

GLOSSARY

A

Afforestation: Planting seeds or trees to make a forest on land where there has not been a forest recently or has never been a forest.

Anti-commons: A situation in which the existence of numerous rights holders pushes the use of resources below the most efficient level.

Anti-particle: A subatomic particle, such as an anti-proton or anti-neutron, having the same mass as the particle to which it corresponds, but having the opposite sign of electric charge and of other intrinsic properties.

Archaea: A group of single-celled organisms that is superficially similar to — but evolutionarily distinct from — bacteria.

Axon: A long projection from a neuron's main body that carries electrical signals towards other cells.

B

Beta phase: A crystalline structure of titanium alloys in which atoms solidify into a cubic body-centred arrangement.

Biodiversity hotspot: An area of high species richness, such as the Amazon.

Biofouling: The undesirable accumulation of microorganisms, plants, algae and/or animals on damp structures, for example barnacles on the hull of a ship.

Biomass: Plant material that is used to generate energy and is usually grown specifically for this purpose.

Biomimetics: Applying structures and processes found in nature to the creation of artificial products.

Birth cohort: A group of people born within a particular period or year.

Black hole: A region where space-time is 'deformed' to produce a gravitational field so powerful that nothing, not even light, can escape.

Boreal forests: A nearly continuous belt of coniferous trees across North America and Eurasia; also known as the taiga, which comes from the Russian meaning swampy moist forest.

C

Chaperonin: A type of molecular chaperone that forms a cage for a single protein molecule to fold in isolation.

Chloroplast: A photosynthetic organelle found in plant cells.

Climatology: The scientific study of climate, which is defined as the mean weather conditions over a period of time.

Cold-atom system: A collection of ultra-cold atoms, typically held in a trap, in which quantum coherent behaviour can be precisely controlled either for scientific inquiry or technological applications.

Connectome: The full set of connections between neurons in a given nervous system.

Convivencia: A period of religious tolerance when Jews, Muslims and Catholics in Spain lived together.

Creative destruction: Proposed by economist Joseph Schumpeter; monopoly power is an incentive that leads to the creative destruction of existing monopolies by new entrants.

Criminal law: A subarea of public law providing criminal sanctions for defined crimes committed by individuals or businesses.

D

Dark energy: A hypothetical form of energy that comprises 74% of the total mass-energy of the Universe.

Dark matter: An exotic form of matter thought to make up five-sixths of all matter in the Universe. Invisible to electromagnetic radiation, the presence of dark matter has been inferred by the gravitational effect it has on ordinary stars and galaxies.

Decoherence: A quantum system interacts with its environment and loses internal correlation, such that it more resembles classical physics.

Depolarization: A relative shift in membrane potential from negative to positive voltage, capable of triggering neuronal activation.

E

Earth-system models: Climate models that describe processes within and among the atmosphere, oceans, cryosphere, and the terrestrial and marine biosphere; these include the global carbon cycle.

Ecological niche: The function or position of an organism or population within its community.

Ecosystem service: A benefit provided to humankind by natural ecosystems.

Electroencephalography (EEG): A technique for recording the brain's electrical activity by placing electrodes on the scalp.

Electromagnetic spectrum: The range of all possible frequencies of electromagnetic radiation extending from low-frequency radio waves to high-frequency γ -radiation, with visible light and heat radiation lying at intermediate frequencies.

Electron cryomicroscopy: A form of electron microscopy in which the sample is studied at cryogenic temperatures, generally those of liquid nitrogen (63 K; -210°C ; -346°F).

Electron microscopy: A technique by which atomic-resolution images can be generated based on the interactions of a sample with a transmitted electron beam.

Endophyte: A microbe, such as a bacterium or fungus, which lives within a plant without causing apparent disease.

Evolutionary signatures: Assuming that the largest part of the genome evolves according to the rules of the neutral theory of evolution, these patterns of departure from neutral expectation indicate a region that has experienced positive or negative selection.

Extrasolar planets: Planets orbiting a star other than the Sun.

F

Founder effect: A loss in genetic variation that occurs when a small group of individuals establishes a new colony.

Fuel cell: An electrochemical device in which fuel such as molecular hydrogen is oxidized to generate energy, producing water as a by-product.

G

Gamma rays: High frequency, high energy electromagnetic radiation.

Gene transfection: Introducing new genetic material into cells without the use of viruses as carriers.

Genetics: The study of heredity and variation in living organisms.

Genome: The full hereditary information of an organism.

Genome-wide association study (GWAS): Comparison of the genome of large numbers of people with and without a specific medical condition to identify variations in the genome that contribute to complex diseases and serve as disease markers.

Genomics: The study of all the genes and genetic information in the genome.

Genotype: An organism's full hereditary information, even if not expressed.

Gravitational waves: Fluctuations in the curvature of space-time predicted by Einstein's theory of general relativity, which propagate as a wave; produced by the motion of massive objects such as black holes, but yet to be directly detected.

Grey matter: Areas of the brain that mainly contain cell bodies of neurons and supporting cells.

H

Helioseismology: Understanding the internal structure of the Sun by measuring the propagation of acoustic waves through it.

Higgs: A hypothetical, massive subatomic particle, posited to be responsible for giving other elementary particles their masses.

Hominins: A group comprising humans and their evolutionary relatives after the divergence from chimpanzees about five to seven million years ago.

Hydrophilic: Having a tendency to attract water.

Hydrophobic: Having a tendency to repel water.

I

Induced pluripotent stem (iPS) cells: Adult cells that are genetically manipulated so that they gain the ability to differentiate into most other types of cell.

Intellectual property: An intangible, unique idea that can be secured in the form of industrial property, such as an invention (patent), logo, trademark or industrial design copyright, which includes literary works (such as novels, poems and plays, and films), musical works, artistic works (such as drawings, paintings, photographs and sculptures), architectural designs and technological achievements (such as computer programs).

Interferometer: A device that exploits the interference of laser light to detect small length changes in two perpendicular arms, for instance those induced by the passage of a gravitational wave.

L

Life-history trait: A mechanism that a species uses to allocate energy and time between reproduction and growth.

M

Macromolecules: Various large molecules related to biological function — typically proteins or nucleic acids.

Macular degeneration: A medical condition characterized by loss of vision due to retinal damage.

Magnetic resonance imaging (MRI): A scanning technique that uses a powerful magnetic field to affect the magnetic alignment of protons (mainly in water molecules), hence locating them in space and building up a picture of the inside of the body.

Marine microbiology: The study of microscopic organisms within the oceans.

Marine property rights: Attempts by governments and non-governmental organizations to set limits on who can fish, where they can fish and how much they can catch in any given year.

Mass spectrometry: A technique used to reveal the size and molecular composition of component molecules within a complex mixture.

Membrane potential: The difference in voltage across the cell membrane; the resting potential is typically -70 millivolts relative to the environment.

Mesosopic: An intermediate length scale between atomic and macroscopic levels at which more average material properties emerge.

Metabolome: The full complement of molecules produced by the metabolic processes in a cell, tissue or organism.

Metabolomics: Study of the metabolic profile created by cellular processes.

Mitochondria: Membrane-bound energy-generating cellular organelles found in all eukaryotic cells.

Mitotic spindle: A protein filament structure used in cell division, which separates chromosomes into daughter cells.

Model species: A species that is extensively studied to understand particular biological phenomena, with the expectation that discoveries made will provide insight into the workings of other organisms that are more difficult to study directly.

Molecular chaperones: Specialized proteins that protect other, not-yet folded proteins from misfolding and clumping together.

Muon: An electron-like elementary subatomic particle.

Mutant phenotype: An individual, organism or new genetic characteristic arising from a base-pair sequence change within the DNA of a gene or chromosome of an organism, resulting in the creation of a new characteristic or trait not found in the wild type.

N

Nanocomposites: A solid material in which one of the components is on the nanometer scale.

Nanofluidics: The study of systems involving nanoscale amounts of liquids.

Neuroendocrinology: The study of the interactions between the nervous system and the endocrine system.

Neurotransmitters: Chemicals used as messengers to deliver signals from one neuron to another.

Neutrino: An electrically neutral, weakly interacting elementary subatomic particle.

New institutional economics: Looks at the role of institutions in reducing transaction costs as well as understanding the role of human-made institutions in shaping economic behaviour; encompasses, *inter alia*, transaction-cost economics (which focuses on the need for rules to help reduce transaction costs) and informational economics (which looks at solutions to the asymmetric distribution of information to market participants).

Nucleotide: The structural units that make up DNA and RNA.

O

Oceanography: The study of the oceans. Biology, chemistry, geology and physics together make oceanography a richly interdisciplinary science.

Organelles: Specialized, membrane-enclosed functional entities within the cell, such as the nucleus or mitochondria.

P

Palaeoclimatology: The study of ancient climate patterns.

Parallel adaptations: Similar evolutionary changes that occur in two different lineages, independent of one another.

Patent thicket: A technology with numerous, sometimes thousands, of patents, some of which will be essential for its use and must be cleared, for instance, in order to manufacture and market goods that implement the technology.

Permafrost: Soil that is at or below the freezing point of water for two or more consecutive years.

Phenotype: An organism's actual observed characteristics or properties, such as morphology, development or behaviour.

Photoreceptors: Specialized neurons in the retina that respond to light.

Photovoltaics: Photovoltaic materials convert solar radiation into direct current electricity.

Plasma: A gas of ionized particles.

Plasma membrane: The biological membrane that separates the inside of a cell from the outside world.

Plasticity (of the brain): Changes in brain structure and function induced by experience.

Pluripotent stem cells: Stem cells that can differentiate or become most types of cell in the body; named from the Latin words 'pluri' meaning many and 'potent' meaning power.

Polyelectrolytes: Polymers with repeating units that carry an electrolyte group.

Positron emission tomography (PET): An imaging technique in which a radioactive tracer is injected into the body fixed to a biologically active molecule; its γ -ray emissions are then measured to give an indication of where it is and what it might be doing.

Private law: The law regulating relationships between citizens (for example, contract law and family law).

Property rights: The authority to determine how a resource is used.

Proteasome: The recycling centre of the cell; a large cylindrical complex that breaks down unneeded or damaged proteins into smaller fragments that can be recycled into new proteins.

Proteome: The complete set of proteins within an organism, cell or sample.

Proteomics: Large-scale study of proteins, their structures and functions.

Public law: The law regulating the relationship between citizens and the state.

Q

Quantitative trait locus (QTL) analysis: The statistical analysis and identification of stretches of DNA markers that are linked to the genes that underlie a particular trait. Increasingly, such QTLs can be reduced to individual genes (quantitative trait genes) and sometimes even to individual nucleotides (quantitative trait nucleotides).

Quantum coherence: Behaviour reflecting unusually strong correlations among many quantum particles, enforced by the laws of quantum mechanics.

Quantum effects: Phenomena in which, at the atomic level, matter behaves as quantum objects, for example exhibiting properties of both waves and particles.

Quark: An elementary subatomic particle that makes up protons and neutrons.

Qubit: A quantum bit or unit of quantum information.

R

Regenerative medicine: The branch of medicine concerned with replacing or regrowing organs and body parts.

RNA: Among other functions, the intermediary between DNA and protein during protein synthesis. It comprises a string of chemical 'letters' that act as a template for protein production.

S

Scanning tunnelling microscope (STM): A surface-sensitive microscope that is able to resolve single atoms; the structure of a surface is studied using a tip that scans the surface at a close distance from it.

Secondary metabolite: Organic compounds not directly involved in growth, development or reproduction that allow plants and other organisms to tackle environmental problems.

Segmentation: A process by which individual features within an image are computationally separated from their surroundings.

CONTRIBUTORS

Selective sweep: A special evolutionary signature. Genomic regions that are shared by most or all individuals of a population indicate a recent strong selection for the same genetic variant, and are said to have experienced a selective sweep. Careful statistical tests are required to distinguish selective sweep signatures from similar signatures caused by population demographic effects.

Semantic disambiguation: Using contextual clues to choose between the different meanings of a word.

Sensorimotor: Pertaining to the sensory and motor functions of the nervous system.

Single-nucleotide polymorphism (SNP): A single base-pair change in DNA.

Stellarator: A nuclear-fusion vessel similar to a tokamak but with a different configuration of the magnetic fields.

String theory: A proposed theory that extends the standard model by suggesting that elementary particles are made up of tiny vibrating strings.

Supersymmetry: A proposed extension to the standard model of particle physics, in which conventional particles are paired with as yet unobserved superpartners.

Supranational institution: An institution to which two or more member states cede some of their sovereignty rights so that the institution can issue binding decisions on an international level.

Synapse: A junction through which chemical or electrical signals pass between neurons.

Synchrotron: A large-scale facility producing bright X-rays for protein crystallography and other research.

Synthetic biology: An area of study that combines biology and engineering to design and construct new biological functions and systems not found in nature.

Systems biology: The application of mathematical and theoretical approaches to understand how the interaction of genes, RNA, proteins, metabolites and cells can lead to systems-level, self-organized behaviours.

Tokamak: A doughnut-shaped nuclear-fusion vessel in which a complicated arrangement of magnetic fields is used to confine an electrically-charged hot plasma.

Transcriptomics: Study of the gene-expression patterns in a given cell population.

Tundra: A biome in which tree growth is limited by low temperatures and short growing seasons; the vegetation mainly comprises dwarf shrubs, sedges and grasses, and mosses and lichens.

United Nations Convention on the Law of the Sea: The international agreement that defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment and the management of marine natural resources. This resulted from the United Nations Law of the Sea from 1973 through 1982 and came into force in 1994.

van der Waals: Weak attractive or repulsive forces between molecules.

White matter: Areas of the brain that mainly contain the axons of neurons, which are the long branches through which a neuron's electrical signal is transmitted.

X-ray crystallography: A technique in which the X-ray bombardment of crystals derived from a molecule of interest yields diffraction patterns that can reveal high-resolution structural information.

SECTION COORDINATORS

JENS BECKERT Max Planck Institute for the Study of Societies, **Köln**

PETER MOMBAERTS Max Planck Institute of Biophysics, **Frankfurt/Main**

JAN-MICHAEL ROST Max Planck Institute for the Physics of Complex Systems, **Dresden**

BRUCE ALLEN Max Planck Institute for Gravitational Physics (Albert Einstein Institute), **Hannover**

OLE KROGH ANDERSEN Max Planck Institute for Solid State Research, **Stuttgart**

MEINRAT ANDREAE Max Planck Institute for Chemistry (Otto Hahn Institute), **Mainz**

MARKUS ANTONIETTI Max Planck Institute for Colloids and Interfaces, **Potsdam**

MARTIN ASPLUND Max Planck Institute for Astrophysics, **Garching**

IAN BALDWIN Max Planck Institute for Chemical Ecology, **Jena**

ERNST BAMBERG Max Planck Institute of Biophysics, **Frankfurt/Main**

JÜRGEN BASEDOW Max Planck Institute for Comparative and International Private Law, **Hamburg**

WOLFGANG BAUMEISTER Max Planck Institute of Biochemistry, **Martinsried**

SIEGFRIED BETHKE Max Planck Institute for Physics (Werner Heisenberg Institute), **Munich**

JOACHIM BILL Max Planck Institute for Metals Research, **Stuttgart**

KLAUS BLAUM Max Planck Institute for Nuclear Physics, **Heidelberg**

IMMANUEL BLOCH Max Planck Institute of Quantum Optics, **Garching**

EBERHARD BODENSCHATZ Max Planck Institute for Dynamics and Self-Organization, **Göttingen**

NILS BROSE Max Planck Institute for Experimental Medicine, **Göttingen**

HANS-JÜRGEN BUTT Max Planck Institute for Polymer Research, **Mainz**

ALLEN CALDWELL Max Planck Institute for Physics (Werner Heisenberg Institute), **Munich**

ANDREA CAVALLERI Max Planck Research Department for Structural Dynamics at the University of Hamburg within the Center for Free Electron Laser Science, **Hamburg**

MARTIN CLAUßEN Max Planck Institute for Meteorology, **Hamburg**

SIEGFRIED DIETRICH Max Planck Institute for Metals Research, **Stuttgart**

JOSEF DREXL Max Planck Institute for Intellectual Property, Competition and Tax Law, **Munich**

GEORGI DVALI Max Planck Institute for Physics (Werner Heisenberg Institute), **Munich**

CHRISTOPH ETTL Headquarters of the Max Planck Society, **Munich**

REINHARD FÄSSLER Max Planck Institute of Biochemistry, **Martinsried**

PETER FRATZL Max Planck Institute for Colloids and Interfaces, **Potsdam**

HANS-JOACHIM FREUND Fritz Haber Institute of the Max Planck Society, **Berlin**

ANGELA FRIEDERICI Max Planck Institute for Human Cognitive and Brain Sciences, **Leipzig**

ALOIS FÜRSTNER Max Planck Institute of Coal Research, **Mülheim/Ruhr**

THEO GEISEL Max Planck Institute for Dynamics and Self-Organization, **Göttingen**

REINHARD GENZEL Max Planck Institute for Extraterrestrial Physics, **Garching**

JURI GRIN Max Planck Institute for Chemical Physics of Solids, **Dresden**

ULRICH HARTL Max Planck Institute of Biochemistry, **Martinsried**

MARTIN HEIMANN Max Planck Institute for Biogeochemistry, **Jena**

STEFAN W. HELL Max Planck Institute for Biophysical Chemistry (Karl Friedrich Bonhoeffer Institute), **Göttingen**

THOMAS HENNING Max Planck Institute for Astronomy, **Heidelberg**

STEPHAN HERMINGHAUS Max Planck Institute for Dynamics and Self-Organization, **Göttingen**

WOLFGANG HILLEBRANDT Max Planck Institute for Astrophysics, **Garching**