Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
**Federal Statistical Office FSO**

Appendix III R&D 2021 in Business Enterprises

R&D in biotechnology, nanotechnology and software

The following examples are designed to help you identify your business research activities in the field of biotechnology, nanotechnology and software.

In section 3.1, you are asked to provide a % estimate of how much of your business's total intramural R&D expenditure in Switzerland (= position 245, Section 1) is devoted to biotechnology, nanotechnology and software.
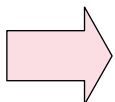
I. Biotechnology
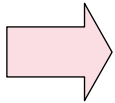
Biotechnology is the application of S&T to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.

Examples of R&D fields in biotechnology:

- **DNA (coding):**
  genomics, pharmaco-genetics, gene probes, DNA sequencing/synthesis/amplification, genetic engineering.
- **Proteins and molecules (functional blocks):**
  protein/peptide sequencing/synthesis, lipid/protein glyco-engineering, proteomics, hormones and growth factors, cell receptors/signalling/pheromones.
- **Cell and tissue culture and engineering:**
  cell/tissue culture, tissue engineering, hybridisation, cellular fusion, vaccine/immune stimulants, embryo manipulation.
- **Process biotechnologies:**
  bioreactors, fermentation, bioprocessing, bioleaching, biopulping, biobleaching, biodesulphurisation, bioremediation, biofiltration, biotransformation, enzyme immobilisation.
- **Sub-cellular organisms:**
  gene therapy, viral vectors.
- **Analytical techniques:**
  Screening: metabolomics, transcriptomics, proteomics, high throughput screening.

II. Nanotechnology

Nanotechnology refers to research, development and eventually the production of products which use materials engineered at the atomic, molecular or macromolecular levels, in the length scale of approximately 1–100 nanometre range. Nano-science refers to the fundamental understanding of phenomena and materials at the nanoscale. On a larger scale, nanotechnology research and development includes the controlled manipulation of nanoscale structures and their integration into larger material components, systems and architectures.

Examples of R&D fields in nanotechnology:

- Development of carbon nano tube (CNT) laminates, structures and devices;
- Manufacture of high temperature CNT composites;
- Low power CNT electronic components;
- New materials based on SiC, GaN;
- Develop materials for sensing and monitoring structural health;
- Design and fabrication of self-healing materials;
- Development of multifunctional CNT structures;
- Devices using quantum dots;
- Pyro-electric micro-thrusters;
- Some deployment of super micro-electro mechanical systems (MEMS);
- Testing of nano sensors;
- Testing and use of nano coating and materials;
- Tech transfer of information from Human Genome Project to create biological approaches to nanotechnology;
- Assembly of micro-mirror arrays;
- Quantum navigation sensors;
- CNT vibration sensors for propulsion diagnostics.

III. Software
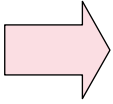
> **For a software development project to be classified as R&D, its completion must be dependent on a scientific and/or technological advance, and the aim of the project must be the systematic resolution of a scientific and/or technological uncertainty.**
>
> **In addition to the software that is part of an overall R&D project, the R&D associated with software as an end product should also be classified as R&D.**

Examples of R&D fields in software development:

- R&D producing new theorems and algorithms in the field of theoretical computer science;
- Development of information technology at the level of operating systems, programming languages, data management, communications software and software development tools;
- Development of internet technology;
- Research into methods of designing, developing, deploying or maintaining software;
- Software development that produces advances in generic approaches for capturing, transmitting, storing, retrieving, manipulating or displaying information;
- Experimental development aimed at filling technology knowledge gaps as necessary to develop a software programme or system;
- R&D on software tools or technologies in specialised areas of computing (image processing, geographic data presentation, character recognition, artificial intelligence and other areas).

Examples of software-related activities not to be included in R&D:

Software-related activities of a routine nature which do not involve scientific and/or technological advances or resolution of technological uncertainties are not to be included in R&D.

Here are some examples:

- Business application software and information system development using known methods and existing software tools;
- Support for existing systems;
- Converting and/or translating computer languages;
- Adding user functionality to application programmes;
- Debugging of systems;
- Adaptation of existing software;
- Preparation of user documentation.