

THE EVOLUTION OF HUMAN PHYSICAL ACTIVITY

Glossary

Adaptive archaic introgression: the persistence of beneficial DNA variants in the modern human **genome** that were gained through interbreeding with now-extinct archaic species, such as **Neanderthals** and **Denisovans**.

Amino acid: organic compounds that are the building blocks of **proteins** and participate in a number of processes such as neurotransmitter transport and biosynthesis. Amino acids are encoded by the **genome** as different three letter codes.

Biomechanics: the science of movement from a mechanical perspective; how muscles, bones, and other parts of the body work to produce movement or locomotion.

Chromatin: a complex of DNA and **proteins** (histone and adaptor proteins) forming **chromosomes**.

Chromosome: discrete strands of tightly packaged **chromatin**.

Cost of transport: how much energy it takes to move from point A to point B.

Cytidine monophospho-N-acetylneuraminic acid hydroxylase (Cmah) enzyme: an **enzyme** encoded by the **CMAH gene** that modifies **sialic acids** in most mammals by modifying **N-acetylneuraminic acid (Neu5Ac)** into **N-glycolylneuraminic acid (Neu5Gc)**. The **enzyme** modifies **sialic acid** in its sugar **nucleotide** form (CMP-Neu5Ac to CMP-Neu5Gc).

Cytidine monophospho-N-acetylneuraminic acid hydroxylase (CMAH) gene: The human lineage lost the function of the **CMAH gene** over 2 million years ago that caused human cells to both lack **Neu5Gc** and carry an excess of **Neu5Ac**.

Daily energy expenditure: total number of calories burned in a day.

Denisovans: an extinct **hominin** population contemporary with **Neanderthals** that hybridized with ancient humans and **Neanderthals**. Knowledge of Denisovan morphology is limited to two small fossils found in Siberia and a jaw in Tibet.

DNA: deoxyribonucleic acid. The molecule of inheritance, which consists of sequences of the four **nucleotide** bases: Adenine, Thymine, Guanine, and Cytosine.

DNA Sequence: the specific order of the **nucleotide** bases Adenine, Thymine, Guanine, and Cytosine.

Eccrine sweat gland: a type of secretory gland found in the skin. These glands are found throughout the body of humans and other primates. In response to neural stimulation, these glands secrete water (sweat) onto the skin. In humans, eccrine sweat glands are the most abundant glands in the skin and are essential for the main mechanism of cooling in our species, which occurs when water (sweat) secreted by these glands causes evaporative cooling.

Ectodermal appendage: a class of organs that all develop from the outer layer of the embryo, the ectoderm, through a series of coordinated and reciprocal interactions between the

embryonic ectoderm and underlying dermal layer. This class of organs includes, sweat glands, hairs, mammary glands, teeth and nails. A largely shared set of genetic pathways initiate and control the development of this organ class.

Efficiency: the relationship between the work performed to move a certain distance to the energy cost of transport.

Endothelia PAS Domain Protein 1 (EPAS1) gene: a **protein** encoding gene for EPAS1. This **gene** is implicated in high altitude adaptation in humans, specifically in Tibetan populations that admixed with **Denisovan archaic hominins** and inherited this advantageous **gene** variant.

Endothelia PAS Domain Protein 1 (EPAS1) protein: a transcription factor involved in the response to changes in oxygen concentration, such as **hypoxia**, through the induction of oxygen regulated genes.

Endothelial cells: the cell type that forms the interior lining of blood and **lymphatic vessels**, and controls the transfer of materials, including **white blood cells**, into and out of the bloodstream.

Enzyme: **proteins** that catalyze chemical reactions inside and outside cells.

Estradiol: an **estrogen steroid hormone** and the major female **sex hormone** that is involved in the regulation of reproductive cycles, the development of female secondary sexual characteristics, the development and maintenance of female reproductive tissues, and has important effects on bone, fat, skin, liver, and the brain. Estradiol also has important roles in males, but is produced in much lower levels.

Estrogen: the category of **sex hormones** that includes estrone, estradiol, and estriol that are involved in the development and regulation of the female reproductive system and secondary sex characteristics.

Evolutionary neuroscience: the study of the evolution and natural history of nervous system structure, functions, and emergent properties.

Evolutionary psychology: a theoretical approach to psychology that seeks evolutionary connections to human psychological traits such as cognition and language.

Exon: sequences at a **locus** that encode parts of a **protein**.

Footfall: the point in time when a foot (or hand in the forelimb) first touches the ground.

Footfall sequence: the distribution of footsteps, relative to one another; some gaits may be defined by footfall sequence.

Fore limb: the front limbs and feet of a quadrupedal animal (also, the upper limbs/arms of a human).

Gait: how a person or animal moves; different categories of movement are different gaits (e.g. a run vs. a walk, a trot vs. a gallop).

Gene: a DNA sequence which encodes a specific function.

Genetic variant: a version of a DNA sequence that differs from others found at the same **locus**. For example, the difference can consist in a single base pair (as in **single nucleotide polymorphisms, SNP**) or in the deletion/insertion of a DNA base(s). See: **indel**.

Genome: the totality of DNA in a cell. Also refers to the DNA sequence that typifies an individual or species.

Glycans: one of the four classes of major biomolecules. Glycans consist of varying numbers of sugars (monosaccharides) attached to **proteins** or **lipids** or secreted as free glycans. Glycans are essential biomolecules whose functions can be divided into three broad categories: structural and modulatory properties (including nutrient storage and sequestration), specific recognition by other molecules, and molecular mimicry of host glycans.

"Great apes": A taxonomic family denoting the extant chimpanzees, bonobos, gorillas, and orangutans. This is biologically invalid grouping given that chimpanzees and bonobos are more closely related to humans.

Hind limb: the back limbs and feet of a quadrupedal animal (also, the lower limbs/legs of a human).

Hippocampus (brain): a part of the limbic system that plays important roles in the consolidation of information from short-term memory to long-term memory, and in spatial memory that enables navigation. Humans and other vertebrates have two hippocampi, one in each side of the brain. It is named after its resemblance to the shape of a sea horse (hippocampus in Latin).

Hominin: a classification of species comprising humans and our extinct relatives following the split with the common ancestor with chimpanzees.

Homo: the **genus** that comprises the species *Homo sapiens*, as well as several extinct species classified as ancestral to, or closely related to, humans.

Hormone: a signaling molecule in multicellular organisms that contributes to the regulation of physiology and behavior.

Hydroxylase: an **enzyme** involved in the first step of aerobic oxidation of organic compounds.

Hypoxia: a conditions characterized by less than the normal amount of oxygen reaching the tissues; also, low partial pressure of oxygen at high elevations (hypobaric hypoxia).

Indel: an insertion or deletion of a DNA sequence.

Kinematics: a description of the motion of objects; how the limbs and joints, or combinations of these bodies, move during a particular type of locomotion.

Kinetics: a description of the forces acting on a body; the forces the body exerts (or resists) during locomotion.

Lipid: one of the four classes of major biomolecules. A fatty or waxy organic compound involved in important cellular activities like storing energy, as a component of the cell membrane, and signaling within and between other cells.

Locomotion: movement causing a person or animal to get

from point A to point B.

Locus: a unique physical position on a **chromosome**.

Lymphatic vessels: thin-walled vessels (tubes) of the lymphatic system that are complementary to the cardiovascular system and are devoted to the movement of lymphatic fluid.

Metabolic rate: the rate at which fuels (such as sugars or fats) are broken down for the production of cellular energy.

Metabolism: the conversion of food into energy and the chemical building blocks for **proteins, lipids, nucleic acids**, and **glycans** as well as the elimination of metabolic wastes.

Mitochondria: membrane-bound cell organelles that generate most of the chemical energy, adenosine triphosphate (ATP), needed to power the cell's biochemical reactions. Mitochondria are believed to be endosymbionts that were originally prokaryotic cells that became incorporated into eukaryotic organisms.

Morphology (biology): the shape or form (outward appearance) of an organism. The branch of biology interested in the form and structure of organisms and their specific structural features.

N-acetylneuraminic acid (Neu5Ac): the most common **sialic acid** in most vertebrates and was first discovered in animal saliva and brains.

Neanderthals: an extinct Eurasian **hominin species** that existed from 500-30 kya and interbred with ancient humans and **Denisovans**.

Neurogenesis: the process by which neural stem cells (NSCs) produce neurons.

Neuroplasticity: the ability of the brain to form and reorganize synaptic connections through growth and reorganization. These changes include new neural connections and cortical remapping resulting from learning, environmental influences, practice, and psychological stress.

N-glycolylneuraminic acid (Neu5Gc): A common variant of **sialic acid** in many vertebrates that is not made by humans but can be incorporated from diets rich in red meat.

Nucleic acid: one of the four classes of major biomolecules. The overall name for **DNA** and **RNA**, which are composed of **nucleotides**.

Nucleotide: molecular building blocks for **DNA** and **RNA**. Specifically, they consist of three components: a 5-carbon sugar, a phosphate group, and a nitrogenous base. The type of sugar, either deoxyribose or ribose, determines if the resulting **nucleic acid** is **DNA** or **RNA**.

Physiological trade-off: a compromise between different physiological needs of body functions.

Power: the product of work and speed (velocity).

Primatology: the scientific discipline involving the study of living and extinct primates (monkeys and apes), especially their evolution and behavior. Modern primatology consists

of Western and Japanese traditions that developed simultaneously but independently in the 1950s.

Progesterone: a **steroid** and **sex hormone** involved in the menstrual cycle, pregnancy, and embryogenesis of invertebrates and mammals.

Protein: One of the four classes of major biomolecules. Proteins are molecules encoded by **DNA sequences** and composed of **amino acids** connected by peptide bonds. These range in size from a few **amino acids** (short peptides) to large molecules (long polypeptides) comprised of thousands of **amino acids**.

Regulatory elements: binding sites on chromosomes for **transcription factors**, which are involved in **gene** regulation.

RNA: ribonucleic acid. A molecule essential in **gene** coding, decoding, regulation, and expression. Consists of sequences of the four **nucleotide** bases: **Adenine**, **Uracil**, **Guanine**, and **Cytosine**. Types of RNA include messenger RNA (mRNA), transfer RNA (tRNA), ribosomal RNA (rRNA), small nuclear RNA (snRNA), and other non-coding RNAs. Some viruses including Influenza A and Sars-Cov-2 have RNA genomes.

Selective sweep: the process through which a new beneficial mutation increases in frequency within a population due to its positive effect on survival and reproduction; this process leads to a reduction in genetic variation among neighboring nucleotide sequences.

Sex hormone: **steroid hormones**, such as androgens, estrogens, and progestogens, that interact with steroid hormone receptors.

Sexual dimorphism: the difference in anatomical and physiological characteristics between the sexes of a **species**, such as body size, weight, and pigmentation.

Sexual selection theory: the selection of and competition for a reproductive partner. Inter-sexual mate selection of the opposite sex is contrasted with intra-sexual competition with same sex members for opposite sex mates.

Sialic acid: acidic sugar molecules prominently found at the outermost fringes of the sugar chains (**glycans**) that cover all vertebrate cells. The two most common sialic acids in mammals are **N-acetylneuraminic acid (Neu5Ac)** into **N-glycolylneuraminic acid (Neu5Gc)**.

Single nucleotide polymorphism (SNP): a variation involving a single base-pair, occurring in at least 1% of the population.

Species: a biological population whose individuals can mate with one another to produce viable and fertile offspring. This is a debated definition and the concept is problematic for extinct fossil organisms for which **DNA** is not available.

Steroid: a biological compound manufactured by plants, animals, and fungi that functions as either important components of cell membranes or as signalling molecules.

Stride length: the distance between two subsequent footfalls.

Transcription factor: **proteins** that bind to specific sequences of **DNA** called **regulatory elements**, or other proteins that do so, and directly or indirectly affect the initiation of transcription. The activities of transcription factors determine where and when genes are expressed.

White blood cells (WBCs): a type of immune cell involved in protecting the body against infectious disease and foreign invaders. WBCs are also called leukocytes.

Work: the product of force and displacement (distance).

VO2 max: the maximum rate of oxygen consumption measured during exercise of increasing intensity.