COVER
A metaphorical USB cable transmitting genetic information to “reprogram” cells symbolizes the Breakthrough of the Year for 2008. Advances in the burgeoning field of cellular reprogramming have brought scientists closer to the goal of using stem cells to better understand and someday treat disease. See the special section beginning on page 1766.

Image: Chris Bickel

SPECIAL SECTION
Breakthrough of the Year

WINNER
Reprogramming Cells 1766

RUNNERS-UP
Seeing Exoplanets 1768
Cancer Genes 1769
New High-Temperature Superconductors 1770
Watching Proteins at Work 1770
Water to Burn 1770
The Video Embryo 1771
Fat of a Different Color 1771
Proton’s Mass ‘Predicted’ 1772
Sequencing Bonanza 1773

OTHER FEATURES
Phenomenon of the Year: European Big Science 1769
Scorecard: Rating Last Year’s Areas to Watch 1770
Breakdown of the Year: Financial Meltdown 1772
Areas to Watch 1773

>> Editorial p. 1757; for related online content, see p. 1751 or go to www.sciencemag.org/btoy2008/

DEPARTMENTS
1751 Science Online
1753 This Week in Science
1758 Editors’ Choice
1760 Contact Science
1763 Random Samples
1765 Newsmakers
1806 AAAS News & Notes
1869 New Products
1870 Science Careers

EDITORIAL
1757 Celebrating a Year of Science by Bruce Alberts
>> Breakthrough of the Year section p. 1766

NEWS OF THE WEEK
Nobelist Gets Energy Portfolio, Raising Hopes and Expectations 1774
Obama’s Choice to Direct EPA Is Applauded
Signs of Drug Resistance Rattle Experts, Trigger Bold Plan 1776
DOE Picks Michigan State Lab for Rare-Isotope Accelerator 1777

SCIENCE SCOPE
Rangers Assess Toll of Congo Conflict on Threatened Mountain Gorillas 1778
Report Faults U.S. Strategy for Nanotoxicology Research 1779
From the Science Policy Blog 1779

NEWS FOCUS
Europa vs. Titan 1780
Zack Booth Simpson: An Artist Develops a New Image—With Aid of Bacteria 1782
Materials Research Society Fall Meeting 1784
Shortfalls in Electron Production Dim Hopes for MEG Solar Cells
Protein Chip Promises Cheaper Diagnostics
Graphene Recipe Yields Carbon Cornucopia
Does ‘Junk Food’ Threaten Marine Predators in Northern Seas? 1786
SCIENCE EXPRESS
www.sciencexpress.org

PALEOCLIMATE
Foraminiferal Isotope Evidence of Reduced Nitrogen Fixation in the Ice Age Atlantic Ocean
H. Ren et al.
Nitrogen fixation in the tropical Atlantic increased during deglaciation and, along with increased denitrification, helped to stabilize the ocean nitrogen reservoir.
10.1126/science.1165787

PLANT SCIENCE
Glucosinolate Metabolites Required for an Arabidopsis Innate Immune Response
N. K. Clay, A. M. Adio, C. Denoux, G. Jander, F. M. Ausubel
10.1126/science.1164627
A Glucosinolate Metabolism Pathway in Living Plant Cells Mediates Broad-Spectrum Antifungal Defense
P. Bednarek et al.
Plant cells defend against fungal attack through an innate immunity pathway in which infection triggers glucosinolate synthesis, stimulating formation of a protective callose.
10.1126/science.1163732

LETTERS
Making Waves with the Clean Water Act L. S. Fore et al. 1788
The State of Global Hunger J. Sastre 1796
Bird Brains Key to the Functions of Sleep
S. M. H. Gobes and J. J. Bolhuis 1796
Old Seeds Coming in from the Cold F. Gugerli
Response S. Sallon et al. 1796

CORRECTIONS AND CLARIFICATIONS 1790

TECHNICAL COMMENT ABSTRACTS
ECOLOGY
Comment on “Declining Wild Salmon Populations in Relation to Parasites from Farm Salmon”
B. E. Riddell, R. J. Beamish, L. J. Richards, J. R. Candy
full text at www.sciencemag.org/cgi/content/full/322/5909/1790b
Response to Comment on “Declining Wild Salmon Populations in Relation to Parasites from Farm Salmon”
M. Krkos ˘ek et al.
full text at www.sciencemag.org/cgi/content/full/322/5909/1790c

BOOKS ET AL.
Spiral Jetta A Road Trip Through the Land Art of the American West E. Hogan, reviewed by M. Parrish 1791
The Tragedy of Thomas Hobbes
S. Chaplin, Royal Shakespeare Theatre, London 1792
BROWSINGS 1793

MICROBIOLOGY
Rapid Membrane Disruption by a Perforin-Like Protein Facilitates Parasite Exit from Host Cells
B. F. C. Kafsack et al.
The human and animal parasite that causes toxoplasmosis escapes from host cells by using a perforin-like protein to make holes in the intracellular vacuole in which it resides.
10.1126/science.1165740

CELL BIOLOGY
Electron Cryomicroscopy of E. coli Reveals Filament Bundles Involved in Plasmid DNA Segregation
J. Salje, B. Zuber, J. Löwe
The actin-like filaments that power movement of DNA during bacterial cell division form small bundles of three to five filaments near the nucleoid.
10.1126/science.1164346

EDUCATION FORUM
Science Faculty with Education Specialties
S. D. Bush et al. 1795

POLICY FORUM
Politics and Funding in the U.S. Public Biomedical R&D System
D. Hegde and D. C. Mowery 1797

PERSPECTIVES
Who’s Your Daddy?
R. O. Prum >> Report p. 1826 1799
The Ethical Frontiers of Robotics
N. Sharkey 1800
Now You See Them
F. C. Meldrum and R. P. Sear >> Report p. 1819 1802
From Genetic Association to Genetic Switch
A. M. Michelson >> Report p. 1839 1803
Gene Expression—Where to Start?
S. Buratowski >> Reports pp. 1845, 1849, 1851, and 1855 1804

REVIEW
DEVELOPMENTAL BIOLOGY
Nuclear Reprogramming in Cells
J. B. Gurdon and D. A. Melton 1811

REPORTS
MATERIALS SCIENCE
Matching Glass-Forming Ability with the Density of the Amorphous Phase
Y. Li, Q. Guo, J. A. Kalb, C. V. Thompson 1816
The change in density during crystallization predicts which copper-zirconium alloys can most easily form a metallic glass.
MATERIALS SCIENCE
Stable Prenucleation Calcium Carbonate Clusters
D. Gebauer, A. Völkel, H. Cölfen 1819
Even unsaturated solutions contain stable neutral clusters of calcium carbonate, which may aid in crystallization and biomineralization. >> Perspective p. 1802

Published by AAAS
**REPORTS CONTINUED...**

**MATERIALS SCIENCE**

Shock-Wave Exploration of the High-Pressure Phases of Carbon
M. D. Knudson, M. P. Desjarlais, D. H. Dolan
A magnetically driven plate shocks diamond to extreme pressures and temperatures, allowing resolution of its melting regime and a possible higher-pressure phase.

**PALEONTOLOGY**

Avian Paternal Care Had Dinosaur Origin
D. J. Varricchio et al.
The large egg clutches of troodontid and oviraptor dinosaurs and evidence that fossils of brooding dinosaurs were males shows that paternal care was ancestral to birds. >> Perspective p. 1799

**PLANETARY SCIENCE**

Orbital Identification of Carbonate-Bearing Rocks on Mars
B. L. Ehlmann et al.
Despite widespread acidic weathering on Mars, detection of carbonate-bearing rocks indicates that nonacidic waters existed in the past.

**PLANT SCIENCE**

The Circadian Clock in Arabidopsis Roots Is a Simplified Slave Version of the Clock in Shoots
A. B. James et al.
A simpler plant circadian clock, which normally has three interlocking feedback loops, is used in the roots, with one feedback loop regulating only a few genes.

**DEVELOPMENTAL BIOLOGY**

Human Fetal Hemoglobin Expression Is Regulated by the Developmental Stage-Specific Repressor BCL11A
V. G. Sankaran et al.
A way to reactivate a fetal form of γ-globin in adults—by releasing it from repression by an inhibitor—may prove useful for treating certain genetic anemias. >> Perspective p. 1803

**MOLECULAR BIOLOGY**

CRISPR Interference Limits Horizontal Gene Transfer in Staphylococci by Targeting DNA
L. A. Marraffini and E. J. Sontheimer
The small CRISPR RNAs in Staphylococci bacteria that protect against phage infection are complementary to foreign phage DNA and target it for destruction.

**CELL BIOLOGY**

Nascent RNA Sequencing Reveals Widespread Pausing and Divergent Initiation at Human Promoters
L. J. Core, J. J. Waterfall, J. T. Lis
RNA sequencing identifies antisense transcription immediately upstream of genes with transcriptionally engaged RNA polymerase. >> Perspective p. 1804

**CELL BIOLOGY**

Divergent Transcription from Active Promoters
A. C. Seila et al.
Active genes produce promoter-localized sense and antisense short RNAs, suggesting frequent transcription by divergently oriented RNA polymerase II complexes at mammalian promoters. >> Perspective p. 1804

**CELL BIOLOGY**

RNA Exosome Depletion Reveals Transcription Upstream of Active Human Promoters
P. Preker et al.
Highly unstable transcripts exist upstream of active human promoters. >> Perspective p. 1804

**CELL BIOLOGY**

The Antisense Transcriptomes of Human Cells
Y. He et al.
The abundance and nonrandom genomic origin of antisense transcripts in human cells suggest that these RNAs are an important feature of gene regulation. >> Perspective p. 1804

**MEDICINE**

Label-Free Biomedical Imaging with High Sensitivity by Stimulated Raman Scattering Microscopy
C. W. Freudiger et al.
Three-dimensional imaging based on stimulated Raman scattering can detect lipids in living cells and monitor the movement of drugs through the skin.

**MEDICINE**

Leukemic Cells Create Bone Marrow Niches That Disrupt the Behavior of Normal Hematopoietic Progenitor Cells
A. Colmone et al.
Cancerous immune cells create abnormal microenvironments in bone marrow that attract normal immune precursor cells, disrupting their function and exacerbating disease.

**NEUROSCIENCE**

Representation of Geometric Borders in the Entorhinal Cortex
T. Solstad et al.
A previously unknown cell type in the brain’s cortex encodes geometric boundaries of the nearby environment, perhaps providing a frame of reference.

**PLANT SCIENCE**

A Conserved Molecular Framework for Compound Leaf Development
T. Blein et al.
A family of transcription factors controls the formation of leaflets and lobes in complex leaves in distantly related plants by controlling outgrowth from leaf margins.

**DEVELOPMENTAL BIOLOGY**

The Developmental Stage-Specific Repressor BCL11A
V. G. Sankaran et al.
A way to reactivate a fetal form of γ-globin in adults—by releasing it from repression by an inhibitor—may prove useful for treating certain genetic anemias. >> Perspective p. 1803

**MEDICINE**

Leukemic Cells Create Bone Marrow Niches That Disrupt the Behavior of Normal Hematopoietic Progenitor Cells
A. Colmone et al.
Cancerous immune cells create abnormal microenvironments in bone marrow that attract normal immune precursor cells, disrupting their function and exacerbating disease.

**NEUROSCIENCE**

Representation of Geometric Borders in the Entorhinal Cortex
T. Solstad et al.
A previously unknown cell type in the brain’s cortex encodes geometric boundaries of the nearby environment, perhaps providing a frame of reference.

**PLANT SCIENCE**

A Conserved Molecular Framework for Compound Leaf Development
T. Blein et al.
A family of transcription factors controls the formation of leaflets and lobes in complex leaves in distantly related plants by controlling outgrowth from leaf margins.

**DEVELOPMENTAL BIOLOGY**

The Developmental Stage-Specific Repressor BCL11A
V. G. Sankaran et al.
A way to reactivate a fetal form of γ-globin in adults—by releasing it from repression by an inhibitor—may prove useful for treating certain genetic anemias. >> Perspective p. 1803

**MEDICINE**

Leukemic Cells Create Bone Marrow Niches That Disrupt the Behavior of Normal Hematopoietic Progenitor Cells
A. Colmone et al.
Cancerous immune cells create abnormal microenvironments in bone marrow that attract normal immune precursor cells, disrupting their function and exacerbating disease.

**NEUROSCIENCE**

Representation of Geometric Borders in the Entorhinal Cortex
T. Solstad et al.
A previously unknown cell type in the brain’s cortex encodes geometric boundaries of the nearby environment, perhaps providing a frame of reference.
Is That You, Seabiscuit?
A horse can peg another’s identity by whinny alone.

Ancient Battlefield Hints at Roman Persistence
2000-year-old site suggests Romans returned to area of massive defeat.

Revenge of the Nerds
Intelligence marks a man as a good match.

Programs Aim to Train Translational Scientists
B. Vastag
New Ph.D. programs in translational medicine provide basic science training and clinical experience.

A Young Scientist at the Forefront of Cell Reprogramming
E. Pain
Curiosity, boldness, and single-mindedness won Austrian scientist Konrad Hohedlanger a place in cell reprogramming, Science’s Breakthrough of the Year for 2008.

Tooling Up: The ABCs of Transitioning to Leadership
D. Jensen
“Activator,” “behavior,” and “consequence” are key concepts in this simple management theory.

From the Archives: Translational Research Careers
K. Travis
Translational researchers are pushing a fundamental change in the way science has operated for decades.