Work programme 2019

Generic call for proposals 2019*

Date of publication
26 July 2018

STAGE 1
CLOSURE OF PRE-PROPOSAL SUBMISSION (PRC, PRCE, JCJC)
AND REGISTRATION (PRCI)

25 October 2018, at 1 P.M. (Paris time)

STAGE 2

CLOSURE OF FULL PROPOSAL SUBMISSION

Full proposal submission phase closure is set for the end of March 2019; the exact date will be specified upon invitation to submit full proposals.

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* In case of any difference of interpretation, the French version of the present document shall prevail

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Applicants are advised to carefully read the entire document as well as ANR funding allocation procedures (http://www.anr.fr/RF) before submitting research project proposals

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Contents

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A. Context and objectives of the Generic Call for Proposals 2019

The Generic Call for Proposals 2019 (AAPG 2019) is the "Research and Innovation" component of ANR's Work Programme 2019.

AAPG 2019 is directed towards all scientific communities and all public and private players involved in French research, including small and medium-sized enterprises and very small enterprises.

It is designed to give researchers in various disciplines access to co-funding in a large number of research themes (applied or otherwise) in addition to their allocated recurrent funding.

The "**Research and Innovation**" component of ANR's Work Programme 2019, which supports AAPG 2019, has been structured into **48 research themes**:

- **35 research themes** spanning 7 **disciplinary** areas
    - o Environmental Sciences
    - o Energy and Materials Sciences
    - o Life Sciences
    - o Social Sciences and Humanities
    - o Digital Sciences
    - o Mathematics and its Interactions
    - o Physics of Matter, High Energy, Earth and Universe Sciences.
- **13 research themes** covering **cross-disciplinary** (or interdisciplinary) issues.

Each research theme corresponds to a dedicated scientific evaluation panel.

When researchers submit a proposal, they select the research theme – and therefore the Scientific Evaluation Panel – that most closely relates to the subject of their research. *This choice cannot be changed during the selection process.*

The panels dealing with cross-disciplinary or interdisciplinary themes include members who cover all required disciplines.

B. Submission, evaluation and funding of projects under the Generic Call for Proposals 2019

The generic call for proposals is open to tenured researchers at a French public research organisation or laboratory or a French company conducting research and development work in France.

B.1.   Funding instruments

AAPG 2019 uses a set of instruments to fund individual research projects coordinated by young researchers (**JCJC**), or collaborative research projects between public entities in a national or international context (**PRC** and **PRCI** respectively), and public and private entities with a potential opening to the world of business (**PRCE**). The four funding instruments proposed under the Generic Call for Proposals each have specific submission and evaluation procedures.

The characteristics and requirements of these funding instrument are outlined in Work Programme 2019 and explained in detail in the "AAPG 2019 Guide".[1]
Researchers will need to select the instrument that best suits the objectives of their project when making their application. ***This choice cannot be changed during the selection***

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[1] Published on the ANR website in late August/early September 2018. The AAPG 2019 Guide is the authoritative document for applicants, experts and panel members, explaining how the submission, evaluation, selection and funding processes work.

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process.

B.2. Eligibility of proposals

ANR will verify the eligibility of the projects throughout the submission, evaluation, selection and funding process on the basis of the criteria described in the AAPG 2019 Guide. ***Projects deemed ineligible will not be evaluated by panel members.***

B.3. Submission rules

> ➢ A researcher may only submit one project as coordinator and cannot be involved (as coordinator or partner's scientific leader) in more than three proposals submitted to the Generic Call for Proposals, including PRCI,[2] and to the specific bilateral calls for proposals outlined in Work Programme 2019.[3] For AAPG 2019, this exclusion rule does not apply to international multilateral calls (EAR-NET, JPI, Article 185, etc.), or to the MRSEI, Astrid and Astrid Maturation, LabCom and LabCom Consolidation, Challenge, Chair and Flash calls.[4]
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> ➢ A coordinator of a PRC, PRCE, PRCI or JCJC proposal selected under the Generic Call for Proposals 2018 cannot submit a PRC, PRCE, PRCI or JCJC proposal as coordinator for the Generic Call for Proposals 2019. However, the researcher may act as a partner's scientific leader or be otherwise involved in a PRC, PRCE or PRCI proposal submitted for the 2019 edition.
>
> ➢ A JCJC project coordinator cannot act as the coordinator for another JCJC, PRC, PRCE or PRCI for the Generic Call for Proposals while the initial JCJC project is ongoing. However, the researcher may be involved in a PRC, PRCE or PRCI proposal submitted for the 2019 edition.
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> ➢ A coordinator cannot be in receipt of funding for a JCJC project, and for an ATIP-Avenir, Momentum, Emergence, ERC or T-ERC project, at the same time.
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> ➢ The project coordinator, funding instrument and Scientific Evaluation Panel indicated when the pre-proposal is submitted cannot be changed during the AAPG2019 selection process.

B.4. Proposal submission process

The submission form must be completed online and the scientific documents (pre-proposal or full proposal) must be submitted in PDF format via the ANR website.

Refer to the AAPG 2019 Guide for details of what the scientific document should contain. The scientific proposal (written in French or English) should not exceed 4 pages (including bibliography, diagrams and references) for a pre-proposal and 20 pages (including

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[2] In a PRCI proposal, the French partner's scientific leader is automatically considered to be the coordinator. The limit to participation in no more than three projects as coordinator or partner's scientific leader applies equally to phase 1 PRCI registrations. Consequently, the coordinator of a phase 1-registered PRCI proposal cannot be the coordinator of a separate PRC, PRCE or JCJC proposal under the Generic Call for Proposals, regardless of the outcome of the phase 1 evaluation for that PRC, PRCE or JCJC proposal.

[3] For a proposal submitted under a specific bilateral call (France-Germany, France-Japan or France-Quebec for 2019 – see ANR's website for open calls), the French partner's scientific leader is automatically considered to be the coordinator. The limit to participation in no more than three projects as coordinator or partner's scientific leader applies equally to specific bilateral calls. Consequently, the coordinator of a specific bilateral call proposal cannot be the coordinator of a separate PRC, PRCE, JCJC or PRCI proposal under the Generic Call for Proposals, regardless of the outcome of the phase 1 evaluation for that PRC, PRCE or JCJC proposal.

[4] A researcher can submit a proposal for the Generic Call for Proposals or a specific bilateral call, and a separate proposal for a MRSEI, Astrid or Astrid Maturation call for proposals. However, the scientific objectives of the separate proposals must be materially different (see the similarity rule in the AAPG 2019 Guide).

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bibliography,[5] diagrams and references) for a full proposal.

Project participants are invited to enter their ORCID ID online.[6]

During the submission phase, the coordinator and any partners undertake to adhere to the French National Charter for Research Integrity to ANR's Code of Ethics and Scientific Integrity. The research proposal will need to give due consideration to sex and/or gender aspects, irrespective of the research area in question. Moreover, an undertaking to comply with the obligations arising from the Nayoga Protocol and the French act for a Digital Republic (pertaining to the national open archives plan) (see §C) will also be required when the proposal is submitted.

B.5.   Project selection

Project selection at ANR is based on the principle of peer review. ANR's selection process includes panels and external experts (i.e. outside these panels).

The Scientific Evaluation Panels comprise highly qualified French or foreign individuals from the relevant research communities. They are in charge of evaluating pre-proposals or full proposals. External experts are involved in phase 1 exceptionally, and in phase 2 systematically.

Each evaluation panel is chaired by a president-referent (chairperson) trained in ANR's selection process procedures and ethics. The president-referent heads the Scientific Evaluation Panels bureau, generally consisting of two vice-chairs[7] who assist him/her in preparing the panel's work.

In first stage, the applicant chooses the panel in which his/her project will be evaluated and this choice cannot be modified during the selection process

The experts in the area(s) concerned by the proposals produce written evaluations of one or more pre-proposals or full proposals without participating in panel meetings. The experts operate individually and confidentially, without any contact with third parties. The only elements at their disposal are the materials in the pre-proposal and/or the full proposal as submitted through the website before the call deadline.

The ANR Code of Ethics and Scientific Integrity[8] applies to all persons involved in the project selection process.

The Generic Call for Proposals 2019 involves a two-stage proposal evaluation and selection process.[9] The draft submission, evaluation and funding schedule can be found on the ANR website. The process is described in detail in the AAPG 2019 Guide.

The first phase (excluding PRCI proposals, which are only registered at this stage[10]) involves identifying PRC, PRCE and JCJC pre-proposals for which it is justified to write full proposals, particularly in terms of quality and scientific aims[11].

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[5]   For the 2019 edition, the coordinator's and partners' CVs may include preprints (https://en.wikipedia.org/wiki/Preprint) that have yet to be published in peer-reviewed academic journals. Applicants are also encouraged to cite preprints with reference to preliminary data.

[6] ORCID is a non-profit organisation supported by a global community of organisational members, including research organisations, publishers, funders, professional associations, and other stakeholders in the research ecosystem. For more information, go to: https://orcid.org

[7] There are between one and three vice-chairs, depending on the panel size.

[8] http://www.anr.fr/CharteDeontologieSelection

[9] The Generic Call for Proposals selection process was awarded ISO 9001 certification in May 2018.

[10] For the PRCI instrument, phase 1 of the Generic Call for Proposals 2019 submission process involves registration only. A full proposal will be required at stage 2 for all registrations at phase 1, unless the registered proposal is ineligible (for instance, under the non-dual coordination rule, see §B.3).

[11] Between 2,500 and 3,000 applicants will be invited to submit full proposals at the end of phase 1.

The second stage (which includes PRCI proposals) aims to select the best proposals by evaluating, in accordance with international competitive project selection principles, the quality and scientific aims of the proposal, how it is organised and how it will be implemented, and what the impact and consequences of the project described in the full proposal will be.[12] This second phase draws on both external experts and the evaluation performed by members of the panel to which the coordinator submitted the proposal. This second phase also includes a rebuttal stage. The coordinator's response to external experts will be taken into account in the ranking meeting for projects selected in phase 2. The Scientific Evaluation Panel will discuss each proposal and rank them. The panel's evaluation report will be sent to the project coordinator, reflecting the consensus reached at the meeting.

B.6. Project funding

At the end of the evaluation and selection process, the decision on whether or not to select a project is made by ANR based on the rankings established by the Scientific Evaluation Panels[13] and budgetary guidelines and priorities approved by MESRI. In July 2019, ANR will publish the list of projects selected to receive potential funding commencing in October 2019.

The proposals selected will be funded by ANR, on the condition that a grant agreement is signed with each of the benefiting partners This might sometimes require additional information and analysis (particularly for companies: i.e. financial statements, company registration (kbis), information on capital relationships).

The procedures for attribution of ANR grants are set out in the "*Regulations concerning the conditions of allocation of ANR funding*" (http://www.anr.fr/RF). Partners are invited to read this document carefully in order to draw up their proposals in compliance with the provisions therein in particular with respect to budget aspects.

C. Special mechanisms and legal requirements

C.1. Very large research infrastructures (TGIR)

Projects relying on resources from very large research infrastructures (TGIR) are invited to make that clear at the time they submit their pre-proposal. An approach independent of the submission of the proposal to the ANR must be undertaken to ensure such resources are obtained if the smooth running of the project depends on them. Evidence of this can be provided in the full proposal.

C.2. Competitiveness clusters

Projects wishing to be labelled by one or more competitiveness clusters must declare this in phase 1 of the selection process.[14]

The scientific coordinator must have the pre-proposal approved by the other partners (including international partners, where applicable) before submitting a labelling request. All project partners are invited to make contact with the competitiveness clusters concerned as early as possible and to be informed as to the commitments they make in case they obtain support from these clusters (including possible membership of the cluster, transmission of mid-term and final project reports).

If a proposal successfully obtains a label from a competitiveness cluster, information on the monitoring of the project will also be provided to the competitiveness clusters. The labelling timetable is set out in the AAPG 2019 Guide.

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[12] The evaluation criteria for each phase of the selection process are explained in § D.
[13] ANR does not alter the rankings produced by the panels.
[14] Such requests will not be accepted in phase 2. PRCI proposals are not eligible for labelling.

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C.3.   French co-funding

The ANR establishes partnerships with other funders. The Generic Call for Proposal's list of co-funders is regularly updated on the ANR website's Generic Call for Proposals page.

In general, co-funders do not provide additional funding but rather contribute to the grant requested from ANR for a project, except where a specific application is made directly to the partner co-funder. Co-funding means that the grant attributed to the project includes a financial contribution from ANR and a co-funder partner with an interest in supporting the research work.

A selected project coordinator may refuse co-funding for his/her project. Similarly, the coordinator may refuse to allow information about the project to be shared with a co-funder prior to the evaluation procedure.

C.4.   Scientific publications and research data

As a signatory to the "Partnership agreement to foster open archives and the HAL (Hyper Articles on Line) shared platform",[15] alongside research and teaching organisations, ANR draws on article 30 of the "Digital Republic" act[16] and requires that the full texts of all publications resulting from the projects it funds should be posted in the open archives, directly in HAL or via a local institutional archive.[17] In the interest of fostering open publication of research data, applicants should understand the importance of research data when setting up projects and throughout the whole process. ANR will require all projects funded from 2019 onwards to have a data management plan (DMP).[18]

For more detailed information on the Optimised Sharing and Interoperability of Research Data, applicants should refer to the Inist-CNRS OPIDoR portal, at: **https://opidor.fr**.

C.5.   Access to genetic resources and traditional knowledge associated with genetic resources

Pursuant to the Nagoya Protocol, ANR must obtain documentary evidence of Due Diligence Declarations (DDDs) for all research projects that it funds. This rule applies to projects funded in 2018 and to applicants for the 2019 calls, who will be asked to make a declaration on potential utilisation of genetic resources during their projects.

DDDs for research work can be submitted online using the special application on the MESRI website. Credentials to access the application can be obtained from the director of the host institution. For full details, go to: http://www.enseignementsup-recherche.gouv.fr/pid37627/utilisation-ressources-genetiques-associees.html

D. Evaluation criteria for projects submitted to the Generic Call for Proposals 2019

Panel members and external experts use the same set of criteria to evaluate pre-proposals and full proposals.

 ➢ **Evaluation of pre-proposals** (phase 1)

  o *Quality and scientific aims (determining criterion)*

  o *Organisation and implementation of the project*

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[15] "Partnership agreement to foster open archives and the HAL (Hyper Articles on Line) shared platform" – 2 April 2013

[16] French act no. 2016-1321 of 7 October 2016 for a Digital Republic

[17] At least the author accepted manuscript (AAM) for publication.

[18] The DMP is a formal document produced at the start of a project or research process, defining how the data will be created/collected, and how it will be documented, used, managed, shared, protected and stored throughout the project and following its completion. The document will be updated on a regular basis until the project is complete.

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➢ **Evaluation of full proposals** (phase 2)

    o *Quality and scientific aims*

    o *Organisation and implementation of the project*

    o *Impact and benefits of the project*

At phase 1, the "Quality and scientific aims" criterion is determining (<u>proposals must achieve an A rating to move to phase 2</u>).

The different criteria applied in phases 1 and 2 of the selection process are outlined below and can also be found in the AAPG 2019 Guide.

Evaluation criteria for projects submitted to the Generic Call for Proposals 2019

Phase 1 (evaluation of pre-proposals)

Quality and scientific aims (determining criterion: A rating is required)

- Clarity of research objectives and hypotheses
- Novelty, originality, position in relation to the state of the art
- Appropriateness of the methodology
- Ability of the project to address the research issues covered by the chosen research theme

Organisation and implementation of the project

- Competences, expertise and involvement of the scientific coordinator and the partners
- *For PRC/PRCE proposals*: Quality and complementarity of the consortium, quality of collaboration,
  or
  For JCJC proposals: Contribution to the coordinator's level of responsibility and team development

Phase 2 (evaluation of full proposals)

Quality and scientific aims

- Clarity of research objectives and hypotheses
- Novelty, originality, position in relation to the state of the art
- Appropriateness of the methodology, management of scientific risks

Organisation and implementation of the project

- Competences, expertise and involvement of the scientific coordinator and the partners
- *For PRC/PRCE/PRCI proposals*: Quality and complementarity of the consortium, quality of collaboration,
  or
  For JCJC proposals: Contribution to the coordinator's level of responsibility and team development
- Appropriateness of implemented and requested resources to the project's objectives

Impact and benefits of the project

- Scientific impact and potential economic, social or cultural impact

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- *For PRC/JCJC proposals*: Research outcome dissemination and application strategy, including promoting scientific culture,

  or

  For PRCE proposals: Action of technology and innovation transfer with regard to the social and economic world,

  or

  For PRCI proposals: Balance and complementarity of scientific contributions by respective partners in each country and added value/benefit for France from this European or international cooperation**.**

The sub-criteria under the main criteria have a degree of detail suited to the content and the size of the scientific document. The sub-criteria are a guide both for the applicant in writing their scientific document and for the reviewer (panel member or external expert) in evaluating the proposal.

E. Scientific axes related to the generic call for proposals 2019

Each research theme corresponds to a dedicated scientific evaluation panel.

E.1. Environmental Sciences

Contacts : Frederic.MONOT@agencerecherche.fr; Maurice.HERAL@agencerecherche.fr

1.1. Fluid and solid Earth

Contacts: Celine.BILLIERE@agencerecherche.fr; Anne.LIEUTAUD@agencerecherche.fr

This area of research covers the projects aiming to acquire fundamental knowledge of the Earth's various spheres (lithosphere, hydrosphere and oceans, atmosphere, biosphere, …)[19]. The scientific scope is defined by the following topics:

- Functioning and evolution of climate and major cycles,
- Characterisation, dynamics and functioning of the critical zone and the associated biosphere,
- Knowledge of mineral resources: deposits and environmental impacts.

Associated keywords: Earth System and interactions of scales, atmosphere, oceans, cryosphere, continental surfaces, interfaces, climate change, climate models, visible and invisible biosphere, greenhouse gas emissions, aerosols, offshore oceans, marine chemistry, biogeochemistry, extreme events, biogeochemical cycles, soil function, erosion, sedimentology, pedogenesis, responses of critical zone to global changes, hydrosphere, hydrology, carbon cycle, nitrogen cycle, wetlands, temporal series (incl. Proxies) and retro-analysis, Coupling Data Assimilation Systems, Paleo-events as analogous to those of the Anthropocene era, geodesy, primary mineral resource deposit: genesis and potential, optimisation of mineral deposit exploitation.

ERC keywords: PE10, LS08.

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[19] *Projects related to paleo-events as analogous to those of the Anthropocene era (from the Quaternary) are assessed in this area of research. Projects related to paleo-events but not analogous to those of the Anthropocene era are assessed in the theme « Subatomic physics, Universe sciences, structure and history of the Earth ».*

Projects regarding the use of mineral resources in the field of Energy are not assessed in this area of research (see theme "Efficient resource management and adaptation to climate change").

Projects regarding extreme events are assessed in this area of research. However, those that related to the subjects of early warning/alert or adaptation/remediation are treated within the topic « Interactions between humans and the environment » or « Scientific and technological innovations to support the ecological transition ».

Projects regarding anthroposphere are not treated within this area of research (see theme « Interactions between humans and the environment »).

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1.2. Living Earth

Contacts*: Antoine.MORISOT@agencerecherche.fr; Anne.LIEUTAUD@agencerecherche.fr*

This axis covers research projects aiming to the acquisition of fundamental knowledge on biodiversity and dynamics of continental and marine ecosystems, little- or non-anthropised[20], past or present. Its scientific scope includes:

- global exploration of biodiversity,
- origin, characterization and evolution of species,
- populations dynamics (species to communities) and their interactions,
- behavioural adaptations of species, populations, communities, and their interactions. The scale can range from molecular level to macro-systems.
- all the clades of these ecosystems.

Associated keywords: *biodiversity, evolution, observation, uncommon species, invasive species, ecological infrastructure, ecosystems, soil, forest, aquatic ecosystems, resilience, systems integration, systems modelling, trophic network, ecology, systematics, phylogeny, ethology, population genetics, biology, functional ecology, animal and plant ecology, phylogeography, modelling, microbiology, bio-geochemistry.*

ERC keywords: *SH01, SH02, SH03, PE01, PE04, PE05, PE06, PE10, LS02, LS03, LS06, LS08, LS09.*

1.3. Scientific and technological innovations to support the ecological transition

Contacts*: Melanie.PATEAU@agencerecherche.fr; Anne.LIEUTAUD@agencerecherche.fr*

This axis covers research projects on environmental technologies in the context of ecological and digital transitions, in particular:

- the development of sensors for monitoring the environment in all its components (*smart monitoring*),
- methods and tools for operational diagnostic, warning and environmental crisis services,
- methods and tools for sustainable remediation, ecological engineering, climate engineering, new approaches for controlling the environmental impact of new or transition economic sectors.

Associated keywords: *warning services and tools for natural and technological risks (cascade effect), sustainable remediation technologies, ecological engineering (incl. phytoremediation and bioremediation), climate engineering, environmental sensors, sensor networks, technology trains, treatment of pollutants, effluents and wastes, measurement of GHG and air pollutants, GHG sequestration, ecodesign, environmental chemistry, water and soil pollution, agroecosystems, socio-ecosystems, biomimetics. biomimicry*

ERC keywords: *LS08, LS09, PE02, PE03, PE04, PE05, PE06, PE07, PE08, PE09, PE10.*

1.4. Biology of animals, photosynthetic organisms and microorganisms

Contacts*: Jannatul.MIA@agencerecherche.fr; Isabelle.HIPPOLYTE@agencerecherche.fr*

This axis covers fundamental and applied research projects in biology of livestock, fish species, photosynthetic organisms, including models, and associated organisms (microorganisms, microbiota, pests, pathogens, ...) and their interactions.

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2 *Projects dealing with productive systems are not considered in this axis but have to apply to the axis « Dynamics of socio-ecosystems and their components in order to their sustainable management »*

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All levels of regulation (genomic, transcriptomic, epigenetic, translational, post-translational, metabolic, developmental, physiological ...) are concerned. The projects are part of a continuum, from gene, molecule to population.

Associated keywords: symbiosis, parasitism, allelopathy, synergy, pathogenicity, models, crop, weed, aquatic, forest, marine, fruit, livestock, fish, fish farming, terrestrial, microbiology, biology, genetics, physiology, genomics, proteomics, metabolomics, epigenetics, biochemistry, bioinformatics, ecophysiology, genetic engineering, transgenesis, genome editing, modelling, bio-control.

ERC keywords: LS02, LS03, LS06, LS08, LS09

1.5. Food and food systems

Contacts*: Mariette.ELKHOURY@agencerecherche.fr; Isabelle.HIPPOLYTE@agencerecherche.fr*

This axis covers fundamental or applied research projects on food, food systems and global food security. These projects could include the following topics:

- biology of human nutrition, excluding projects dealing with pathologies[21],
- evolution of technologies and food processing,
- safety of the food chain,
- evolution of consumer behaviours,
- the determinants and impacts of food transition and of the evolution of food consumption practices,
- social and economic organisation of food systems.

The general objective is to offer food meeting consumer needs, accessible to all, supporting welfare and health by developing safe and sustainable food systems, based on a resilient job-creating economic system which fairly distributes the value between the actors and favours the development of nations and territories.

Associated keywords: multi-actor approaches, preventive nutrition, specific populations, consumption practices, taste and sensoriality, access to food, governance, markets, retailing, competitiveness, preservation, pathogens, decontamination, microbiota, processes, engineering, physical-chemistry, nutrition, diet, epidemiology, physiology, microbiology, economics, sociology, cultural and biological anthropologies, sectors, clean label

ERC keywords: LS09, PE01, PE04, PE05, PE06, PE07, PE08, SH01, SH02, SH03.

1.6. Dynamics of socio-ecosystems and their components to improve their sustainable management

Contacts: *Audrey.ARNAULT@agencerecherche.fr; Isabelle.HIPPOLYTE@agencerecherche.fr*

This axis covers basic and applied research projects aiming at i) understanding the dynamics of productive ecosystems to improve their sustainable management, ii) proposing innovations for the integrated and sustainable management of socio-ecosystems, iii) contributing to the development of pathways and scenarios to support ecological and digital transitions. It includes the following topics:

- exploration of biodiversity and dynamics of adaptation of socio-ecosystems,
- role of biodiversity and related ecosystem services in socio-ecosystems,
- interfaces and interactions between productive or exploited ecosystems and their environment,
- impact of agro-ecosystem practices on environmental changes,

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[21] which must be submitted to the « Life Sciences » domain.

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- origin, characterisation and evolution of exploited species,
- alterations of productive aquatic ecosystems (marine or continental).

Multidisciplinary approaches are welcome.

Associated keywords: biodiversity, biomonitoring, biocontrol, design of systems and/or agricultural policies, animal and plant health management, soil management, major cycles, biology, functional ecology, agronomy, animal sciences, sociology, economy, geography, political science, modelling, genetics, physical chemistry, microbiology, practices, environmental law, ecosystem service, landscape, multi-stakeholder approach, forms of agriculture, livestock, aquaculture and fishing.

ERC keywords: LS02, LS06, LS08, LS09, PE01, PE06, PE07, PE08, PE10, SH01, SH02, SH03.

E.2. Energy and materials sciences

Contacts: olivier.spalla@agencerecherche.fr; pascal.bain@agencerecherche.fr

2.1. A sustainable, clean, secure and efficient energy

Contacts: Romain.BRISSE@agencerecherche.fr ; Linda.OUKACINE@agencerecherche.fr ; Pascal.BAIN@agencerecherche.fr

This research area aims to mobilise all national research skills to respond to the challenges of the energy transition (set by the law of August 18, 2015) whose scientific obstacles are described in the National Research Strategy for Energy (SNRE). On all these issues (reduction of energy consumption and of greenhouse gases emissions, etc.) are therefore expected projects promoting systemic and integrative approaches, the design of new materials and systems, methods and processes as well as contributions of the digital society and of human and social sciences.

This research area is also largely open to basic sciences for energy, with essentially an exploratory vocation. The aim is to mobilize all scientific disciplines (chemistry, geosciences, physics, mathematics, etc.), not always classically recognizable under the "energy" theme, in order to produce the fundamental and exploratory knowledge that may be useful for the energy transition and to prepare the emergence of radically new ideas and breakthrough concepts.

Proposals can address the following topics:

- basic energy sciences: fundamental, exploratory research, breakthrough concepts to answer the long-term challenges of energy,
- renewable energies, energy harvesting,
- clean hydrogen production,
- production of synthetic fuels and platform molecules from CO_2; activation of stable small molecules (CO_2, CH_4, N_2, ...),
- hydrogen storage, fuel cells,
- electrochemical energy storage: batteries and supercapacitors,
- dynamic management of energy systems: smart-grids and storage,
- sustainable uses of the underground in an energy perspective, including the temporary storage of energy with a low environmental impact,
- energy efficient equipment and industrial processes, CO_2 capture and reuse,
- energy efficiency and reduction of the emissions of transport vehicles (combustion, hybridization, overall optimization of energy in vehicles ...),
- efficiency of the components and infrastructures enabling a digital society,
- energy transition and human and social sciences: integrative approaches of the challenges (political, societal, economic, environmental, territorial, technological, etc.) of the energy

transition, link with climate mitigation and adaptation policies, representations and new practices of energy, etc.

Projects dedicated to the production of biomass or its transformation into bioenergy must be treated within the "*Bioeconomy*" research area.

Associated key words: *wind energy, marine energy, geothermal energy, hydropower, solar thermal, CSP, photovoltaic, hydrogen-energy, electrolysis, fuel cells, solar fuels, bio-inspired energy production, biofuel-cells, energy harvesting, CO_2 reuse, carbon cycle, power-to-X, energy storage, electrochemical storage, batteries, supercapacitors, electrical engineering, power electronics, smart-grids, thermal and thermodynamic systems, energy efficiency, turbines, engines, HVAC equipment, heating, cooling, clean combustion, energy efficient and with low GHG emissions transport vehicles and industrial processes, capture / transport / storage of CO_2, geosciences, methodology of exploration and evaluation of the underground for energy use, recovery and valorisation of waste heat, nuclear power, SSH & energy, digital & energy, basic energy sciences.*

ERC codes*: LS09, PE01, PE02, PE03, PE04, PE05, PE06, PE07, PE08, PE10, SH01, SH02, SH03, SH06.*

2.2. Polymers, composites, soft matter physics and chemistry

Contacts: *Nela.ROY@agencerecherche.fr ; Leo.MAZEROLLES@agencerecherche.fr*

This research area covers the scientific fields:

- Design and using of new monomers, oligomers and non-toxic polymers, the functionalization of polymers (natural or synthetic) and precision macromolecular chemistry, the development of synthesis methods of performance polymers enabling to be used under extreme conditions, composite resins with polymerization process verifiable at moderate temperature or systems for additive manufacturing. The proposal of chemistries allowing for both the synthesis and efficient recycling of polymers will be much appreciated,
- Soft-matter physics and engineering, where the properties come from interactions, structuring and dynamics at different temporal and spatial scales. Proposals on the production of synthons enabling supramolecular organizations through their self-assembling or self-organization properties are expected,
- Development of polymer-based materials with special properties (self-repairing, thermo-mechanical….) for specific applications (e.g., sensors, membranes, smart textiles, etc.),
- innovative formulation concepts, study of structure-property relationships and multi-scale modelling of soft-matter, composites, polymer materials, nano-composites in order to predict their properties including the ageing issues,
- Organic matrix composites addressing different industrial areas (aerospace, automotive, buildings, energy, health …) and the research activity for optimizing their thermal and mechanical properties, promoting their recycling abilities, or obtaining functional properties by surface patterning. .

The scientific fields requested involve chemists, physical chemists and physicists. The proposals will address four topics :

- chemistry and synthesis of polymers,
- supramolecular chemistry and physical-chemistry, molecular assembly,
- polymer materials and functional composites,
- polymer surfaces and interfaces.

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Associated key words: design, synthesis and properties of molecular units, supramolecular and macromolecular, synthetic polymer chemistry, polymerization processes including additive manufacturing, synthesis, elaboration and properties of functional polymer materials (composites, hybrids, biomaterials, membranes,…), polymer shaping processes, sustainability and life-cycle of supra- and macro-molecular systems, supramolecular chemistry and physics, confinement, encapsulation, self-assembly, molecular and hybrid materials, thin films, bio-inspired systems, impregnation resins, organic matrix composites, soft matter, complex fluids, structural characterization, functionalization, oligomers, liquid polymers, surfactants, liquid crystals, micelles, vesicles, colloids, gels and hydrogels, molecular machines, micro-nanoreactors, molecular recognition, structural and mechanical properties of organic biomaterials, surface and interface, additive manufacturing.

ERC codes : PE03, PE04, PE05, PE08.

2.3. Molecular chemistry and associated processes for a sustainable chemistry

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Molecular chemistry, sustainable chemistry and associated processes are the essential bases of the chemical industry whose products are used by many other sectors. Thus, any fundamental advance, any breakthrough concept in the field of chemical synthesis, the choice of raw materials used, the molecules and compounds, the processes implemented, etc., on which breakthrough innovations can then be developed, have a great potential for application that will benefit to many industrial segments. The projects described herein can be part of three topics:

- the development of new reaction paradigms or new molecules (organic synthesis ...). Projects on synthetic routes or processes more respectful of the environment as well as on the synthesis of molecules of interest are expected,
- catalysis in general (enzymatic, heterogeneous, homogeneous or multiple, assisted). Works on the stability and recycling of the catalysts as well as the use of non-toxic metals or ligands are expected. The link with activation modes can also be a subject.
- Eco-efficient processes and new reaction media. The development of processes, new technologies, and the exploration of new environments are welcomed in this area.

Projects submitted in this area may be experimental, theoretical, technological, industrial (processes), while favoring a multidisciplinary approach. The projects will be able to address all stages of manufacturing, from the selection of raw materials to the development of the reaction pathway and the development of associated processes

Bio-based chemistry and white biotechnology projects must be treated within the "Bioeconomy" research area.

Associated key words: chirality and asymmetric synthesis, bond activation and reaction processes, structure-activity relationships, new molecules, substitution of molecules, extraction, separation, detection, identification, design of new ligands, alternatives to rare and/or toxic metals, catalyst recycling, supported nanocatalysts, electrocatalysts, organocatalysis, multicatalysis: dual, hybrid, tandem, redox, cascade, tandem, domino or multicomponent reactions, one-pot reaction, enzymatic catalysis, metallo-enzymes, artificial enzymes, host-guest, microfluidics, microreactors, flow chemistry, miniaturization, solvent-free processes, recycling processes, emerging reaction media and eco-compatible media, reduction of waste, photochemistry, process intensification.

ERC codes: PE04, PE05, PE08.

2.4. Metals and inorganic materials and related processes

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This research area covers the scientific fields:

- Functional inorganic materials,
- Metallurgical science and engineering,
- Surfaces and interfaces : functionalization, surface treatment,
- Assembly,
- Implementation of materials.

Proposals will address the topics about:

- The metallic or iono-covalent materials (metals and alloys, ceramic and glasses, inorganic compounds, hybrids, natural materials…) and related surfaces and interfaces with pathways used to obtain them (synthesis, shaping, assembly…),
- Development of new materials and innovative approaches as well for the used processes as the targeted properties,
- The surface treatments or thin film coatings conferring new characteristics or functionalities to bulk material in relation to the environment,
- Recycling issues, substitution of sensitive elements (scarcity, chemical risk, cost…),
- New materials for use in extreme conditions (very high temperatures, severe mechanical, energetic or chemical stresses).

In order to cover all the materials science area, this axis will involve specialists of solid chemistry and condensed matter, metallurgy, solid mechanics and implementation processes (synthesis, assembly, additive manufacturing) or treatment processes. .

Associated key words : functional properties, multi-scale approaches for characterization and modelling, multi-physics coupling, metallurgical thermodynamics, preparation and shaping processes, metal working and treatment, additive manufacturing, innovative synthesis methods, microstructure, solid chemistry, tribology, surfaces, interfaces, damage, fatigue, corrosion, coatings, thin films, processes modelling, recycling, structural materials, structural and mechanical properties of inorganic biomaterials.

ERC codes : PE01, PE02, PE03, PE04, PE05, PE06, PE07, PE08, PE09.

2.5. Chemistry: analytical chemistry, theory, modelling

Contacts: Eric.PINEL@agencerecherche.fr ; Virginie.VIDAl@agencerecherche.fr

This research area welcomes projects whose core research lays primarily in fundamental approaches in the following disciplines of chemistry:
• spectroscopy and spectrometric techniques,
• analytical chemistry,
• instrumentation for chemistry,
• theoretical chemistry/modeling.
It also deals with specific aspects of chemical instrumentation that are not be covered by the other areas of the "Energy and Materials Science" field.

Associated key words: NMR, RPE, spectroscopies (UV-visible, IR, Raman ...), electron spectroscopy, mass spectrometry, chromatography, theoretical chemistry, modelling/simulation (molecular dynamics, ab initio methods, Monte-Carlo…), physical-chemistry (photochemistry, electrochemistry, thermodynamics ...), miniaturization, imaging, trace detection, structural properties.

ERC Code: PE04

E.3. Life Sciences

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The strategic priorities defined by the French State and the application of government programs are included as follows within the scientific axes.

- **Antibiotic resistance**: axes 3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.9, 3.10, and scientific axes of other domains such as axis 2.3 and the transverse axes 8.2, 8.3, 8.4, 8.5 and 8.7.
- **Autism among neurodevelopment disorders**: axes 3.3, 3.4, 3.7, 3.8, 3.9, 3.10 and scientific axes of other domains such as axis 4.3 and the transverse axis 8.7.
- **Translational research on rare diseases :** only in axis 3.9 "translational research for health"

3.1. Biochemistry of living organisms

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This research axis aims at the characterization and modeling of chemical and biochemical transformations performed by cells. Its scientific area at the interface with chemistry includes the following items:

- enzymology, pharmacology, toxicology,
- metabolism and bio-energetic studies,
- analytic and "-omics" approaches, including proteomics, lipidomics, glycomics, metabolomics and quantitative multi-omics.
- approaches designed to act on living organisms and their applications to mechanistic analyses in functional biology, as well as in human health (screening and molecular engineering, probes, inhibitors, ligands, molecules for diagnostic or therapy),
- design of new biological systems (synthetic biology) and controlled alteration of metabolic pathways, aiming at understanding the fundamental mechanisms of living organisms or the development of biotechnological applications.

Associated key words: biochemistry; enzymology; pharmacology; toxicology; bioenergy; proteomics; lipidomics, glycomics, metabolomics; synthetic biology; screening, biotechnology.

Associated ERC nomenclature: major one LS01, other ones LS02, LS04, LS07, LS08, LS09

3.2. Characterization of structures and structure-function relationships of biological macromolecules

Contacts: Quentin.MEREL@agencerecherche.fr; Philippe.BOUVET@agencerecherche.fr

This research axis at the interface with physico-chemistry and biophysics includes :

- prediction and resolution of structures of biological macromolecules and their complexes and deciphering their structure-function relationships,
- study of the dynamics of biological macromolecules and their interactions either in vitro, using isolated or reconstituted systems, or in their cellular context,
- technology or methodological developments in structural biology (NMR, crystallography, cryo-electron microscopy….),
- technology or methodological developments in imaging (super-resolution microscopy, correlative microscopy, ...),
- technology or methodological developments in molecular dynamics
- structural spectroscopy and single molecule approaches.

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Associated *keywords*: *Intracellular trafficking; cell cycle; senescence; apoptosis; cellular homeostasis; Differentiation and cell functions; cell adhesion; movement and cell migration; tissue homeostasis; morphogenesis; stem cells; developmental biology; signaling; biology of evolution, physics of the cells.*

Associated ERC nomenclature: major one LS03, other one LS08

3.5. Physiology and pathophysiology

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This scientific axis includes:
- understanding the hierarchical assembly of both molecular and cellular components of tissues and organs, and analyses of the related signalling pathways (including metabolic pathways), as well as their subsequent interactions and physiological properties,
- understanding the properties of these interactions and their significances within the entire organisms, including the microbiote, and taking into account the interface with the environment,
- understanding alterations of these mechanisms in pathophysiological processes, including with the use of organoïds.

This panel can evaluate multidisciplinary projects addressing all the biological, nutritional, behavioural, psychological and social determinants underlying physiological and/or pathophysiological functioning.

Associated key words: physiology, pathophysiology; systemic/comparative physiology and pathophysiology; multifactorial chronic diseases, diseases and ageing; endocrinology; metabolism and nutrition; microbiome, reproduction biology.

Associated ERC nomenclature: main one LS04, other one LS07.

3.6. Immunology, infection by pathogens and inflammation

Contacts: Ana.NAVARRETE@agencerecherche.fr; Michel.CHIGNARD@agencerecherche.fr

This scientific axis includes:
- characterization of the molecular and cellular actors involved in host defenses and inflammatory reaction which are associated with the innate and adaptive responses. The aim is to get an integrated view of the immune system in normal and pathologic conditions, including immune deficit, hypersensitivity, auto-immunity, auto-inflammation and transplantation,
- study of the mechanisms used by human and animal pathogens to use host factors for their survival, dissemination and transmission at the scale of the organism,
- identification of infection restriction factors in human and animals,
- the development of new computer-aided and mathematical approaches for: (i) a better understanding of the development and homeostasis of the various components of the immune system, of inflammation and of allergy, (ii) the host-pathogen relationships at the cellular, organ and whole organism scales,
- study on microorganisms that can open new anti-infectious approaches.

Associated key words: Immune defenses; pathogen infection, host-pathogen interactions, inflammation, microbiology, microbiote, symbiose/dysbiose, immune deficit, allergy, inflammatory process, modeling, graft response

Associated ERC nomenclature: major LS06

3.7. Molecular and Cellular Neuroscience - Developmental Neurobiology

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This scientific axis includes:
- the set of studies carried out at molecular and cellular scales to understand the mechanisms governing the formation, functioning, networks dynamics and plasticity of the normal or pathological nervous system and sensory organs in normal and pathologic conditions (including neurovascular and neuro-inflammatory components),
- the logic of the hierarchical assembly of the molecular, cellular and tissue components of the nervous system and the sensory organs, the relationships between their dynamics, their plasticity and the functional properties of the nervous system,
- the understanding of the mechanisms and the identification of the molecular and cellular determinants involved in psychiatric illness, addiction, neurodevelopmental diseases, autism spectrum disorders, neurodegenerative diseases and rare neurologic diseases. The neurovascular and neuro-inflammatory components of these pathologies are also included, except for the non-neural aspects under the axis "Physiology and physiopathology".

All invertebrate and vertebrate animal models can be considered, as well as the development of experimental and technological approaches in the view to improve the above study (imaging, computation and models, artificial intelligence, behavior, electrophysiology, pharmacology, optogenetics, ...).

Associated key words: neuro-genetics, cellular neurobiology, neurodevelopment; biophysics, neuropharmacology; neurodevelopment; neurodegenerative diseases; addiction; psychiatry, mental health.

Associated ERC nomenclature: major one LS05, other ones LS03, LS07

3.8. Integrative Neuroscience

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This scientific axis includes:
- the set of studies carried out at an integrative scale designed to understand high-level brain properties,
- the different levels of hierarchy and interactions specific to the brain functioning, for example those involved in multi-sensory integration, recognition of objects and actions, sensorimotor decisions, memory, behaviors, cognition, the state of consciousness,
- All aspects specific to human brain including its social dimensions, for example, self-awareness, language, social interactions and their dysregulations,
- the mechanisms and determinants of social relationships and mental health disorders, neurodevelopmental diseases, autism spectrum disorders, neurodegenerative diseases, addictions, rare neurologic diseases, in the view to prevent them and to treat them. One goal is to favor complementarities and synergies between fundamental, pre-clinical and clinical researches in the field of mental health, psychiatry and addiction.

The experimental approaches include functional and multi-modal *in vivo* imaging (MRI, fMRI, PET, photonics, ultrasound approaches), electrophysiology, computational analysis, brain-machine interface, artificial intelligence, behavior, optogenetics, psychophysics, ...).
The epidemiological approach of mental health inequalities is included in axis 8.4 "Public health", connected devices are included in the transverse axis 8.7 "Technologies for health".

Associated key words: cognition; behavior; computational neuroscience; psychiatry, mental health; neurodegenerative diseases; addictions, physiopathology; clinical approaches; cross-sectional studies.

4.1 Innovation, work

Contact: *Marie.FLECK@agencerecherche.fr*

This research axis covers themes relating to different domains: social innovation, on the one side, progress and mutations of work and employment, on the other side. These themes theoretically concern the whole spectrum of disciplines in humanities. They are expected to facilitate the submission of genuine projects, in different aims and scopes, and in the perspective of multi or interdisciplinary research. Experimental and/or participatory methods and researches with an international dimension are welcome. The concept of "social innovation" must be understood in the broadest perspective (as social, cultural, economic, political innovation or progress and their social conditions, but as well technological innovation including digital issues). Any conceptual framework, fieldwork, historical or geographic location is acceptable, as well as any topic in relation to the mutations of work and employment is valuable (at the level of the individual activity, of organization and collective activity, professional performances and their interactions with lifestyles and/or life cycles).

Fundamental or more applied projects can be submitted in one of the following themes (or more)

- Social and economic innovation and experimentation, regarding especially the domain of work
- Theories of innovations, or dealing with the conditions and impacts of innovation phenomenon, notably in connection with sustainable development and rights for innovation
- More generally, social, cultural and ideological mutations
- Market quality, form and transformation of work in relation to society
- Employment (access to, forms of, cycles of, counselling, insertion in) and work (places, territories, conditions, mobility)
- Regulations and dynamics of productive organizations

Associated key-words: *work, sustainable work, conditions of work, conditions of life, innovation, employment, counselling, insertion, rights, social transformations, individuals, societies, social movements, organisations, work market, economic and social regulations, enterprises, new economies in relation with the area of digital.*

Associated ERC Codes: *SH01, SH02, SH03, SH04, and SH06.*

4.2. Culture, creation, heritage

Contact: *Catherine.PELLINI@agencerecherche.fr*

This research axis aims at welcoming projects dealing with culture and cultures, including creation processes and issues relating to heritage, cultural and museographic patrimonialization. Every aspect or dimension of the genesis, the transformations, the evolutions and diffusion of material and immaterial cultures, languages, knowledge, ideas and beliefs, arts and humans productions, as well as the corresponding technologies of production and circulation are here under consideration. These themes theoretically concern the whole spectrum of disciplines in humanities. They are expected to facilitate the submission of genuine projects, in different aims and scopes, and in the perspective of multi or interdisciplinary research. Experimental and/or participatory methods and researches with an international dimension are welcome.

Projects can be submitted in one of the following themes (or more)

- Cultural creation, economy, rights and politics of creation
- Material and immaterial heritages, sciences and studies of heritages
- Birth and evolution of cultural forms,
- Populations, settlements, and intercultural relationships
- Linguistic and environmental variations of humanities
- religions, *laïcité* or secularism, and their dynamics,

- cultural, economic, political and technological issues

Associated key-words: material and immaterial culture, heritage studies, interdisciplinary and historical approaches, comparatism, languages, beliefs and religions, populations, demographic and geographic approaches, linguistics, Arts, creation, rights and economy of creation, cultural safeguard and preservation, technologies of conversation and of rehabilitation, museography and heritage valorisation.

Associated ERC Codes: SH01, SH02, SH03, SH05, and SH06.

4.3. Cognition, education, lifelong training

Contact: Maria.TSILIONI@agencerecherche.fr

This axis is about researches, both fundamental and applied, pertaining to the domains of cognition, learning, sociocognitive development, be it normal or pathologic, practices regarding education and livelong training. These themes theoretically concern the whole spectrum of disciplines in humanities. They are expected to facilitate the submission of genuine projects, in different aims and scopes, and in the perspective of multi or interdisciplinary research. Experimental and/or participatory methods and researches with an international dimension are welcome.
The scientific perimeter of this axis covers
- cognitive capacities through the ages of life, learning abilities, possibilities to educate oneself or to be trained all the time from early childhood to old age, mechanisms linking sensorimotor abilities, , cognitive, emotional and linguistic development in relation to elements of environment (family, social, school, emotional, territorial).
- the aims and place of education in human life ; the role of body and language in education ; the study of education programs in relation to the political history of one country; the social dimension of educational issues, especially in relation with sustainable development, socio-economic analysis of educational, political and institutional contexts, etc.
- fight against school, university and lifelong training failures; the renewal of educational tools, the factors of inequality or success in school (sensorial, motor, cognitive disabilities, precocity), motivations to learn versus withdrawal and aggressive behaviour, influence of learning institutions on performance (effects relative to class, discipline, teachers team, neighbourhood) , influence of gender and the corresponding representations on choices of studies, success in certain disciplines (divide between public and private, school mapping, selective languages, ranking of schools…), effects of early schooling, school dropout, leaving without diploma, measure and evaluation of these effects…
- New educational spaces, planning of educational territories, rise and development of learning territories

Associated key words: cognition, school inequalities, pedagogical innovations and experimentations, impact evaluation, school failures, learning, soft skills

Associated ERC codes: SH01, SH02, and SH04.

4.4. Inequalities, discriminations, migrations

Contact : Severine.BOUE@agencerecherche.fr

This axis welcomes projects locating issues of inequalities and discriminations at the forefront of their scientific agenda, as well as researches dealing with inequalities and segregations linked to economic, social, cultural, age or any other factor playing a role in the context of social differentiations. These themes theoretically concern the whole spectrum of disciplines in humanities. They are expected to facilitate the submission of genuine projects, in different aims and scopes, and in the perspective of multi or interdisciplinary research. Experimental and/or participatory methods and researches with an international dimension are welcome.

This axis also covers issues relating to governance, democracy (in the broader meaning of the term), violence, conflict, and to the study of violent radicalization whatever the perspective - historical, sociological, political, anthropological, psychological or any other domain in the field of SSH.

The concept of "inequalities" can be studied at different scales and under different forms, like:
• Social, political, geopolitical inequalities and inequalities related to gender, disabilities, or minorities
• Critical analysis of models and of indicators of inequalities
• examining the link between discriminations and social, economic, cultural and territorial diversities
• Models and forms of integration, identities, belonging(s), multiculturality, plurilingualism
• Quantitative and/or qualitative studies of mobilities and migrations, conducted at regional or international scales, and their relationships to one society's sustainable development

Associated key words: inequalities, discriminations, migrations, social recognition, integration, belonging, identities, mobilities, violence, radicalization, rights, democracy, governance, rurality

Associated ERC codes: SH01, SH02, SH03, SH04, and SH06.

E.5.   Digital Sciences

5.1. Foundations of digital technology: computer science, automatic, signal processing

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This area of research covers basic research projects aiming for excellence and breakthroughs in the fundamental aspects of computer science, automatic and signal processing.

The projects with a component in biology or health should be submitted in the corresponding cross-disciplinary axis « Mathematics and digital sciences for biology and health ».

Related keywords: logic, computability, decidability, complexity, theoretical computer science, combinatorics, graph theory, formal methods, models, calculations, semantics, cryptography, fundamental-sequential and distributed algorithmic, game theory, optimization, statistical signal processing, detection-estimation, analysis and representation, information theory, control and optimization, command and observation, estimation and identification, dynamical systems, systems theory and modeling

ERC panel: PE01, PE06, PE07

5.2. Artificial Intelligence

The priority of the State "Artificial Intelligence" is mainly declined within this research axis. Projects from disciplinary or interdisciplinary research axes outside the field but involving an AI component are also eligible for this priority.

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This research axis covers the projects on artificial intelligence, in the broad sense, on machine learning and its mathematical underpinnings, as well as on symbolic approaches, big data processing and data science, and knowledge management.
The following topics are indicative:
- methods and models to manage and exploit large volumes of data, whatever their variety (structured data, textual data, images, audio data), their production mode (observation data, sensor data, calculated data, data from simulation) and their quality (imperfect, incomplete, heterogeneous, parsimonious data) ;

- knowledge extraction and machine learning: data mining and text mining, machine learning (supervised, unsupervised, reinforcement, ...), constitution and annotation of corpus, design of complex decision rules, modeling of decision-making processes and construction of decision-making tools ;
- knowledge management methods and models, including knowledge representation and knowledge reasoning theories, ontologies and their use in data enrichment and information retrieval, multi-agent systems, semantic web, etc.

This axis also supports research projects aiming at advancing the state of the art in order to accomplish complex tasks (computer vision, language and speech processing, automatic translation,...), to develop autonomous decision-making systems or allow high-level interactions with human users.
Research work contributing to research in human-machine interaction and robotics should be addressed in the *"Interaction, robotics"* axis. Research work in the fields of health, transport or security, or at the interface between Artificial Intelligence and Human and Social Sciences, should be addressed, respectively, in the transversal axes *"Mathematics and digital sciences for biology and health"*, *"Urban societies, territories, constructions and mobility"* and *"Global security and cybersecurity"* or *"Digital revolution: relationship to knowledge and culture"*.

Related keywords: *machine learning (supervised, unsupervised, reinforcement,…), representation learning and domain transfer, unstructured data (texts, tweets, blogs, and other electronic medias for example), statistical models, optimisation, data mining, text and data mining (TDM) ; computer vision, scene analysis and interpretation, pattern recognition, language and speech processing, multimodal data processing ; decision-making, game theory, computational social choice, multi-agent systems ; planning, heuristic search, constraint satisfaction, SAT ; knowledge acquisition, knowledge representation, reasoning, ontologies, semantic web, fusion, uncertainty ; big data, new models of large-scale distributed computing, distributed Artificial Intelligence, content indexation, information retrieval, visual analytics ; data quality, trust and privacy protection ; ethics, validation and certification of AI technologies, explicability, transparency, causality and equity, reproducibility.*

ERC panel: *PE01, PE06, PE07.*

5.3. Micro- and nanotechnologies for information and communication

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This research axis supports research actions related to the "Digital Sciences" domain and covers the *"Micro and nanotechnologies for information and communication"* fields except the quantum technologies covered by the *"Quantum technologies"* axis.
This area of research covers the key enabling technologies such as electronics and photonics for information and communication, the integration of devices into systems and the exploration of new paradigms for the next generations of components (neuromorphic, bio-inspired).
All projects should address well-identified scientific and technological hurdles in the field of ICT and seek to demonstrate either quantifiable improvements in performance or breakthroughs compared with existing knowledge.
Projects mainly or exclusively targeting theoretical or numerical approaches (simulation and/or design of components, materials, processes, complex systems) are entirely legitimate, but so are generic methodologies (design, testing, metrology), reliability studies, the advanced characterisation of materials or the performance of nanodevices/basic components.
At the concerned dimensional scales (micro and nano), they must fit into one of the three areas described below:
- materials for components and devices: development-manufacturing-processes:
- basic components and devices: characterisation, integration, application…
- circuits, architectures and systems : design, simulation, test…

Related keywords: semiconductors, materials, electronics (micro and nano), photonic (micro and nano), spintronic, metamaterials, artificial materials, technological processes, design, simulation, fabrication, characterization, instrumentation, optical devices, non linear optics, near field optics, optical sources, optical fibers, millimetric components, THz, nanophotonics, plasmonics, electronics (organic, flexible), devices (alternative, neuromorphic), components for AI, circuits, systems, 3D integration, heterogeneous integration, photodetection, imagers, alternative architectures, RF, micro-nanosystems, sensors for ICT.

ERC panels: PE02, PE03, PE05, PE07.

5.4. Multi-purpose communication networks, high-performance infrastructures, software sciences and technologies

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This area of research is looking for proposals aiming at breaking down fundamental or applied research barriers around:

- Software execution platforms, methods and tools for software development, modeling, validation and / or verification of software systems, embedded computing, etc.
- Broadband communications infrastructures, object networks, etc.
- HPC infrastructures and big data processing, etc.
- Cloud and integrated network architectures, infrastructure management, control, optimisation, monitoring, and programming, service creation, deployment and optimisation, etc.

Related keywords: Operating Systems, real-time Operating Systems, middleware specific to different architecture principles (parallelism, distribution, real-time, safety, security, etc.), virtualization, virtualization of executions and systems, execution on embedded hardware, connected objects, virtual prototyping, memory management, distributed memory, composition of services, Web programming, service platforms, optimized compilation towards centralized or parallel architectures (multi-core), calculation models for parallelism, distribution, mobility, security and real-time, distributed algorithmic, software architectures, program analysis, verification and proof of safety and security properties, verification and optimization of quantitative properties (time, memory, energy, etc.), test and debugging methods, optical communications, radio communication, architecture and programmability of communication systems, reliability and availability, generalized mobility, scalability, elasticity, energy efficiency, control, management and information plans, hardware accelerators, massive parallelism, edge cloud, dynamic and combined orchestration and optimization of communication / execution / storage resources, QoS and SLA assurance, data analytics and deep learning for optimization, end-to-end security, shared infrastructure management, context-sensitive services, service-infrastructure interface.

ERC panels: PE06, PE07.

5.5. Interaction, robotics

Contacts: Vincent.RAPP@agencerecherche.fr ; Martine.GARNIER@agencerecherche.fr

This area of research covers, on the one hand, human-machine interaction in all its dimensions including natural dialogue and the creation of multimedia content and, on the other hand, autonomous and interactive robotics in all its components (service robotics, medical robotics, industrial robotics, cooperative multi-robot systems). Proposals including ethical aspects are encouraged.

The industrial robotics proposals aiming at industrial performance rather than the development of

robotics per se, should be submitted in the axis "Factory of the future: Man, organisation, technologies".

Related keywords: Multi-sensory interfaces (gesture, movement, audio,…), learning, wearable computing, augmented reality, virtual reality, immersive environment, user-centric design, conversational agents, adaptable interfaces, collaborative interactions, multimedia content creation, multi-source data, interface ergonomics, augmented human, visualization, vision, dialogue, human / data interaction, humanoids, aerial robots, land robots, autonomous vehicles, submarine robots, adaptable systems, exoskeletons, planning, cognitive architectures, decision-making autonomy, human-robot collaboration, mobility, sensors, field robotics, multi-robot systems, cognitive psychology, interpretation, social robotics, affective robotics, affective computing, surgical robotics, instrument / organ interaction, soft robots, Computer-Aided Medical Interventions (CAMI), manufacturing robotics, cobotics.

ERC panels: PE06, PE07, LS09, LS05, SH04.

5.6. Numerical models, simulation, applications

Contacts: Cyril.DEMANGE@agencerecherche.fr

Multidisciplinary proposals gathering probabilistic experts, analysts, statisticians, data scientists, computer scientists are encouraged to promote disciplinary breakthroughs allowing to gain orders of magnitude in performance, cost, time, quality, volume, etc.
Topics of interest in this axis include:
• In the programming paradigms related to future architectures, the introduction of *runtimes*, in situ visualization, fault tolerance ... ("Post Moore era" framework),
• In algorithms and numerical methods: construction and exploitation of surrogate models, time / space parallelism, data transfer, etc. for the software and hardware side, power consumption, use of NVM memories etc.,
• For the modeling of complex problems: assimilation problems - possibly mixed with "data models" - , probabilistic, multi-scale and multi-disciplinary analyzes, optimization methods (robust, stochastic ...),
• Model development and optimization for the coupling and interaction between hardware and computer systems, virtual representations, simulations and the physical world: real-time simulations and interactivity, quantization of uncertainties, combination of various computational architectures, design of scalable and data-driven models, etc.
This axis also supports projects that address more application oriented problems of numerical modeling and simulation such as energy, climate, environment, cosmology, smart cities, etc.

Related keywords: High performance computing (HPC), exascale, scalability, performance, resilience / fault tolerance; massive, hierarchical and heterogeneous parallelism, heterogeneous, hybrid architecture; (co-) processor, CPU, GPU, FPGA, multi-core, many core, cluster of machines; energy efficiency, optimization; (quantification) uncertainties, multi-scale, multi-physics, domain decomposition, data assimilation and inversion, modeling and simulation, digital twins, system coupling hardware and IT; validation and verification, scientific computing library, modeling languages, workflows, pre and post-processing (mesh, visualization, ...), linear algebra, co-design (software, hardware, application), data lifecycle.

ERC panels: PE01, PE06, PE07, PE08.

5.7. Quantum Technologies

The priority of the State "Quantum Technologies" is declined within this research axis.

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This research axis supports research activities related to the «Energy and Materials Sciences » and «Digital Sciences » fields.
It covers technological and scientific projects based on quantum concepts of superposition and entanglement, in the following areas:
• quantum communication in a provably secure way,
• quantum computation: quantum processors and architectures based on so-called "qubits" and quantum algorithms, models and programming environment for quantum computing, applications for quantum computing, etc.
• quantum simulation, methods and systems for its implementation,
• sensors and quantum metrologies (imaging, including medical imaging, atomic clocks, accelerometer, gyroscopes)
• fundamental research and applications in quantum science and technologies.

Related keywords: *quantum optics, quantum light sources, quantum communications, security, cryptography, memories, repeaters, protocols, multiparty communications, quantum simulation, platforms, control and verification methods, quantum computing and computer, qubits, atomic and ionic qubits, superconducting qubits, semiconductor qubits, spin qubits, topological qubits, gates and measurements, integration, algorithms, model and programming environment for quantum computing, quantum metrology, sensors, error correction code, gravimeters, accelerometers, gyroscopes, atomic clocks, quantum imaging, optimal quantum control, quantum feedback, squeezing, quantum non-demolition measurement, quantum systems, tapped ions and atoms, Rydberg atoms, quantum dots, solid defects, rare-earth ions, 2D materials, nuclear and electronic spins, quantum information science, superposition, entanglement, decoherence, estimation, quantum state reconstruction, quantum tomography, topological systems, component independent processes.*

ERC panels*: PE02, PE03, PE06.*

E.6.   Mathematics and their interactions

6.1. Mathematics

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This axis supports projects ranging from the most fundamental to the most applied aspects, aiming at excellence and shifts or breakthroughs in mathematical research.
Projects that have a strong component in biology or health should be addressed in the transverse axis *"Mathematics and digital sciences for biology and health".*
More generally, mathematical projects that have strong interaction with other disciplines can be submitted to other scientific axes.

Related keywords*: algebraic, arithmetic and differential geometry, topology, algebra, number theory, dnamic systems, ordinary differential equations, analysis, functional analysis, partial differential equations, mathematical physics, probability, statistics, numerical analysis, scientific computing, data processing, logic , discrete mathematics and combinatorics, cryptography, modeling, simulation, optimization, control, game theory, mathematics for signal and image, history of mathematics*

ERC panels*: PE01, PE06.*

E.7. Physics of Matter, High Energy, Earth and Universe Sciences

7.1. Physics of condensed matter and of dilute matter

Contacts: Linh.TRAN@agencerecherche.fr ; Pascal.ROYER@agencerecherche.fr

This research area covers a broad field of physics disciplines, mainly fundamental and described essentially by the ERC disciplines PE02 (with the exception of the sub-disciplines PE02_01 in 04) "Fundamental constituents of matter: plasma, atom, molecule, gas and optics " and PE03 (with the exception of the sub-disciplines PE03_05 and 07) "Physics of condensed matter: structure, electronic properties, fluids, nanosciences, biophysics ".

The projects dealing with physics of the soft matter, traditionally part of the physics of condensed matter, are covered by this axis. On the other hand, the projects of physical-chemistry of soft matter are to be sent in the research area "Polymers, composites, physics and chemistry of soft matter".

Besides, the projects relevant to the generic theme of the quantum technologies are to be sent in the research area " Quantum Technologies ".

Associated key words : physics of gas and plasmas, turbulence, electromagnetism, optics, non-linear optics, quantum optics, ultra-fast optics, nano-optics, wave propagation in complex media, Laser physics, structure of solids and liquids, surfaces, growth, self-assembly, heterostructures and nano-objects, magnetism and spin electronics[22], strongly correlated fermions, molecular electronics, aggregates, structure and dynamics of disordered systems, physics of mechanical behavior, acoustic, fluid dynamics, atomic and molecular physics, ultra-cold atoms and molecules, quantum fluids and gases, atomic and molecular spectroscopy, atomic and molecular collisions, relativity, non-linear physics, hydrodynamics, instabilities, non-equilibrium phenomena, statistical physics, macroscopic quantum phenomena, supraconductivity, superfluidity, photonic and electronic interaction, mesoscopic physics, biological systems and biophysics, complex system, radiation and matter interaction morphogenesis.

ERC codes: PE02, PE03.

7.2. Subatomic Physics, Sciences of the Universe, Structure and History of the Earth

Contacts: Konstantin.GRIGORIEV@agencerecherche.fr; Frederic.MONOT@agencerecherche.fr

This axis covers research projects aiming to acquire fundamental knowledge in the field of subatomic and theoretical physics, astrophysics, cosmology, astronomy, planetology, exobiology, structure and history, and the dynamics of the earth (including distant paleo-environments without analogues with the current era).

The scientific scope is defined in two parts:

- Subatomic physics and theoretical physics & Astrophysics,
- Planetology & Structure, history and dynamics of the Earth.

Are also included projects on instrumentation and observation systems aiming to favour innovative developments in instrumentation, networking, data processing and data recovery in all the fields of this axis.

Associated keywords:

- *Subatomic physics, theoretical physics, accelerator physics and associated instrumentation, physics of fundamental interactions, particle physics, string theory, classical and quantum gravitation,*

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[22] Projects dealing with devices for spintronic have to be proposed to the axis : « *Micro et nanotechnologies for the treatment of the information and communication* » area of « *Numerical sciences* » (SDNum).

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astroparticles, nuclear physics, gravitational waves, mathematical physics, integrable systems, mathematical aspects of theories of strings, classical and quantum dynamical systems, rigorous statistical mechanics and applications, disordered systems, out of equilibrium phenomena, nonlinear physics, algorithm and complexity, quantum information, low dimensional quantum systems, cold atoms;

- *astronomy, astrophysics, solar physics, stellar physics, interstellar medium, formation and evolution of galaxies, astronomy of high energies and particles, dark matter and dark energy, cosmology, spatio-temporal reference systems ;*

- *planetology, planetary formation, chemistry and physics of planetary atmospheres, sun-earth relations, exoplanets, hazards and risks (including telluric hazards, space weather and Near-Earth Objects), paleo-environments, geochemistry, geochronology, geodynamics, geophysics, mineralogy, paleontology, petrology, sedimentology, structure of the globe, tectonics, primitive earth, deep earth, volcanology.*

ERC keywords*: PE02, PE09, PE10***.**

E.8. Transverse domains

8.1. Humans-Environment interactions

Contacts*: Melanie.PATEAU@agencerecherche.fr ; Anne.LIEUTAUD@agencerecherche.fr*

This axis supports interdisciplinary research activities dealing with the anthroposphere. Its scientific scope covers three aspects:

- vulnerability of societies to environmental changes (incurred or decided)
- integrated approaches for sustainable development of territories,
- building and mobilising a basis of SSH knowledge for food security and ecosystem sustainability.

This axis covers research projects contributing to the analysis of development patterns and governance aimed at being adapted to environmental changes, natural and technological risks and depletion of resources, taking into account vulnerabilities and social, cultural, economic or political developments. Projects can approach various temporal and spatial scales, sectoral or multisectoral, comparative, retrospective or prospective, qualitative and quantitative approaches.

The submitted projects belong to various fields of human and social sciences, environmental and life sciences or integrated and multidisciplinary approaches.

This axis does not include projects dealing with the sustainable management of exploited ecosystems (see section "*Development of socio-ecosystems and their components for sustainable management*").

Associated keywords: *anthroposphere, stakeholders, multi-stakeholders approaches, collective action, transitions, adaptation, political systems, behaviours, conflicts, environmental mediation, cooperation, territorial dynamics, diachronic studies, sustainable management, risks, disasters and impacts, institutions, instruments, ecosystems/socio-economic systems interactions, theories of justice, rights, norms, economic organizations, perceptions, public policies, practices, prevention, representations, resilience, resources, ecosystem services, political systems, territories, vulnerability, integrated management, environmental migration.*

ERC keywords*: LS08, PE10, SH01, SH02, SH03, SH06.*

8.2. Contaminants, ecosystems and health

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This axis covers research projects aiming to improve knowledge on characterisation and fate of physical, chemical and biological contaminants as well as their effects on human, animal and plant health and on ecosystems in the « Eco-Health » concept. It includes projects on the following topics:

- determination of the exposome (incl. cocktail of contaminants),
- contaminants, environmental metrology, bio-indicators and bio-markers,
- effects and mechanisms of the action of contaminants on organisms, ecosystems and human health,
- eco-dynamics of contaminants and interactions and impacts on progeny,
- adaptive mechanisms in exposed organisms,
- evaluation of new tools for the management of risks and risks linked to contaminations,
- unintentional effects of phytosanitory and pharmaceutical treatments on non-targeted organisms.

Multidisciplinary approaches are welcome.

Associated keywords: adaptability, biodiversity, biocides, bio-indicators, biomarkers, cocktail of contaminants, physical contaminants, eco-dynamics, ecosystems, ecotoxicology, environment, epidemiology, exposome, metals, metrology, microbiota, microplastics, modelling, nanomaterials, organometallic, endocrine disruptors, pesticides, mineral pollutants, persistent organic pollutants, animal health, human health, plant health, environmental toxicology, toxins, ecology of health, legal and regulatory frameworks, controversies, strategies of economic actors, public perception.

ERC keywords: LS02, LS04, LS07, LS08, LS09, PE01, PE02, PE03, PE04, PE05, PE07, PE06, PE 08, SH01, SH02, SH03.

8.3. Health-Environment : Environment, pathogenic agents and emerging and re-emerging infectious diseases, adaptations and resistance to antimicrobials.

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This axis covers research projects on the following topics:

- all the human, animal and plant pathogenic agents regardless of their origin (bacteria, viruses, parasites, fungi, algae and non-conventional agents) and their products,
- the modes of diffusion and adaptation of pathogenic agents and their vectors, the genetic and non-genetic determinants of transmission, the mechanisms of infectious diseases emergence (human, plant or animal, including zoonoses) in relation with environmental and anthropogenic factors,
- methods of control, monitoring and prevention, of identification of at-risk population and risk areas, of preparation to epidemic and pandemic risks, social conditions of management of epidemics,
- modelling parameters of emergence, diffusion, exposure, transmission or elimination, retrospective analyses as well as constitution of databases contributing to the definition of indicators for a predictive approach of evolution of epidemics in a context of health monitoring,
- resistance to antimicrobial, antiparasite, antifungal, insecticide and biocide treatments
- adaptation of pathogens and their vectors to environmental changes,
- organization and resilience of human and animal health care systems towards risks of emerging and re-emerging infectious diseases,

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- Individual and collective practices of health, lifestyles

Associated keywords: emerging and re-emerging pathogens, determinants of infectious diseases (biological, medical, environmental, social, …), conditions for prevention and management of emerging diseases, resistance to antimicrobial agents, modelling, database, exposome/infections, predictive approaches, « One Health » and « Eco-Health » approaches, risks, reservoirs, vectors, wildlife populations, niches, persistence, zoonoses, virulence, spatial and temporal, anthropogenic, care, epidemics, pandemics, global health, transfer between species.

ERC keywords: LS01, LS02, LS06, LS07, LS08, PE06, PE10, SH02, SH03.

8.4. Public Health

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This research axis is dedicated to integrated and multidisciplinary researches in the field of public health (epidemiology, bio-statistics, management, economy, sociology, law, history, philosophy, ethics …).
Goals of projects can concern:

- analysis and understanding the roles of various factors (social, economics, behavioral, environmental, health systems) and their interactions on well-being, vulnerability, health, emergence or reduction of inequalities,
- integrated interdisciplinary analyses of the impact of multiple determinants on health and diseases, including mental diseases,
- risk evaluation, development of methods for monitoring and anticipation of risks, as well as for therapeutic prevention, adaptation of public policies and health systems (including primary cares),
- analyses of roles of public and private actors, including companies, as well as the opinion of population in elaboration and application of both local and global strategies in the field of health.

A peculiar interest will be given to conceptual research and methodologies allowing the analysis of social, behavioral, and environmental determinants of health and their interactions, as well as the effect of public health intervention and of the health system during human life and in various activity areas (residential, at school, professional…).

Associated key words: determinants for social inequality in the field of health and human frailty; identification of population with risks; individual and collective behavior, risk relationship, perception, health standards, early diagnosis, chronic diseases, access to care; functioning of heath medical system; risk prevention, protection, politics, organizations, regulations, actors, health promotion, use of existing health data bases, health practice.

Associated ERC nomenclature: LS02, LS07, SH01,SH02,SH03,SHO4, SH06.

8.5. Mathematics and digital sciences for biology and health

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This axis supports interdisciplinary research projects combining innovative research in the fields of biology and health, development of concepts and development of new methods using tools from mathematics, computer science, automatic, physics, or signal processing.
The submitted projects may concern:
• the development of methods for collecting, extracting, managing, securing, matching massive or heterogeneous data from various sources ranging from omic biology to the medico-administrative

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health databases (National System of Health Data) or any other source of personal health data for preclinical, clinical, population or epidemiological research, or decision support;

• the analysis and modeling of data from omic approaches (transcriptomic, proteomic, ...), structural biology, cell and tissue microscopy, imaging or e-health approaches, and virtual and augmented visualization of these complex multimodal, multi-scale and high content data;

• the processing of signals and medical images for segmentation, extraction and characterization of the conveyed information, as well as the fusion of multimodal, multi-scale, morpho-functional information, with the aim of deepening knowledge in biology and / or develop new approaches of medical interest;

• the quantitative analysis and modeling of biological and physiological processes allowing the development of predictive approaches in biology and health, as well as the methods allowing their confrontation with experimental data, in particular, data assimilation and machine learning approaches;

• simulation of complex biological systems using scientific and high performance computing and associated optimization, immersive simulation (virtual and augmented).

Related keywords: big data in biology, artificial intelligence for life sciences, large-scale machine learning and decision support, predictive analysis, signal and image analysis and processing, biological process modeling, simulation in biology, emerging properties of biological systems, computational biology, bioinformatics, biomathematics, e-health, medical informatics

ERC panels : LS01, LS02, LS03, LS05, LS07, PE01, PE06, PE07.

8.6. The digital revolution : relationship to knowledge and culture

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This research axis supports interdisciplinary research in the fields of « Digital sciences » and « Humanities and social sciences » related to actions. The projects mus fit into one of the two areas described below :
• Digital humanities :
- Education and training,
- Knowledge creation and sharing,
- Arts, culture and heritage.
• Computational social sciences
Projects will be led by an interdisciplinary team or partnership, bringing together researchers in digital science and technology and researchers in the humanities and social sciences. The targeted progress may concern a single disciplinary field (HSS or ICT) if it mobilizes concepts or tools resulting from recent advances in the other field. These conditions explain an encouragement for the submission of interdisciplinary projects, indicating in what and how the co-construction of common research objects, at the interface of disciplines, makes it possible to better formalize scientific questions and/or contribute to the renewal of methodologies. This axis therefore does not concern projects that would conduct both types of research (HSS; ICT) in two separate sets of tasks.

Related keywords: Learning scenario design ; serious games and gamification ; personnalisation and learner adaptation ; training to understand the digital technologies ; digital literacy ; distance learning ; co-learning, co-teaching ; digital schools in a connected area ; immersive environments ; cognitive, sociological and anthropological approaches ; pedagogic, digital innovation and participative sciences, open access to publications and research data ; credibility and verification of online information ; training for the use of digital information media ; analysis of discourses and controversies ; new capabilities for data analysis ; quantified self, behavioral sciences ; digital humanities ; big / open / linked data ; digital heritage : digitization, exploitation, preservation, documentation, indexing and archiving ; knowledge modeling ; information retrieval ; cultural and digital mediations ; virtual

collections ; nomadic and immersive devices ; digital approach to artistic creation ; digital governmentality / algorithmic, democracy and citizen debates in the digital context ; public policy analysis ; open data ; computational social sciences

ERC panels: *PE06, SH03, SH04, SH05, SH06.*

8.7. Technologies for health

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This axis aims at funding interdisciplinary researches in the engineering field that are dedicated to the design of new concepts, tools, methods and technologies for health. The following areas are concerned:

- instrumentation, detection systems and new products for anatomic and functional imaging, as well as for cellular and molecular imaging of health interest and their integration in multimodal systems.
- Technologies and devices to improve screening efficiency, drug delivery and vectorization, or bio-production processes,
- Implantation in or on living organisms of diagnostic, analysis (embedded sensors) or therapeutic systems,
- Biomaterials design and implantation, including those for regenerative medicine,
- Technologies for in vitro diagnosis and analysis,
- Surgical technologies including tele-surgery, associated supply and equipment, implantable systems, device to supply functional inefficiency, prosthesis, the progress can concern reliability, biocompatibility, efficiency, miniaturization, tele operability, increase of energetic autonomy, all these improvements can be subjects for modeling, simulation and realization,
- Technology pour eHealth,
- Disability compensation and autonomy.

The PRCE projects (collaboration with at least one company) are well suited to this axis taking into account the possible applications and valorizations of the proposed researches.

Associated keywords: *medical devices; robotics; biosensors and monitoring instruments; medical imaging; stimulation tools; signal and image processing; biomaterials, biomechanics, automation, home equipment, handicap; e-health, medical Informatics, bio-printing, regenerative medicine.*

Associated ERC nomenclature: *main one LS07*

8.8 Global Security, Cybersecurity

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This research area requires research projects aimed at characterizing the risks and vulnerabilities in relation to European societies; to work for the prevention and protection of properties and people; to develop the protection of infrastructures and networks as well as the protection of goods, data, content and software; manage crises and contribute to resilience; analyze instruments, including legal instruments, participating in the exercise of the rights and freedoms of individuals. Projects can propose an integrated approach of risk management and protection in the physical world and in cyberspace.

The research area is open to both basic and finalized research, mono-disciplinary, multidisciplinary or interdisciplinary, leading to a social, scientific or technological evolution in safety and security. Projects involving users (both main users or end-users, institutional, NGOs, local authorities, etc.) are encouraged.

Projects must be addressed within four topics:

•risks, crisis management regardless of origin, resilience of systems and educational approach

•organised crime, terrorism and violent radicalization (operational aspects, data management...)
• cybersecurity: freedom and security in the cyberspace, securing information systems and fight against cybercrime
• protection of critical infrastructures (CI) and networks of vital importance, sensitive sites; protection and urban security of the so-called "soft" targets; control of sovereign areas.

Associated key words: cybersecurity of infrastructures, equipment and goods devices and embedded systems, networks and information systems; security of hardware and software infrastructures associated with data management; ethical and legal security by construction (security by design); system engineering for physical and digital protection, equipment of security forces; forensics; relief to persons; security of institutions and open places to the public; digital and biometric authentication; monitoring of maritime, land and air space; resilience of systems; public and international policies; sociology of organizations; national security, global security; shift from safe to unsafe societies; fight against CBR-E threat agents.

ERC Code: LS07, LS09, PE01, PE02, PE03, PE04, PE05, PE06, PE07, PE08, SH01, SH02, SH03, SH04, SH06, LS2.

8.9. Bioeconomy: chemistry, biotechnology, processes and systemic approaches, from biomass to usages

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This research area covers projects of fundamental and applied research in "Bioeconomy" and in particular the cascade usages of biomass and the closure of the cycles. It is opened to transverse and/or systematic approaches specific of the stakes of bioeconomy, as well as to the methods and the technologies related to the processing of biomass for various usages (biofuel, biogas, platform molecules), including biotechnologies and chemical or physical transformation processes. All the bioresources (exploited, cultivated, from animal production, forestry, wastes) of continental and marine systems can be considered.
The research area covers the disciplines involved in:
•   the production, the mobilization and the sustainable management of bio-resources,
•   the processing of bioresources: biotechnology, chemistry, associated processes and their couplings,
•   the modelling, the scenarisation of fluxes (materials, energy, monetary), at various scales and in particular at the territory scales,
•   the socio-economic analysis of new value chains.
The scientific fields requested involve life sciences, engineering, chemistry and social sciences and humanities. Multidisciplinary approaches are welcome.

*Associated key words : biomass (quality, availability, management), biowastes, co-products, land use, energy crops, micro-organisms, photosynthetic micro-organisms, biocatalysts, biorefinery, biosourced materials, biosourced chemistry, bioenergy, biofuel, biogas, platform molecules, natural substances, metabolic engineering, synthetic biology, industrial biotechnology, fermentation, anaerobic digestion, methanisation, biomass thermochemical conversion method, biomass biological conversion method, energy-matter coproduction integrated processes, hybridisation of mechanical-physical treatments, thermochemical and/or biological methods of conversion, public policy, environmental economy, life cycle analysis, circular bioeconomy, modelling the impact of bioeconomy, scenarisation, land use planning, use and protection of ecosystems and soils **, environmental services.*

*** in the context of the development of bioeconomy,*

ERC Codes: LS02, LS08, LS09, PE04, PE05, PE08, SH02, SH03.

8.10. Urban societies, territories, building and mobility   p. 37

Contacts: Laure.MIRMAN@agencerecherche.fr ; Pascal.BAIN@agencerecherche.fr

Expected research in this area should explore the ways in which territories at any scale - from neighbourhoods to city systems - transport, housing, and their users, adapt to the requirements of sustainable development.

While taking into account vulnerabilities and socio-spatial inequalities, research must make it possible to evaluate and improve the performance of buildings, transport and territories, and to bring out alternatives. Those research should be placed in the perspective of reducing pressures on the environment and adaptation to future changes (disruptive or incremental), including climate or demographic (aging...) change. Particular attention should be paid to the advances of the digital society to accompany and push this transition. The questions of governance and the evolution of public policies and regulations, which interfere in the management and transformation of urban systems, must also be analysed in relation to these issues.

It means taking part in the construction of a methodological and technological offer, bringing in particular the necessary elements of understanding to analyse, measure, carry out diagnostics, help to design, build, rehabilitate or renew urban systems, transport systems[23] and the built environment and develop modelling as well as data mining and use. Interdisciplinary, integrated and systemic approaches are also expected in order to analyse societal, environmental and technical processes in their interactions, complexity and dynamics. In addition to companies, participation of stakeholders such as local authorities is encouraged.

The scope of this research area is defined by the following three topics:

- the territories and the city, at any scale and in all their dimensions (social, environmental, physical), in OECD countries as well as in emerging or southern countries:
  - o urban growth, urban sprawl, land planning, urban forms, public spaces, uses, quality of life, territorial inequalities (environmental, health...), diversity, universal design and accessibility, access to urban amenities, mobility, urban tourism, attractiveness, urban economy, governance;
  - o environmental quality (pollution, nuisances...), hydrology, urban micro-climate (heat island ...), soil quality, urban ecology, ecosystem services, urban flows and metabolism, circular economy;
  - o risks, vulnerabilities, resilience, mutations and adaptation of territories and urban systems / urban societies;
- sustainable construction: buildings (new and old), low-carbon city blocks and neighbourhoods with low environmental impact, sustainable construction and management of built heritage and infrastructure,
- transport systems: transport safety and security, mobility and driving assistance, autonomous and connected vehicles

and a transversal topic on networks and services: networks and services for the transport of people and goods, urban engineering (water, sanitation, waste, etc.), and urban (e-)services.

Associated keywords: city, urbanism, mobility, housing, urban planning, urban morphologies, universal design and accessibility, accessibility to urban amenities, public spaces, economy, public policies, urban governance, citizen mobilizations, social inequalities, lifestyles, practices, environmental quality, urban imagery, pollution, urban landscapes, soil quality, urban ecosystem services, urban metabolism, urban micro-climate, vulnerabilities and resilience of urban systems, urban transitions, buildings, city blocks and neighbourhoods with low carbon and low environmental impact, energy and environmental

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[23] Research on the energy efficiency of transport (combustion, hybridization, overall optimization of energy on board vehicles ...) is excluded from this domain and is linked to the "Sustainable, clean, secure and efficient energy" research area.

renovation, civil engineering, construction, management and rehabilitation of built heritage, infrastructure, safety and security of transport, driving assistance, autonomous vehicle, connected vehicle, reliability of vehicles, urban engineering, networks and transport services of people, logistics, urban services, e-services, urban data, smart cities.

ERC codes: LS08, LS09, PE01, PE02, PE03, PE06, PE07, PE08, PE10, SH01, SH02, SH03

8.11. Nanomaterials and Nanotechnologies for the Products in the Future

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This research area welcomes projects that include nanoscale effects for the synthesis and the conception of materials. Proposals should aim to deliver nanoobjects or deal with specific effects occurring at the nanoscales in the benefit of the final output. Examples of such proposals might include research that:
1 - Focuses on the production or the synthesis of complex functional nano-objects;
2 – Manages interfaces at the nanoscales, or deals with interfaces interaction;
3 - Assembles nano-objects or includes material nanostructuration in 2 or 3d;
4 - Deals with innovative nanoobjects and nanomaterials for healthcare. This research area is open to proposals dealing with the study of new families of nano-materials preferentially multifunctional but proposals do not need to deliver medical proofs of concepts (In the latter case, the proposal must be submitted in the corresponding research area in the domain "Life sciences").
Proposals focusing on sensors with the benefit of a nanometer scale proportion or dimension to, for example, improve their performance, should be submitted in the framework of the research area "Sensor and Instrumentation".
Proposals for information and communication technology devices should be submitted in the framework of the axis "Micro and Nanotechnologies for information processing and communication".

Associated key words: Nanomaterials, nanoparticles, nanowires, nanotubes, core-shell structures, mechanisms of formation and stability mechanisms, eco-design, durability, life cycle, control of physical properties (optical, thermal, magnetic, …), composite interfaces for composite materials, surface functionalization and/or nanoobjects, control of the chemical and biological activity, interaction between surfaces and interfaces, numerical simulation, modelling, assembling, self-assembling, electrospinning, microfluidic, nanofluidic, nanometric aspects of adhesion, adhesive bonding, fluid interfaces managing, nano-powder rheology, imaging agent, encapsulation, targeted delivery and release mechanisms, biocompatibility, biophysical properties of nanoparticles and of nano-structured materials, recyclability of nanomaterials.

ERC-codes : LS08, LS09, PE01, PE02, PE03, PE06, PE07, PE08, PE10, SH01, SH02, SH03.

8.12. Sensors-Instrumentation

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This research area welcomes projects in the broad area of innovative sensors and instrumentation for on-line monitoring of processes and characterization (materials, biomaterials, fluids, etc.). This research area encompasses three broad topics :
1 - Measurement methods and instrumentation: development Operando methodologies for material characterization and synthesis ; design and methods to monitor processes, of sensors where the sensing part is micrometric or above (without nanostructuration or surface functionalization at the nanometer scale).
2 - Characterization at the nanometer scale: nanomaterial characterization, instrumentation development for nanometer scale characterization for metrology of measurement and sensing in

complex environments (fluids, solids, or diluted suspensions). The methods of measurement can be based of any kind of physical properties.

3 - Innovative sensor concepts at the nanometer scale: proposals should be disruptive by virtue of nanometer scales for the sensors and the actuators. Proposals should go beyond simple material synthesis and characterization sensitivity due to chemical, physical or biological parameters. They should encompass a more integrated approach for instrumental purpose.

Proposals focusing on Quantum technologies must be treated within the "Quantum technologies" research area (SDNum)

Associated key words: *On-line control, in-situ characterization, operando, sensor performance, detection sensitivity, discrimination sensitivity, metrology, surface nano-structuration , electronic-optical-force microscopy.*

ERC-codes : *PE02, PE03, PE04, PE05, PE07, PE08*

8.13. Factory of the future: human being, organisation, technologies

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This research area is open to basic research and industrial research projects for the factory of the future. The expected projects will have to contribute to overtake scientific and\or technological barriers within the following objectives:

• support and amplify the development of new digital technologies or manufacturing to meet the demand for innovative, personalized and optimized products,

• promote a system-oriented vision and organization of the factory, for an agile development process integrating the products life cycle and value chain network dimensions,

• center the factory on the human being who stays at the heart of the operations while the organization of the work becomes more flexible. It is also necessary to answer the stakes in production while relieving the cognitive and physical work of the operator.

These objectives are associated with seven topics :

• the Human being in the new productive organizations,

• intelligent, connected, piloted factory,

• virtual factory,

• flexible and agile factory,

• green and citizen factory,

• robotics for industrial performance, human-robot collaboration in production systems (technological, organizational and regulatory aspects),

• new technologies of production and control.

The expected projects have to join these topics, they can arise from various communities: sciences for the engineer, information and communication technologies, sciences of systems, social and human sciences, etc.

Cross-cutting projects that take into account both technological and human aspects are strongly encouraged as they are likely to provide significant breakthrough in the design of future production systems. Finally, exploratory research projects for the factory of the future are particularly welcome in this axis.

Associated key words : *Personalization of products and services, eco-conception, recycling, management and evaluation of the life cycle of the product-service systems, products, processes and sustainable services, economy of functionality, frugal innovation, industrial innovations, production sober in energy and in resources, circular economy, local eco-system, supply chain and logistics networks, rapid configuration, internet of things, cyberphysics systems, systems engineering, decision supports, diagnosis, maintenance in particular predictive and anticipative, virtual reality, augmented reality, cognitive ergonomics, knowledge engineering, regulation of individual or collective activity, human work, assistance to the operator, industrial robotics, Human-machine interaction, cobots,*

learning techniques, control-command, innovative instrumentation of measurement and control, integration of the additive manufacturing, innovative technologies of manufacturing, organization of work, adaptation-resistance and the support to change, theory of industrial innovations, fab-lab, optimization and operational research

ERC Codes*: LS05, LS06, LS07, PE01, PE02, PE06, PE07, PE08, SH01, SH02, SH03, SH04.*