

# Nanoscience

This section presents the requirements for programs in:

- Nanoscience B.Sc. Honours

## Program Requirements

### Nanoscience

#### B.Sc. Honours (20.0 credits)

##### A. Credits Included in the Major CGPA (11.5 credits)

###### 1. 5.0 credits in: 5.0

|                 |  |
|-----------------|--|
| CHEM 1001 [0.5] | General Chemistry I                                  |
| CHEM 1002 [0.5] | General Chemistry II                                 |
| CHEM 2103 [0.5] | Physical Chemistry I                                 |
| CHEM 2501 [0.5] | Introduction to Inorganic and Bioinorganic Chemistry |

CHEM 3100 [0.5] Physical Chemistry II

CHEM 3107 [0.5] Experimental Methods in Nanoscience

CHEM 3503 [0.5] Inorganic Chemistry I

CHEM 3600 [0.5] Introduction to Nanotechnology

CHEM 4908 [1.0] Research Project and Seminar

###### 2. 1.0 credit from: 1.0

CHEM 2203 [0.5] Organic Chemistry I

CHEM 2204 [0.5] Organic Chemistry II

CHEM 2302 [0.5] Analytical Chemistry I

CHEM 2303 [0.5] Analytical Chemistry II

###### 3. 1.0 credit from: 1.0

CHEM 4103 [0.5] Surface Chemistry and Nanostructures

CHEM 4104 [0.5] Physical Methods of Nanotechnology

CHEM 4201 [0.5] Macromolecular Nanotechnology

###### 4. 3.5 credits in: 3.5

ELEC 2501 [0.5] Circuits and Signals

ELEC 2507 [0.5] Electronics I

ELEC 3908 [0.5] Physical Electronics

ELEC 3105 [0.5] Basic EM and Power Engineering

ELEC 4609 [0.5] Integrated Circuit Design and Fabrication

ELEC 4700 [0.5] The Physics and Modeling of Advanced Devices and Technologies

ELEC 4704 [0.5] Nanoscale Technology and Devices

###### 5. 1.0 credit from: 1.0

ELEC 2607 [0.5] Switching Circuits

ELEC 3500 [0.5] Digital Electronics

ELEC 3509 [0.5] Electronics II

ELEC 3909 [0.5] Electromagnetic Waves

##### B. Credits Not Included in the Major CGPA (8.5 credits)

###### 6. 2.5 credits in: 2.5

MATH 1004 [0.5] Calculus for Engineering or Physics

MATH 1005 [0.5] Differential Equations and Infinite Series for Engineering or Physics

MATH 1104 [0.5] Linear Algebra for Engineering or Science

MATH 2004 [0.5] Multivariable Calculus for Engineering or Physics

|                           |   |            |
|---------------------------|---|------------|
| STAT 3502 [0.5]           | Probability and Statistics  |            |
| <b>7. 1.0 credits in:</b> |   | <b>1.0</b> |
| PHYS 1003 [0.5]           | Introductory Mechanics and Thermodynamics   |            |
| PHYS 1004 [0.5]           | Introductory Electromagnetism and Wave Motion                                     |            |
| <b>8. 1.5 credits in</b>  | Advanced Science Faculty Electives:   | <b>1.5</b> |
| <b>9. 0.5 credit in</b>   | Science Continuation (not CHEM)   | <b>0.5</b> |
| <b>10. 0.5 credit in:</b> |   | <b>0.5</b> |
| NSCI 1000 [0.5]           | Seminar in Science  |            |
|                           | (or approved courses outside the faculties of Science and Engineering and Design) |            |
| <b>11. 1.5 credits in</b> | approved courses outside the faculties of Science and Engineering and Design      | <b>1.5</b> |
| <b>12. 1.0 credit in</b>  | free electives  | <b>1.0</b> |
| Total Credits             |   | 20.0       |

## B.Sc. Regulations

The regulations presented in this section apply to all Bachelor of Science programs. In addition to the requirements presented here, students must satisfy the University regulations common to all undergraduate students including the process of Academic Performance Evaluation (see the *Academic Regulations of the University* section of this Calendar).

### Breadth Requirement for the B.Sc.

Students in Bachelor of Science Honours, Major, or General programs must present the following credits at graduation:

- 2.0 credits in Science Continuation courses not in the major discipline; **students completing a double major are considered to have completed this requirement providing they have 2.0 credits in science continuation courses in each of the two majors**
- 2.0 credits in courses outside of the faculties of Science and Engineering and Design (but may include NSCI 1000)

In most cases, the requirements for individual B.Sc. programs, as stated in this Calendar, contain these requirements, explicitly or implicitly.

Students admitted to B.Sc. programs by transfer from another institution must present at graduation (whether taken at Carleton or elsewhere):

- 2.0 credits in courses outside of the faculties of Science and Engineering and Design (but may include NSCI 1000) if, on transfer, the student received credit for fewer than 10.0 credits.
- 1.0 credit in courses outside of the faculties of Science and Engineering and Design (but may include NSCI 1000) if, on transfer, the student received credit for 10.0 or more credits.

### Declared and Undeclared Students

Students who are registered in a program within the degree are called Declared students. Most students designate a program of study when they first apply for admission and so begin their studies as Declared students. Students may also choose to begin their studies

within the B.Sc. degree without being registered in a program. These students are referred to as Undeclared students. The recommended course pattern for Undeclared students is provided in the Undeclared entry of the Programs section of this Calendar. Undeclared students normally must apply to enter a program before beginning their second year of study. The Science Student Success Centre (SSSC) provides Undeclared students guidance to the appropriate support services in making this decision.

### Change of Program within the B.Sc. Degree

Students may transfer to a program within the B.Sc. degree if upon entry to the new program they would be in good academic standing.

Other applications for change of program will be considered on their merits; students may be accepted in the new program in *Good Standing* or on *Academic Warning*.

Applications to declare or change their program within the B.Sc. Degree must be made online through Carleton Central by completing a Change of Program Elements (COPE) application form within the published deadlines. Acceptance into a program or into a program element or option is subject to any enrolment, and/or specific program, program element or option requirements as published in the relevant Calendar entry.

### Minors, Concentrations and Specializations

Students may add a minor, concentration or specialization by completing a Change of Program Elements (COPE) application form online through Carleton Central. Acceptance into a minor, concentration or specialization requires that the student be in *Good Standing* and is subject to any specific requirements of the intended Minor, Concentration or Specialization as published in the relevant Calendar entry.

### Experimental Science Requirement

Students in B.Sc. Honours, Major, or General degree programs must present at graduation at least two full credits of experimental science chosen from two different departments or institutes from the list below:

#### Approved Experimental Science Courses

##### Biochemistry

|                 |  |
|-----------------|--|
| BIOC 2200 [0.5] | Cellular Biochemistry                        |
| BIOC 4001 [0.5] | Methods in Biochemistry                      |
| BIOC 4201 [0.5] | Advanced Cell Culture and Tissue Engineering |

##### Biology

|                 |                            |
|-----------------|----------------------------|
| BIOL 1103 [0.5] | Foundations of Biology I   |
| BIOL 1104 [0.5] | Foundations of Biology II  |
| BIOL 2001 [0.5] | Animals: Form and Function |
| BIOL 2002 [0.5] | Plants: Form and Function  |
| BIOL 2104 [0.5] | Introductory Genetics      |
| BIOL 2200 [0.5] | Cellular Biochemistry      |
| BIOL 2600 [0.5] | Ecology                    |

##### Chemistry

|                 |                      |
|-----------------|----------------------|
| CHEM 1001 [0.5] | General Chemistry I  |
| CHEM 1002 [0.5] | General Chemistry II |

|                 |   |
|-----------------|---|
| CHEM 1005 [0.5] | Elementary Chemistry I                  |
| CHEM 1006 [0.5] | Elementary Chemistry II                 |
| CHEM 2103 [0.5] | Physical Chemistry I                    |
| CHEM 2203 [0.5] | Organic Chemistry I                     |
| CHEM 2204 [0.5] | Organic Chemistry II                    |
| CHEM 2302 [0.5] | Analytical Chemistry I                  |
| CHEM 2303 [0.5] | Analytical Chemistry II                 |
| CHEM 2800 [0.5] | Foundations for Environmental Chemistry |

##### Earth Sciences

|                 |  |
|-----------------|--|
| ERTH 1006 [0.5] | Exploring Planet Earth                             |
| ERTH 1009 [0.5] | The Earth System Through Time                      |
| ERTH 2102 [0.5] | Mineralogy to Petrology                            |
| ERTH 2404 [0.5] | Engineering Geoscience                             |
| ERTH 2802 [0.5] | Field Geology I                                    |
| ERTH 3111 [0.5] | Vertebrate Evolution: Mammals, Reptiles, and Birds |
| ERTH 3112 [0.5] | Vertebrate Evolution: Fish and Amphibians          |
| ERTH 3204 [0.5] | Mineral Deposits                                   |
| ERTH 3205 [0.5] | Physical Hydrogeology                              |
| ERTH 3806 [0.5] | Structural Geology                                 |

##### Food Sciences

|                 |                   |
|-----------------|-------------------|
| FOOD 3001 [0.5] | Food Chemistry    |
| FOOD 3002 [0.5] | Food Analysis     |
| FOOD 3005 [0.5] | Food Microbiology |

##### Geography

|                 |                              |
|-----------------|------------------------------|
| GEOG 1010 [0.5] | Global Environmental Systems |
| GEOG 3108 [0.5] | Soil Properties              |

##### Neuroscience

|                 |                                |
|-----------------|--------------------------------|
| NEUR 3206 [0.5] | Sensory and Motor Neuroscience |
| NEUR 3207 [0.5] | Systems Neuroscience           |
| NEUR 4600 [0.5] | Advanced Lab in Neuroanatomy   |

##### Physics

|                 |  |
|-----------------|--|
| PHYS 1001 [0.5] | Foundations of Physics I   |
| PHYS 1002 [0.5] | Foundations of Physics II  |
| PHYS 1003 [0.5] | Introductory Mechanics and Thermodynamics                        |
| PHYS 1004 [0.5] | Introductory Electromagnetism and Wave Motion                    |
| PHYS 1007 [0.5] | Elementary University Physics I                                  |
| PHYS 1008 [0.5] | Elementary University Physics II                                 |
| PHYS 2202 [0.5] | Wave Motion and Optics   |
| PHYS 2604 [0.5] | Modern Physics I   |
| PHYS 3007 [0.5] | Third Year Physics Laboratory: Selected Experiments and Seminars |
| PHYS 3606 [0.5] | Modern Physics II  |
| PHYS 3608 [0.5] | Modern Applied Physics   |

### Course Categories for B.Sc. Programs

#### Science Geography Courses

|                 |                                       |
|-----------------|---------------------------------------|
| GEOG 1010 [0.5] | Global Environmental Systems          |
| GEOG 2006 [0.5] | Introduction to Quantitative Research |
| GEOG 2013 [0.5] | Weather and Water                     |
| GEOG 2014 [0.5] | The Earth's Surface                   |
| GEOG 3003 [0.5] | Quantitative Geography                |

|                 |   |
|-----------------|---|
| GEOG 3010 [0.5] | Field Methods in Physical Geography       |
| GEOG 3102 [0.5] | Geomorphology                             |
| GEOG 3103 [0.5] | Watershed Hydrology                       |
| GEOG 3104 [0.5] | Principles of Biogeography                |
| GEOG 3105 [0.5] | Climate and Atmospheric Change            |
| GEOG 3106 [0.5] | Aquatic Science and Management            |
| GEOG 3108 [0.5] | Soil Properties                           |
| GEOG 4000 [0.5] | Field Studies                             |
| GEOG 4005 [0.5] | Directed Studies in Geography             |
| GEOG 4013 [0.5] | Cold Region Hydrology                     |
| GEOG 4017 [0.5] | Global Biogeochemical Cycles              |
| GEOG 4101 [0.5] | Two Million Years of Environmental Change |
| GEOG 4103 [0.5] | Water Resources Engineering               |
| GEOG 4104 [0.5] | Microclimatology                          |
| GEOG 4108 [0.5] | Permafrost                                |

### Science Psychology Courses

|                 |  |
|-----------------|--|
| PSYC 2001 [0.5] | Introduction to Research Methods in Psychology |
| PSYC 2002 [0.5] | Introduction to Statistics in Psychology       |
| PSYC 2700 [0.5] | Introduction to Cognitive Psychology           |
| PSYC 3000 [1.0] | Design and Analysis in Psychological Research  |
| PSYC 3506 [0.5] | Cognitive Development                          |
| PSYC 3700 [1.0] | Cognition (Honours Seminar)                    |
| PSYC 3702 [0.5] | Perception                                     |
| PSYC 2307 [0.5] | Human Neuropsychology I                        |
| PSYC 3307 [0.5] | Human Neuropsychology II                       |

### Science Continuation Courses

A course at the 2000 level or above may be used as a Science Continuation credit in a B.Sc. program if it is not in the student's major discipline, and is chosen from the following:

|  |
|--|
| BIOC (Biochemistry)  |
| BIOL (Biology)   |
| CHEM (Chemistry)   |
| COMP (Computer Science) A maximum of two half-credits at the 1000-level in COMP, excluding COMP 1001 may be used as Science Continuation credits.  |
| ERTH (Earth Sciences), except ERTH 2415 which may be used only as a free elective for any B.Sc. program. Students in Earth Sciences programs may use ERTH 2401, ERTH 2402, and ERTH 2403 only as free electives. |
| Engineering. Students wishing to register in Engineering courses must obtain the permission of the Faculty of Engineering and Design.  |
| ENSC (Environmental Science)   |
| FOOD (Food Science and Nutrition)  |
| GEOM (Geomatics)   |
| HLTH (Health Sciences)   |
| MATH (Mathematics)   |
| NEUR (Neuroscience)  |
| PHYS (Physics), except PHYS 2903   |
| Science Geography Courses (see list above)   |

Science Psychology Courses (see list above)

STAT (Statistics)

TSES (Technology, Society, Environment) except TSES 2305. Biology General, Major, and Honours students may use these courses only as free electives. Integrated Science and Environmental Science students may include these courses in their programs but may not count them as part of the Science Sequence.

### Science Faculty Electives

Science Faculty Electives are courses at the 1000-4000 level chosen from:

BIOC (Biochemistry)

BIOL (Biology) Biology & Biochemistry students may use BIOL 1010 and BIOL 2005 only as free electives

CHEM (Chemistry) except CHEM 1003, CHEM 1004 and CHEM 1007

COMP (Computer Science) except COMP 1001

ERTH (Earth Sciences) except ERTH 1010, ERTH 1011 and ERTH 2415. Earth Sciences students may use ERTH 2401, ERTH 2402, and ERTH 2403 only as free electives.

Engineering

ENSC 2001

FOOD (Food Science and Nutrition)

GEOM (Geomatics)

HLTH (Health Science)

MATH (Mathematics)

NEUR (Neuroscience)

PHYS (Physics) except PHYS 1901, PHYS 1902, PHYS 1905, PHYS 2903

Science Geography (see list above)

Science Psychology (see list above)

STAT (Statistics)

TSES (Technology, Society, Environment) Biology General, Major and Honours students may use these courses only as free electives.

### Advanced Science Faculty Electives

Advanced Science Faculty Electives are courses at the 2000-4000 level chosen from the Science Faculty Electives list above.

### Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

All courses offered by the Faculty of Arts and Social Sciences, the Faculty of Public Affairs, and the Sprott School of Business are approved as Arts or Social Sciences courses EXCEPT FOR: All Science Geography courses (see list above), all Geomatics (GEOM) courses, all Science Psychology courses (see list above). NSCI 1000 may be used as an Approved Course Outside the Faculties of Science and Engineering and Design.

### Free Electives

Any course is allowable as a Free Elective providing it is not prohibited (see below). Students are expected to comply with prerequisite requirements and enrolment restrictions for all courses as published in this Calendar.

### Courses Allowable Only as Free Electives in any B.Sc. Program

|                 |   |
|-----------------|---|
| CHEM 1003 [0.5] | The Chemistry of Food, Health and Drugs |
| CHEM 1004 [0.5] | Drugs and the Human Body                |
| CHEM 1007 [0.5] | Chemistry of Art and Artifacts          |
| ERTH 1010 [0.5] | Our Dynamic Planet Earth                |
| ERTH 1011 [0.5] | Evolution of the Earth                  |
| ERTH 2415 [0.5] | Natural Disasters                       |
| ISCI 1001 [0.5] | Introduction to the Environment         |
| ISCI 2000 [0.5] | Natural Laws                            |
| ISCI 2002 [0.5] | Human Impacts on the Environment        |
| MATH 0107 [0.5] | Algebra and Geometry                    |
| PHYS 1901 [0.5] | Planetary Astronomy                     |
| PHYS 1902 [0.5] | From our Star to the Cosmos             |
| PHYS 1905 [0.5] | Physics Behind Everyday Life            |
| PHYS 2903 [0.5] | Physics Towards the Future              |

#### Prohibited Courses

The following courses are not acceptable for credit in any B.Sc. program:

|                 |   |
|-----------------|---|
| COMP 1001 [0.5] | Introduction to Computational Thinking for Arts and Social Science Students |
| MATH 0005 [0.5] | Precalculus: Functions and Graphs   |
| MATH 0006 [0.5] | Precalculus: Trigonometric Functions and Complex Numbers                    |
| MATH 1009 [0.5] | Calculus: with Applications to Business                                     |
| MATH 1119 [0.5] | Linear Algebra: with Applications to Business                               |
| MATH 1401 [0.5] | Elementary Mathematics for Economics I                                      |
| MATH 1402 [0.5] | Elementary Mathematics for Economics II                                     |

#### Admissions Information

Admission Requirements are for the 2020-21 year only, and are based on the Ontario High School System. Holding the minimum admission requirements only establishes eligibility for consideration. The cut-off averages for admission may be considerably higher than the minimum. See also the **General Admission and Procedures** section of this Calendar. An overall average of at least 70% is normally required to be considered for admission. Some programs may also require specific course prerequisites and prerequisite averages and/or supplementary admission portfolios. Higher averages are required for admission to programs for which the demand for places by qualified applicants exceeds the number of places available. The overall average required for admission is determined each year on a program by program basis. Consult [admissions.carleton.ca](http://admissions.carleton.ca) for further details.

Note: Courses listed as *recommended* are not mandatory for admission. Students who do not follow the recommendations will not be disadvantaged in the admission process.

#### Degrees

- B.Sc. (Honours)
- B.Sc. (General)
- B.Sc. (Major)

#### Admission Requirements

##### Honours Program

##### First Year

The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. For most programs including Biochemistry, Bioinformatics, Biotechnology, Chemistry, Combined Honours in Biology and Physics, Chemistry and Physics, Computational Biochemistry, Food Science, Nanoscience, Neuroscience, Neuroscience and Mental Health, and Psychology, the six 4U or M courses must include Advanced Functions and two of Biology, Chemistry, Earth and Space Sciences or Physics. (Calculus and Vectors is strongly recommended).

##### Specific Honours Admission Requirements

For the Honours programs in Earth Sciences, Environmental Science, Geomatics, Interdisciplinary Science and Practice, and Physical Geography, Calculus and Vectors may be substituted for Advanced Functions.

For the Honours programs in Physics and Applied Physics and for double Honours in Mathematics and Physics, Calculus and Vectors is required in addition to Advanced Functions and one of 4U Physics Chemistry, Biology, or Earth and Space Sciences. For all programs in Physics, 4U Physics is strongly recommended.

For the Combined Honours program in Chemistry and Computer Science, 4U Chemistry and Calculus and Vectors are strongly recommended.

For Honours in Psychology, a 4U course in English is recommended.

For Honours in Environmental Science, a 4U course in Biology and Chemistry is recommended.

##### Advanced Standing

For entry to an Honours program after the completion of 5.0 included credits, a student must have a major CGPA of 5.50 or higher, an overall CGPA of 4.50 or higher and the recommendation of the Honours department or committee. A student beginning the final 10.0 credits towards an Honours degree must present a major CGPA of 6.00 or higher, an overall CGPA of 5.00 or higher and the recommendation of the Honours department or committee. A student beginning the final 5.0 credits towards an Honours degree must present a major CGPA of 6.50 or higher and an overall CGPA of 5.00 or higher, as calculated for graduation. Advanced standing will be granted for studies undertaken elsewhere when these are recognized as the equivalent of subjects offered at Carleton University.

##### Major Program

##### General Program

**First Year**

The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. The six 4U or M courses must include Advanced Functions and two of Calculus and Vectors, Biology, Chemistry, Earth and Space Science or Physics (Calculus and Vectors is strongly recommended). For the B.Sc. Major in Physics. 4U Physics is strongly recommended. Equivalent courses may be substituted between the old and new Ontario mathematics curriculum.

**Advanced Standing**

For entry to a General or Major program after the completion of 5.0 included credits, a student must have a major and core CGPA of 3.50 or higher and an overall CGPA of 3.50 or higher. A student beginning the final 5.0 credits towards a General or Major degree must present a major and core CGPA of 4.00 or higher and an overall CGPA of 4.00 or higher, as calculated for graduation. Advanced standing will be granted for studies undertaken elsewhere when these are recognized as the equivalent of subjects offered at Carleton University.

**Co-op Option****Direct Admission to the First Year of the Co-op Option**

Applicants must:

1. meet the required overall admission cut-off average and prerequisite course average. These averages may be higher than the stated minimum requirements;
2. be registered as a full-time student in the Bachelor of Science Honours program;
3. be eligible to work in Canada (for off-campus work placements).

Note that meeting the above requirements only establishes eligibility for admission to the program. The prevailing job market may limit enrolment in the co-op option.

Note: continuation requirements for students previously admitted to the co-op option and admission requirements for the co-op option after beginning the program are described in the Co-operative Education Regulations section of this Calendar.