph

**Illustration Credit: P. W. Claassen**

P4c

Stonefly nymph

**Photo Credit: David Moon**

P4d

Stonefly adult

Plecoptera are an order of insects, commonly known as stoneflies. There are some 2,000 species worldwide. These are aquatic insects whose nymphs (immatures) live in streams (running waters) while the adults live in the air. The presence of stonefly nymphs is among the best indicators that a river is clean and healthy.

[Info:](http://en.wikipedia.org/wiki/Plecoptera) <http://en.wikipedia.org/wiki/Plecoptera>

**Photo Credit: Yves Dubuc**

R40

R41

Charts of the nuclides (elements and their family of isotopes) the second showing the limits of observations (yellow area), the drip lines, and the astrophysical rp- and r- process pathways

[Source:](http://www.ph.surrey.ac.uk/%7Ephs1wc/SIRIUS-science-pix.html) <http://www.ph.surrey.ac.uk/%7Ephs1wc/SIRIUS-science-pix.html>

**Photo Credit: Wilton Catford**

R42

Diagram of a coronal emission event (a well known one) as recorded using radio waves

Represents radio emissions from shock fronts moving (left to right) from the Sun to Earth. The shock fronts are being driven in both cases by large explosions called coronal mass ejections on the sun. The WAVES instrument is one of about 8 instruments on the Wind spacecraft, which sits on a 'line' between sun and Earth about 4 times the moon's distance from Earth. Wind's job is to monitor solar events with particles and fields instruments for the study of 'space weather' -- a new field of research that tries to predict when solar events will impact Earth.

[Source:](http://sohowww.nascom.nasa.gov/) <http://sohowww.nascom.nasa.gov/>

**Photo Credit: SOHO – NASA – WAVE**

T6

Electron flow pattern juxtaposed with the sun

The Transport series renders electron flow paths in a "two dimensional electron gas" (2DEG), Inspired by the experiments of Mark Topinka, Brian Leroy, and Prof. Robert Westervelt at Harvard. Our group was responsible for the theoretical treatment of the problem, primarily Scot Shaw, and myself.

Exponential is based on the electron flow patterns for electrons riding over a bumpy landscape, which is what they encounter in the 2DEG. The electrons have more than enough energy to ride over any bump in the landscape, and the concentrations of electron flow seen here are unexpected indirect effects of that bumpy ride. The channeling or branching was a surprise, and has real implications for small electronic devices of the future. "Exponential" gets its name from the exponential divergence of trajectories which start out very close to each other. This is a hallmark of the unstable dynamics which leads to chaos. Over 100,000 individual electron paths were traced out, starting at the top right, where they were launched on their journey, each with a slightly different direction. In this image, the white regions show the paths preferred by the electrons. Some paths taken by individual electrons can be seen. Code written in Fortran computed the trajectories, and wrote information about them to a very large raster image. The algorithm used to write to pixels which had already been accessed by previous electron paths gives the the peculiar shading and form to this image. The electron tracks in Exponential are an excellent example of the wonderful way nature emulates herself in different contexts. The branching pattern is reminiscent of familiar natural forms.

[Source](http://www.ericjhellergallery.com/index.pl?page=image;iid=7): <http://www.ericjhellergallery.com/index.pl?page=image;iid=7>

**Photo Credit: Eric Heller**

T7

Photo of the sun with solar flares

A solar prominence is a large bright feature located in the solar corona. While the corona consists of extremely hot gases which do not emit much visible light, prominences contain much cooler gas, similar in composition to that of the chromosphere. A prominence forms over timescales of about a day, and may persist in the corona for several weeks.

[Info](http://en.wikipedia.org/wiki/Solar_prominence): [http://en.wikipedia.org/wiki/Solar\\_prominence](http://en.wikipedia.org/wiki/Solar_prominence)

**Photo Credit:**

B32

Imaginary instrument for measuring (something)

B33

Bank: Tuning fork (metaphorical reference to the “music of the spheres”)

R43

Solar flare

**Photo Credit:**

R44

Interpretation of energy waves from the sun reaching towards a chloroplast for photosynthesis

**Photo Credit:**

B34

B35

Tool to measure size

B36

B37

B38

Bank: Floral impressions

B39

Tool to study plants

B40

Magnifying glass

B41

Tool to study plants

B42

??? of plant cells

R45

B43

Tool for collecting pollen seeds or dew

R45

Electron scanning micrograph of a pea chloroplast

Coloured transmission electron micrograph (TEM) of two chloroplasts seen in the leaf of a pea plant *Pisum sativum*. Each chloroplast is seen cut lengthways and contains stacks of flattened membranes (yellow) known as grana. The chloroplasts are surrounded by an external double membrane. The grana contain the chlorophyll pigments, where light reactions occur during photosynthesis. Light and carbon dioxide are converted into carbohydrates by the chloroplast. Large sites of starch produced during photosynthesis are seen as dark circles within each chloroplast. Magnification: x16,000 at 5x7cm size. x56,000 at 8x10"size.

**Photo Credit: DR KARI LOUNATMAA / SCIENCE PHOTO LIBRARY**

R46

Tobacco chloroplast

False-colour transmission electron micrograph of a chloroplast from a leaf of the tobacco plant, *Nicotiana tabacum*. Chloroplasts are the sites of photosynthesis in green plants. The threadlike structures running the length of the chloroplast are grana, stacks of flattened membranes that contain the photosynthetic pigments, or chlorophylls. These pigments absorb & convert the Sun's energy into the chemical energy required by the plant. The faint white patches within the chloroplast are called nucleoids, where chloroplast DNA is stored. Magnification: x6300 at 35mm size, x44,000 at 8x10-inch size.

**Photo Credit: DR JEREMY BURGESS / SCIENCE PHOTO LIBRARY**

R47

Aerial view of the Connecticut River. Watershed (including Keene and the Ashuelot River)

**Photo Credit:**

B44

Imaginary tool for pumping fluid

P6

Leaf microtubules

*Arabidopsis* leaf epidermal cells transformed with GFP-tubulin to show the pattern of microtubules that regulate cell morphogenesis.

[Source:](http://www.cepceb.ucr.edu/gallery/gallery.htm) <http://www.cepceb.ucr.edu/gallery/gallery.htm>

**Photo Credit:**

P7 a,b,c,d,e,f,g

Micrographs of Pear Leaf Cells – mesophylls, xylem & phloem, stoma

[Source:](http://biology.clc.uc.edu/fankhauser/Labs/Cell_Biology/pear_leaf_histology.html) [http://biology.clc.uc.edu/fankhauser/Labs/Cell\\_Biology/pear\\_leaf\\_histology.html](http://biology.clc.uc.edu/fankhauser/Labs/Cell_Biology/pear_leaf_histology.html)

**Photo Credit:**

T9

The image shows the ventral ganglion in the brain of a fruit fly larva (third instar *Drosophila* larva) expressing Green Fluorescent Protein specifically in motor neurons.

[Source:](http://www.bio.brandeis.edu/griffithlab/) <http://www.bio.brandeis.edu/griffithlab/>

**Photo Credit: James Hodge**

B45

Banksia Seed Pod

Banksia is a genus of the Proteaceae, named after the great English botanist Sir Joseph Banks, of the Cook expedition in 1768. They are native to Australia, growing in the form of shrubs and trees (they are also known as Australian Honeysuckle Trees). The smallest banksias are prostrate miniatures and the largest are fully-grown trees.

[Info:](http://en.wikipedia.org/wiki/Banksia) <http://en.wikipedia.org/wiki/Banksia>

B46

Dissection tool

R48

Circuit board

A printed circuit board consists of "printed wires" attached to a sheet of insulator. The conductive "printed wires" are called "traces". The insulator is called the substrate, and is made of 'Pertinax' (a phenol formaldehyde resin) or a fiberglass-reinforced epoxy composite material.

[Info:](http://en.wikipedia.org/wiki/Circuit_board) [http://en.wikipedia.org/wiki/Circuit\\_board](http://en.wikipedia.org/wiki/Circuit_board)

**Photo Credit:**

P8

Plant protein molecules that have potent anti-cancer qualities

**Photo Credit:**

Upper Oxbow: Abstract squiggly forms

Upper tributary:

B47

Fluid collector

B48

flask

T8

Zebra fish embryos

The Zebra Danio or Zebrafish (*Brachydanio rerio* or *Danio rerio*) is a tropical fish belonging to the minnow family (Cyprinidae). Originating in Eastern India, it grows to about 2 inches (6 cm) and lives for around 5 years. There are long-finned and other color forms of this danio.

[Info:](http://en.wikipedia.org/wiki/Brachydanio_rerio#Genetical_model_organism) [http://en.wikipedia.org/wiki/Brachydanio\\_rerio#Genetical\\_model\\_organism](http://en.wikipedia.org/wiki/Brachydanio_rerio#Genetical_model_organism)

**Photo Credit: Paul Myers**

P9

Aquatic crustaceans

Composite image of light micrographs of aquatic planktonic crustaceans with strands of filamentous algae. The four crustaceans seen are: a water flea (suborder Cladocera, upper left), a seed shrimp (*Cyclocypris* sp., upper right), a copepod (*Cyclops* sp., lower right) and the nauplius larva of a copepod crustacean (lower left). Dark field illumination. Magnification unknown.

**Photo Credit: LAGUNA DESIGN / SCIENCE PHOTO LIBRARY**

B49

Tool for measuring pressure

T10

Folate Biosynthetic Enzyme (HPPK)

Folates are essential for all organisms. Mammals are unable to synthesize folates but have an active transport system for deriving folates from the diet. In contrast, most microorganisms must synthesize folates de novo because they lack the active transport system. Thus, the folate biosynthetic pathway is an attractive target for developing antimicrobial agents.

[Source](http://www.bch.msu.edu/faculty/yan/moreYan.html): <http://www.bch.msu.edu/faculty/yan/moreYan.html>

**Photo Credit: Hoggao Yan**

B50

Sensitive pressure sensor

R49

Cellular Automata

A cellular automaton (plural: cellular automata) is a discrete model studied in computability theory and mathematics. It consists of an infinite, regular grid of cells, each in one of a finite number of states. The grid can be in any finite number of dimensions. Time is also discrete, and the state of a cell at time  $t$  is a function of the state of a finite number of cells called the neighborhood at time  $t-1$ . These neighbors are a selection of cells relative to some specified, and does not change (Though the cell itself may be in its neighborhood, it is not usually considered a neighbor). Every cell has the same rule for updating, based on the values in this neighbourhood. Each time the rules are applied to the whole grid a new generation is produced.

[Info](http://en.wikipedia.org/wiki/Cellular_automata): [http://en.wikipedia.org/wiki/Cellular\\_automata](http://en.wikipedia.org/wiki/Cellular_automata)

**Photo Credit: Stephen Wolfram**