4. ANNEXES

4.1 ERC EVALUATION PANELS AND KEYWORDS

Physical Sciences and Engineering

**PE1**  Mathematics
All areas of mathematics, pure and applied, plus mathematical foundations of computer science, mathematical physics and statistics

- **PE1_1** Logic and foundations
- **PE1_2** Algebra
- **PE1_3** Number theory
- **PE1_4** Algebraic and complex geometry
- **PE1_5** Lie groups, Lie algebras
- **PE1_6** Geometry and global analysis
- **PE1_7** Topology
- **PE1_8** Analysis
- **PE1_9** Operator algebras and functional analysis
- **PE1_10** ODE and dynamical systems
- **PE1_11** Theoretical aspects of partial differential equations
- **PE1_12** Mathematical physics
- **PE1_13** Probability
- **PE1_14** Mathematical statistics
- **PE1_15** Generic statistical methodology and modelling
- **PE1_16** Discrete mathematics and combinatorics
- **PE1_17** Mathematical aspects of computer science
- **PE1_18** Numerical analysis
- **PE1_19** Scientific computing and data processing
- **PE1_20** Control theory, optimisation and operational research
- **PE1_21** Application of mathematics in sciences
- **PE1_22** Application of mathematics in industry and society

**PE2**  Fundamental Constituents of Matter
Particle, nuclear, plasma, atomic, molecular, gas, and optical physics

- **PE2_1** Theory of fundamental interactions
- **PE2_2** Phenomenology of fundamental interactions
- **PE2_3** Experimental particle physics with accelerators
- **PE2_4** Experimental particle physics without accelerators
- **PE2_5** Classical and quantum physics of gravitational interactions
- **PE2_6** Nuclear, hadron and heavy ion physics
- **PE2_7** Nuclear and particle astrophysics
- **PE2_8** Gas and plasma physics
- **PE2_9** Electromagnetism
- **PE2_10** Atomic, molecular physics
- **PE2_11** Ultra-cold atoms and molecules
- **PE2_12** Optics, non-linear optics and nano-optics
- **PE2_13** Quantum optics and quantum information
- **PE2_14** Lasers, ultra-short lasers and laser physics
- **PE2_15** Thermodynamics
- **PE2_16** Non-linear physics
- **PE2_17** Metrology and measurement
- **PE2_18** Equilibrium and non-equilibrium statistical mechanics: steady states and dynamics
PE3  **Condensed Matter Physics**
Structure, electronic properties, fluids, nanosciences, biological physics

PE3_1  Structure of solids, material growth and characterisation
PE3_2  Mechanical and acoustical properties of condensed matter, lattice dynamics
PE3_3  Transport properties of condensed matter
PE3_4  Electronic properties of materials, surfaces, interfaces, nanostructures
PE3_5  Physical properties of semiconductors and insulators
PE3_6  Macroscopic quantum phenomena, e.g. superconductivity, superfluidity, quantum Hall effect
PE3_7  Spintronics
PE3_8  Magnetism and strongly correlated systems
PE3_9  Condensed matter – beam interactions (photons, electrons, etc.)
PE3_10  Nanophysics, e.g. nanoelectronics, nanophotonics, nanomagnetism, nanoelectromechanics
PE3_11  Mesoscopic quantum physics and solid-state quantum technologies
PE3_12  Molecular electronics
PE3_13  Structure and dynamics of disordered systems, e.g. soft matter (gels, colloids, liquid crystals), granular matter, liquids, glasses, defects
PE3_14  Fluid dynamics (physics)
PE3_15  Statistical physics: phase transitions, condensed matter systems, models of complex systems, interdisciplinary applications
PE3_16  Physics of biological systems

PE4  **Physical and Analytical Chemical Sciences**
Analytical chemistry, chemical theory, physical chemistry/chemical physics

PE4_1  Physical chemistry
PE4_2  Spectroscopic and spectrometric techniques
PE4_3  Molecular architecture and Structure
PE4_4  Surface science and nanostructures
PE4_5  Analytical chemistry
PE4_6  Chemical physics
PE4_7  Chemical instrumentation
PE4_8  Electrochemistry, electrodialysis, microfluidics, sensors
PE4_9  Method development in chemistry
PE4_10  Heterogeneous catalysis
PE4_11  Physical chemistry of biological systems
PE4_12  Chemical reactions: mechanisms, dynamics, kinetics and catalytic reactions
PE4_13  Theoretical and computational chemistry
PE4_14  Radiation and Nuclear chemistry
PE4_15  Photochemistry
PE4_16  Corrosion
PE4_17  Characterisation methods of materials
PE4_18  Environment chemistry

PE5  **Synthetic Chemistry and Materials**
New materials and new synthetic approaches, structure-properties relations, solid state chemistry, molecular architecture, organic chemistry

PE5_1  Structural properties of materials
PE5_2  Solid state materials chemistry
PE5_3  Surface modification
PE5_4  Thin films
PE5_5  Ionic liquids
PE5_6  New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles
PE5_7  Biomaterials synthesis
PE5_8  Intelligent materials synthesis – self assembled materials
PE5_9  Coordination chemistry
PE5_10 Colloid chemistry
PE5_11 Biological chemistry and chemical biology
PE5_12 Chemistry of condensed matter
PE5_13 Homogeneous catalysis
PE5_14 Macromolecular chemistry
PE5_15 Polymer chemistry
PE5_16 Supramolecular chemistry
PE5_17 Organic chemistry
PE5_18 Medicinal chemistry

PE6  Computer Science and Informatics
Informatics and information systems, computer science, scientific computing, intelligent systems

PE6_1  Computer architecture, embedded systems, operating systems
PE6_2  Distributed systems, parallel computing, sensor networks, cyber-physical systems
PE6_3  Software engineering, programming languages and systems
PE6_4  Theoretical computer science, formal methods, automata
PE6_5  Security, privacy, cryptology, quantum cryptography
PE6_6  Algorithms and complexity, distributed, parallel and network algorithms, algorithmic game theory
PE6_7  Artificial intelligence, intelligent systems, natural language processing
PE6_8  Computer graphics, computer vision, multimedia, computer games
PE6_9  Human computer interaction and interface, visualisation
PE6_10 Web and information systems, data management systems, information retrieval and digital libraries, data fusion
PE6_11 Machine learning, statistical data processing and applications using signal processing (e.g. speech, image, video)
PE6_12 Scientific computing, simulation and modelling tools
PE6_13 Bioinformatics, bio-inspired computing, and natural computing
PE6_14 Quantum computing (formal methods, algorithms and other computer science aspects)

PE7  Systems and Communication Engineering
Electrical, electronic, communication, optical and systems engineering

PE7_1  Control engineering
PE7_2  Electrical engineering: power components and/or systems
PE7_3  Simulation engineering and modelling
PE7_4  (Micro- and nano-) systems engineering
PE7_5  (Micro- and nano-) electronic, optoelectronic and photonic components
PE7_6  Communication systems, wireless technology, high-frequency technology
PE7_7  Signal processing
PE7_8  Networks, e.g. communication networks and nodes, Internet of Things, sensor networks, networks of robots
PE7_9  Man-machine interfaces
PE7_10  Robotics
PE7_11  Components and systems for applications (in e.g. medicine, biology, environment)
PE7_12  Electrical energy production, distribution, applications

PE8  Products and Processes Engineering
Product and process design, chemical, civil, environmental, mechanical, vehicle engineering, energy processes and relevant computational methods

PE8_1  Aerospace engineering
PE8_2  Chemical engineering, technical chemistry
PE8_3 Civil engineering, architecture, offshore construction, lightweight construction, geotechnics
PE8_4 Computational engineering
PE8_5 Fluid mechanics
PE8_6 Energy processes engineering
PE8_7 Mechanical engineering
PE8_8 Propulsion engineering, e.g. hydraulic, turbo, piston, hybrid engines
PE8_9 Production technology, process engineering
PE8_10 Manufacturing engineering and industrial design
PE8_11 Environmental engineering, e.g. sustainable design, waste and water treatment, recycling, regeneration or recovery of compounds, carbon capture & storage
PE8_12 Naval/marine engineering
PE8_13 Industrial bioengineering
PE8_14 Automotive and rail engineering; multi-/inter-modal transport engineering

PE9 Universe Sciences
Astro-physics/-chemistry/-biology; solar system; planetary systems; stellar, galactic and extragalactic astronomy; cosmology; space sciences; astronomical instrumentation and data

PE9_1 Solar physics – the Sun and the heliosphere
PE9_2 Solar system science
PE9_3 Exoplanetary science, formation and characterization of extrasolar planets
PE9_4 Astrobiology
PE9_5 Interstellar medium and star formation
PE9_6 Stars – stellar physics, stellar systems
PE9_7 The Milky Way
PE9_8 Galaxies – formation, evolution, clusters
PE9_9 Cosmology and large-scale structure, dark matter, dark energy
PE9_10 Relativistic astrophysics and compact objects
PE9_11 Gravitational wave astronomy
PE9_12 High-energy and particle astronomy
PE9_13 Astronomical instrumentation and data, e.g. telescopes, detectors, techniques, archives, analyses

PE10 Earth System Science
Physical geography, geology, geophysics, atmospheric sciences, oceanography, climatology, cryology, ecology, global environmental change, biogeochemical cycles, natural resources management

PE10_1 Atmospheric chemistry, atmospheric composition, air pollution
PE10_2 Meteorology, atmospheric physics and dynamics
PE10_3 Climatology and climate change
PE10_4 Terrestrial ecology, land cover change
PE10_5 Geology, tectonics, volcanology
PE10_6 Palaeoclimatology, palaeoecology
PE10_7 Physics of earth’s interior, seismology, geodynamics
PE10_8 Oceanography (physical, chemical, biological, geological)
PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry
PE10_10 Mineralogy, petrology, igneous petrology, metamorphic petrology
PE10_11 Geochemistry, cosmochemistry, crystal chemistry, isotope geochemistry, thermodynamics
PE10_12 Sedimentology, soil science, palaeontology, earth evolution
PE10_13 Physical geography, geomorphology
PE10_14 Earth observations from space/remote sensing
PE10_15 Geomagnetism, palaeomagnetism
PE10_16 Ozone, upper atmosphere, ionosphere
PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
PE10_18 Cryosphere, dynamics of snow and ice cover, sea ice, permafrosts and ice sheets
PE10_19 Planetary geology and geophysics
PE10_20 Geohazards
PE10_21 Earth system modelling and interactions
**PE11 Materials Engineering**

Advanced materials development: performance enhancement, modelling, large-scale preparation, modification, tailoring, optimisation, novel and combined use of materials, etc.

- PE11_1 Engineering of biomaterials, biomimetic, bioinspired and bio-enabled materials
- PE11_2 Engineering of metals and alloys
- PE11_3 Engineering of ceramics and glasses
- PE11_4 Engineering of polymers and plastics
- PE11_5 Engineering of composites and hybrid materials
- PE11_6 Engineering of carbon materials
- PE11_7 Engineering of metal oxides
- PE11_8 Engineering of alternative established or emergent materials
- PE11_9 Nanomaterials engineering, e.g. nanoparticles, nanoporous materials, 1D & 2D nanomaterials
- PE11_10 Soft materials engineering, e.g. gels, foams, colloids
- PE11_11 Porous materials engineering, e.g. covalent-organic, metal-organic, porous aromatic frameworks
- PE11_12 Semi-conducting and magnetic materials engineering
- PE11_13 Metamaterials engineering
- PE11_14 Computational methods for materials engineering
Life Sciences

LS1  Molecules of Life: Biological Mechanisms, Structures and Functions

For all organisms:
Molecular biology, biochemistry, structural biology, molecular biophysics, synthetic and chemical biology, drug design, innovative methods and modelling

LS1_1 Macromolecular complexes including interactions involving nucleic acids, proteins, lipids and carbohydrates
LS1_2 Biochemistry
LS1_3 DNA and RNA biology
LS1_4 Protein biology
LS1_5 Lipid biology
LS1_6 Glycobiology
LS1_7 Molecular biophysics, biomechanics, bioenergetics
LS1_8 Structural biology
LS1_9 Molecular mechanisms of signalling processes
LS1_10 Synthetic biology
LS1_11 Chemical biology
LS1_12 Protein design
LS1_13 Early translational research and drug design
LS1_14 Innovative methods and modelling in molecular, structural and synthetic biology

LS2  Integrative Biology: from Genes and Genomes to Systems

For all organisms:
Genetics, epigenetics, genomics and other ‘omics studies, bioinformatics, systems biology, genetic diseases, gene editing, innovative methods and modelling, ‘omics for personalised medicine

LS2_1 Genetics
LS2_2 Gene editing
LS2_3 Epigenetics
LS2_4 Gene regulation
LS2_5 Genomics
LS2_6 Metagenomics
LS2_7 Transcriptomics
LS2_8 Proteomics
LS2_9 Metabolomics
LS2_10 Glycomics/Lipidomics
LS2_11 Bioinformatics and computational biology
LS2_12 Biostatistics
LS2_13 Systems biology
LS2_14 Genetic diseases
LS2_15 Integrative biology for personalised medicine
LS2_16 Innovative methods and modelling in integrative biology

LS3  Cellular, Developmental and Regenerative Biology

For all organisms:
Structure and function of the cell, cell-cell communication, embryogenesis, tissue differentiation, organogenesis, growth, development, evolution of development, organoids, stem cells, regeneration, therapeutic approaches

LS3_1 Cell cycle, cell division and growth
LS3_2 Cell senescence, cell death, autophagy, cell ageing
LS3_3 Cell behaviour, including control of cell shape, cell migration
LS3_4 Cell junctions, cell adhesion, the extracellular matrix, cell communication
LS3_5  Cell signalling and signal transduction, exosome biology
LS3_6  Organelle biology and trafficking
LS3_7  Mechanobiology of cells, tissues and organs
LS3_8  Embryogenesis, pattern formation, morphogenesis
LS3_9  Cell differentiation, formation of tissues and organs
LS3_10 Developmental genetics
LS3_11 Evolution of developmental strategies
LS3_12 Organoids
LS3_13 Stem cells
LS3_14 Regeneration
LS3_15 Development of cell-based therapeutic approaches for tissue regeneration
LS3_16 Functional imaging of cells and tissues
LS3_17 Theoretical modelling in cellular, developmental and regenerative biology

LS4  **Physiology in Health, Disease and Ageing**
Organ and tissue physiology, comparative physiology, physiology of ageing, pathophysiology, inter-organ and tissue communication, endocrinology, nutrition, metabolism, interaction with the microbiome, non-communicable diseases including cancer (and except disorders of the nervous system and immunity-related diseases)

LS4_1  Organ and tissue physiology and pathophysiology
LS4_2  Comparative physiology
LS4_3  Physiology of ageing
LS4_4  Endocrinology
LS4_5  Non-hormonal mechanisms of inter-organ and tissue communication
LS4_6  Microbiome and host physiology
LS4_7  Nutrition and exercise physiology
LS4_8  Impact of stress (including environmental stress) on physiology
LS4_9  Metabolism and metabolic disorders, including diabetes and obesity
LS4_10 The cardiovascular system and cardiovascular diseases
LS4_11 Haematopoiesis and blood diseases
LS4_12 Cancer
LS4_13 Other non-communicable diseases (except disorders of the nervous system and immunity-related diseases)

LS5  **Neuroscience and Disorders of the Nervous System**
Nervous system development, homeostasis and ageing, nervous system function and dysfunction, systems neuroscience and modelling, biological basis of cognitive processes and of behaviour, neurological and mental disorders

LS5_1  Neuronal cells
LS5_2  Glial cells and neuronal-glial communication
LS5_3  Neural development and related disorders
LS5_4  Neural stem cells
LS5_5  Neural networks and plasticity
LS5_6  Neurovascular biology and blood-brain barrier
LS5_7  Sensory systems, sensation and perception, including pain
LS5_8  Neural basis of behaviour
LS5_9  Neural basis of cognition
LS5_10 Ageing of the nervous system
LS5_11 Neurological and neurodegenerative disorders
LS5_12 Mental disorders
LS5_13 Nervous system injuries and trauma, stroke
LS5_14 Repair and regeneration of the nervous system
LS5_15 Neuroimmunology, neuroinflammation
LS5_16 Systems and computational neuroscience
LS5_17 Imaging in neuroscience
LS5_18 Innovative methods and tools for neuroscience

**LS6 Immunity, Infection and Immunotherapy**

The immune system, related disorders and their mechanisms, biology of infectious agents and infection, biological basis of prevention and treatment of infectious diseases, innovative immunological tools and approaches, including therapies

- LS6_1 Innate immunity
- LS6_2 Adaptive immunity
- LS6_3 Regulation of the immune response
- LS6_4 Immune-related diseases
- LS6_5 Biology of pathogens (e.g. bacteria, viruses, parasites, fungi)
- LS6_6 Infectious diseases
- LS6_7 Mechanisms of infection
- LS6_8 Biological basis of prevention and treatment of infection
- LS6_9 Antimicrobials, antimicrobial resistance
- LS6_10 Vaccine development
- LS6_11 Innovative immunological tools and approaches, including therapies

**LS7 Prevention, Diagnosis and Treatment of Human Diseases**

Medical technologies and tools for prevention, diagnosis and treatment of human diseases, therapeutic approaches and interventions, pharmacology, preventative medicine, epidemiology and public health, digital medicine

- LS7_1 Medical imaging for prevention, diagnosis and monitoring of diseases
- LS7_2 Medical technologies and tools (including genetic tools and biomarkers) for prevention, diagnosis, monitoring and treatment of diseases
- LS7_3 Nanomedicine
- LS7_4 Regenerative medicine
- LS7_5 Applied gene, cell and immune therapies
- LS7_6 Other medical therapeutic interventions, including transplantation
- LS7_7 Pharmacology and toxicology
- LS7_8 Effectiveness of interventions, including resistance to therapies
- LS7_9 Public health and epidemiology
- LS7_10 Preventative and prognostic medicine
- LS7_11 Environmental health, occupational medicine
- LS7_12 Health care, including care for the ageing population
- LS7_13 Palliative medicine
- LS7_14 Digital medicine, e-medicine, medical applications of artificial intelligence
- LS7_15 Medical ethics

**LS8 Environmental Biology, Ecology and Evolution**

*For all organisms:*

Ecology, biodiversity, environmental change, evolutionary biology, behavioural ecology, microbial ecology, marine biology, ecophysiology, theoretical developments and modelling

- LS8_1 Ecosystem and community ecology, macroecology
- LS8_2 Biodiversity
- LS8_3 Conservation biology
- LS8_4 Population biology, population dynamics, population genetics
- LS8_5 Biological aspects of environmental change, including climate change
- LS8_6 Evolutionary ecology
- LS8_7 Evolutionary genetics
- LS8_8 Phylogenetics, systematics, comparative biology
LS8 9  Macroevolution and paleobiology
LS8 10  Ecology and evolution of species interactions
LS8 11  Behavioural ecology and evolution
LS8 12  Microbial ecology and evolution
LS8 13  Marine biology and ecology
LS8 14  Ecophysiology, from organisms to ecosystems
LS8 15  Theoretical developments and modelling in environmental biology, ecology, and evolution

LS9  Biotechnology and Biosystems Engineering
Biotechnology using all organisms, biotechnology for environment and food applications, applied plant and animal sciences, bioengineering and synthetic biology, biomass and biofuels, biohazards

LS9 1  Bioengineering for synthetic and chemical biology
LS9 2  Applied genetics, gene editing and transgenic organisms
LS9 3  Bioengineering of cells, tissues, organs and organisms
LS9 4  Microbial biotechnology and bioengineering
LS9 5  Food biotechnology and bioengineering
LS9 6  Marine biotechnology and bioengineering
LS9 7  Environmental biotechnology and bioengineering
LS9 8  Applied plant sciences, plant breeding, agroecology and soil biology
LS9 9  Plant pathology and pest resistance
LS9 10  Veterinary and applied animal sciences
LS9 11  Biomass production and utilisation, biofuels
LS9 12  Ecotoxicology, biohazards and biosafety
Social Sciences and Humanities

SH1 Individuals, Markets and Organisations
Economics, finance, management

SH1_1 Macroeconomics; monetary economics; economic growth
SH1_2 International trade; international management; international business; spatial economics
SH1_3 Development economics; structural change; political economy of development
SH1_4 Finance; asset pricing; international finance; market microstructure
SH1_5 Corporate finance; banking and financial intermediation; accounting; auditing; insurance
SH1_6 Econometrics; operations research
SH1_7 Behavioural economics; experimental economics; neuro-economics
SH1_8 Microeconomic theory; game theory; decision theory
SH1_9 Industrial organisation; entrepreneurship; R&D and innovation
SH1_10 Management; strategy; organisational behaviour
SH1_11 Human resource management; operations management, marketing
SH1_12 Environmental economics; resource and energy economics; agricultural economics
SH1_13 Labour and demographic economics
SH1_14 Health economics; economics of education
SH1_15 Public economics; political economics; law and economics
SH1_16 Historical economics; quantitative economic history; institutional economics; economic systems

SH2 Institutions, Governance and Legal Systems
Political science, international relations, law

SH2_1 Political systems, governance
SH2_2 Democratisation and social movements
SH2_3 Conflict resolution, war, peace building, international law
SH2_4 Legal studies, constitutions, human rights, comparative law
SH2_5 International relations, global and transnational governance
SH2_6 Humanitarian assistance and development
SH2_7 Political and legal philosophy
SH2_8 Big data in political and legal studies

SH3 The Social World and Its Diversity
Sociology, social psychology, social anthropology, education sciences, communication studies

SH3_1 Social structure, social mobility, social innovation
SH3_2 Inequalities, discrimination, prejudice
SH3_3 Aggression and violence, antisocial behaviour, crime
SH3_4 Social integration, exclusion, prosocial behaviour
SH3_5 Attitudes and beliefs
SH3_6 Social influence; power and group behaviour
SH3_7 Kinship; diversity and identities, gender, interethnic relations
SH3_8 Social policies, welfare, work and employment
SH3_9 Poverty and poverty alleviation
SH3_10 Religious studies, ritual; symbolic representation
SH3_11 Social aspects of teaching and learning, curriculum studies, education and educational policies
SH3_12 Communication and information, networks, media
SH3_13 Digital social research
SH3_14 Social studies of science and technology
The Human Mind and Its Complexity
Cognitive science, psychology, linguistics, theoretical philosophy

- Cognitive basis of human development and education, developmental disorders; comparative cognition
- Personality and social cognition; emotion
- Clinical and health psychology
- Neuropsychology
- Attention, perception, action, consciousness
- Learning, memory; cognition in ageing
- Reasoning, decision-making; intelligence
- Language learning and processing (first and second languages)
- Theoretical linguistics; computational linguistics
- Language typology; historical linguistics
- Pragmatics, sociolinguistics, linguistic anthropology, discourse analysis
- Philosophy of mind, philosophy of language
- Philosophy of science, epistemology, logic

Cultures and Cultural Production
Literary studies, cultural studies, study of the arts, philosophy

- Classics, ancient literature and art
- Theory and history of literature, comparative literature
- Philology; text and image studies
- Visual and performing arts, film, design and architecture
- Music and musicology; history of music
- Museums, exhibitions, conservation and restoration
- Cultural studies, cultural identities and memories, cultural heritage
- Metaphysics, philosophical anthropology; aesthetics
- Ethics and its applications; social philosophy
- History of philosophy
- Computational modelling and digitisation in the cultural sphere

The Study of the Human Past
Archaeology and history

- Historiography, theory and methods in history, including the analysis of digital data
- Classical archaeology, history of archaeology, social archaeology
- General archaeology, archaeometry, landscape archaeology
- Prehistory, palaeoanthropology, palaeodemography, protohistory, bioarchaeology
- Palaeography and codicology
- Ancient history
- Medieval history
- Early modern history
- Modern and contemporary history
- Colonial and post-colonial history
- Global history, transnational history, comparative history, entangled histories
- Social and economic history
- Gender history, cultural history, history of collective identities and memories, history of religions
- History of ideas, intellectual history, history of economic thought
- History of science, medicine and technologies
SH7  Human Mobility, Environment, and Space
Human geography, demography, health, sustainability science, territorial planning, spatial analysis

SH7_1  Human, economic and social geography
SH7_2  Migration
SH7_3  Population dynamics: households, family and fertility
SH7_4  Social aspects of health, ageing and society
SH7_5  Sustainability sciences, environment and resources
SH7_6  Environmental and climate change, societal impact and policy
SH7_7  Cities; urban, regional and rural studies
SH7_8  Land use and planning
SH7_9  Energy, transportation and mobility
SH7_10 GIS, spatial analysis; big data in geographical studies