NOTICE CANDIDATS

Version anglaise

INTERNATIONAL ENTRANCE EXAM 2027

Filière Universitaire Internationale (FUI)

Preambule

This document details the application procedures for the FUI (International University Track) entrance exam, the international admissions pathway for the École Polytechnique's engineering cycle, intended for international candidates wishing to join the engineering program.

This entrance exam is intended exclusively for students pursuing a university science or engineering curriculum outside of France, and whose academic path is not comparable to a French Classes Préparatoires aux Grandes Écoles (CPGE) program.

This document aims to provide candidates with information on:

- The competition timeline
- The eligibility requirements
- The registration procedures
- The examination process

For any questions, you may contact the Admissions Office at the following address:

concours-international@polytechnique.fr

I. KEY DATES : 2026 – 2027 SCHEDULE

Opening of applications	Mid- June 2026
Application deadline	Mid-September 2026
Deadline for submission of required documents	Mid-September 2026
Publication of eligibility results	October 10, 2026
Oral admission examinations ***(by videoconference at an official examination center)***	November 2 to 15, 2026
Publication of admission results	December 2, 2026
Academic entry to the School ***(except in special cases, such as double-degree programs)***	September 2027

II. ELIGIBILITY REQUIREMENTS

1. Nationality Requirement

The international entrance exam is exclusively reserved for candidates of foreign nationality.

Candidates holding French nationality, including those with dual citizenship, are not eligible and must apply via the French University Track (FUF) or, where applicable, via the CPGE pathway.

2. Age Requirement

Candidates must be under 25 years of age on January 1, 2027 (the year of integration into École Polytechnique).

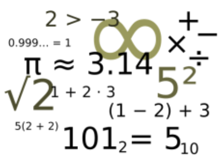
3. Language Requirements

Proficiency in English and/or French is required to take the examinations.

Please note that most courses in the Cycle Ingénieur at École Polytechnique are taught in French. Nevertheless, **candidates without prior French proficiency may still apply**. Admitted non-French speakers benefit from an intensive language program to improve their French, experience French culture, and ease their integration into the program.

4. Academic Requirements

- **Possessing an excellent background in mathematics, as well as in one of the following five scientific disciplines—physics, computer science, chemistry, or life sciences—is essential.**






- Be enrolled in the first cycle of university studies (Bachelor's degree) at the time of the examinations and not have been enrolled in a Master's program in science or engineering.

- Not have pursued scientific higher education studies at a French higher education institution (excluding university exchange programs).

- Have completed at least two years of higher education in science or engineering by the application deadline.

- Meet the physical fitness requirements set by the Ministry of Defense, as verified by the School's Chief Medical Officer at the start of the academic year.

A candidate may apply a maximum of two times for the international entrance exam, provided that for each application they meet all eligibility requirements.

A candidate is prohibited from applying to the same degree program through multiple admission pathways. Any application submitted in violation of this rule will be declared inadmissible.

III. LES FORMALITES D'INSCRIPTION

1. Application Period

Applications will be open online from mid-May to mid-September 2026, with exact dates to be confirmed.

https://candidatures.polytechnique.fr/candidatures-mutualisees/logincandidature/?cursus=

2. Required Documents

Candidates must complete the online application form on the dedicated website and submit the following supporting documents:

Academic File

a) **Personal Statement** (2 to 3 pages):
* Presentation of scientific and extracurricular interests.
* Explanation of motivations and plans related to the application.
* Optional: Appendices (university or personal projects).
b) **Curriculum Vitae** (mandatory template).
c) **Course descriptions** for all courses taken since the beginning of higher education (mandatory template).
d) **Complete, official transcripts**, validated by the president/dean of the home university.
e) Official certificates:
* Entrance examination ranking (for university admission).
* End-of-year ranking for each academic year in the candidate's curriculum.
f) **Diplomas and degrees obtained** (if applicable).
g) **Certificates for awards and distinctions** mentioned in the application.
h) **Two letters of recommendation** (mandatory template), written by professors or academic supervisors who have mentored the candidate.

i) Proof of French and/or English proficiency.

Administrative Documents

a) **Certificate of enrolment** for the current academic year.
b) **Clear copy of a valid ID document** (national identity card or passport).
c) Recent passport-style photograph.

⚠ **Important:**

- Please enter your surname (last name) and first name(s) exactly as they appear on your ID document.
- Documents must be translated into French or English if necessary

IV. THE EXAMINATION PROCESS

The exam consists of two stages: preselection (based on the application file) and admission (oral examinations).

The use of artificial intelligence is strictly prohibited.

1. First Stage: Preselection

Preselection is based on the evaluation of the academic file.

The admissions committee separately evaluates the academic and extracurricular aspects of the application file. Both elements are considered in determining preselection.

2. Second Stage: Admission

The admission oral examinations consist of two scientific tests:

- **Major Subject Oral Examination**
  - Discipline chosen by the candidate among: Mathematics, Physics, Computer Science, Chemistry, or Life Sciences.
  - Duration: 55 minutes
  - Coefficient: 8

- **Minor Subject Oral Examination**
  - For candidates whose major subject is **not** Mathematics: the minor subject is **mandatorily** Mathematics.
  - For candidates whose major subject is Mathematics: the minor subject is chosen from Physics, Computer Science, Chemistry, or Life Sciences.
  - Duration: 55 minutes
  - Coefficient: 5

IMPORTANT A core syllabus for each discipline is provided in the appendix. Candidates may also be questioned on topics from their own curriculum relevant to the chosen discipline.

Each oral examination is divided into two parts:

- The first part consists of scientific questions on the relevant discipline.
- The second part is a discussion with the candidate focusing on their motivation, scientific curiosity, general knowledge, and serves to assess their level of French or English.

Each of the two scientific oral examinations is assessed based on both scientific knowledge and motivation.

The oral examinations are conducted remotely via videoconference between late October and mid-November. They are organized from one of the official centers located in the country where the candidate's home institution is based.

Following the admission oral examinations, each candidate receives a **"Scientific Oral Score"**, calculated as the weighted average of the major and minor subject scores, each with its respective coefficient.

The **"Candidate's Overall Scientific Score"** is then determined using the following formula:

Overall Scientific Score = 0.75 × Scientific Oral Score + 0.25 × Academic File Score

Admission results are communicated to candidates after the deliberation of the admissions jury, which establishes the list of admitted candidates. Admitted candidates receive a message inviting them to confirm their acceptance of the offer via their applicant portal.

Annexes

Please find below the essential topics in

- **Mathematics**
- **Physics**
- **Computer Science (coming soon)**
- **Life Sciences (coming soon)**
- **Chemistry (coming soon)**

Mathematics: recommended background knowledge

1 - ALGEBRA

1.1 Set theory

Operations on sets, characteristic functions. Maps, injectivity, surjectivity.
Direct and inverse image of a set.

Integer numbers, finite sets, countability.

1.2 Numbers and usual structures

Composition laws; groups, rings, fields.
Equivalence relations, quotient structures.
Real numbers, complex numbers, complex exponential.
Application to plane geometry.

Polynomials, relations between the roots and the coefficients.
Elementary arithmetics (in **Z/nZ**).

1.3 Finite dimensional vector spaces (*)

Free families, generating families, bases, dimension.
Determinant of n vectors; characterization of bases.
Matrices, operations on matrices.

Determinant of a square matrix; expansion with respect to a line or to a column; rank, cofactors.

Linear maps, matrix associated to a linear map. Endomorphisms,
trace, determinant, rank.

Linear systems of equations.

1.4 Reduction of endomorphisms

Stable subspaces.

Eigenvalues, eigenvectors of an endomorphism or a square matrix; similar matrices; geometrical interpretation.

Characteristic polynomial, Cayley-Hamilton theorem.

Reduction of endomorphisms in finite dimension; diagonalizable endomorphisms and matrices.

1.5 Euclidean spaces, Euclidean geometry

Scalar product; Cauchy-Schwarz inequality; norms and associated distances. Euclidean spaces of finite dimension, orthonormal bases; orthogonal projections. Orthogonal group O(E); orthogonal symmetries.

Orthogonal matrices; diagonalization of symmetric real matrices. Properties of orthogonal endomorphisms of $\mathbf{R}^2$ and $\mathbf{R}^3$.

(*) In several countries linear algebra is studied only in $\mathbf{R}^k$ or $\mathbf{C}^k$; the candidates from these countries are strongly advised to get familiar with the formalism of abstract vector spaces.

2 - ANALYSIS AND DIFFERENTIAL GEOMETRY

2.1 Topology in finite dimensional normed vector spaces

Open and closed sets, accumulation points, interior points.

Convergent sequences in normed vector spaces; continuous mappings.

Compact spaces, images of compact sets by continuous mappings, existence of extrema. Equivalence of norms.

2.2 Real or complex valued functions defined on an interval

Derivative at a point, functions of class C^k. Mean value theorem, Taylor's formula.

Primitive of continuous functions.

Usual functions (exponential, logarithm, trigonometric functions, rational fractions). Sequences and series of functions, simple and uniform convergence.

2.3 Integration on a bounded interval

Integral of piecewise continuous functions.

Fundamental theorem of calculus (expressing the integral of a function in terms of a primitive).

Integration by parts, change of variable, integrals depending on a parameter. Continuity under the sign ∫ , differentiation under the sign ∫.

Cauchy-Schwarz inequality.

2.4 Series of numbers, power series

Series of real or complex numbers, simple and absolute convergence. Integral comparison criterion, product of absolutely convergence series.

Power series, radius of convergence; function that can be expanded in a power series on an interval.

Taylor series expansion of e^t, sin(t), cos(t), ln (1+t), $(1+t)^a$ where a is a real number.

2.5 Differential equations

Linear scalar equations of degree 1 or 2, fundamental systems of solutions.
Linear systems with constant coefficients.

Method of the variation of the constants.

Notions on non-linear differential equations.

2.6 Functions of several real variables

Partial derivatives, differential of a function defined on $\mathbf{R}^k$. Chain rule.

C^1-functions; Schwarz theorem for C^2-functions.

Diffeomorphisms, inverse function theorem. Critical points, local and global extrema. Plane curves; tangent vector at a point, metric properties of plane curves (arc length, curvature).

Surfaces in $\mathbf{R}^3$, tangent plane to a surface defined by a Cartesian equation $F(x,y,z) = 0$.

Physics: recommended background knowledge

I. MECHANICS

- Newtonian mechanics
- Mechanics of solids
- Statics and mechanics of fluids
- Applications of mechanics

II. ELECTRIC CIRCUITS

III. ELECTRICITY AND MAGNETISM

- Electrostatics
- Magnetostatics
- Electromagnetic waves

IV. OPTICS

- Geometrical optics
- Wave optics

V. THERMODYNAMICS

- Perfect gas
- First and second principles of thermodynamics

Physical constants

The values of Planck, Boltzmann and Avogadro constants, the charge and the mass of the electron, the speed of light in vacuum, the electric permittivity and the magnetic permeability of free space, in *SI* system of units (at least two significant digits are required).

Orders of magnitude

The orders of magnitude of quantities such as the magnetic field of the Earth, the radius of the Earth, the acceleration of free fall at the Earth's surface, the concentration of electrons in a typical metal, the wavelengths of the electromagnetic waves of the visible spectrum, the distance between two atoms in a solid or liquid, the Bohr radius of the fundamental state of the hydrogen atom, the size of the nucleus.

Compulsory minimal requirements of calculation skills

Mastering a certain number of calculation skills such as is compulsory

Expansions

Be able to study the behaviour of a physical quantity $A(x)$ in the neighbourhood of a given value of its argument x. The common expansions about $x \approx 0$

$$\sin x \approx x - \frac{x^3}{6}; \quad \cos x \approx 1 - \frac{x^2}{2}; \quad \tan x \approx x + \frac{x^3}{3}; \quad \cot g\, x \approx \frac{1}{x} - \frac{x}{3}$$

$$e^x \approx 1 + x + \frac{x^2}{2}; \quad \ln(1+x) \approx x; \quad (1+x)^\alpha \approx 1 + \alpha x + \frac{\alpha(\alpha-1)}{2} x^2$$

Derivatives and primitives of the functions of a single variable

Derivatives of the elementary functions (x^n, $\ln x$, e^x, $\sin x$, $\cos x$, $tg\, x$, $\cot g\, x$) as well as of the composition function $f(g(x))$.
Rules for the derivative of the product and the quotient of two functions of a real variable. Primitives of the elementary functions above.
Integration by parts.
Conditions for the convergence of an integral in the cases of an infinite integration interval or the presence of points of discontinuity.

Functions of several variables. Common differential operators.

Total differential.
Partial derivatives with respect to an independent variable in the case of a function of several variables.

Nabla operator $\vec{\nabla}$. Gradient $\vec{\nabla} f$ of a function $f(\mathbf{r})$.

Curl $\vec{\nabla} \times \mathbf{A}$ of a vector field $\mathbf{A}(\mathbf{r})$. Divergence $\vec{\nabla} . \mathbf{A}$. Circulation $\oint_{(C)} \mathbf{A}.d\mathbf{l}$.

Laplacian $\nabla^2 f$ and vector Laplacian $\nabla^2\mathbf{A}$.

Multiple integrals. Stokes, Gauss – Ostrogradski theorems.

Reduction of multiple integrals to simple integrals by using the symmetry properties (cylindrical, spherical) of the integrants and surfaces (volumes) involved
Stokes theorem.
Gauss-Ostrogradski theorem.

Differential equations

Solution of first order differential equations with separable variables.
Solution of second order linear and homogeneous differential equations with constant coefficients. Characteristic polynomial, number and nature of solutions, critical damping.
Solution of second order linear inhomogeneous equations with constant coefficients. Concepts of forced oscillations and resonance.

Equations with partial derivatives

D'Alembert's solution of the wave equation.
Progressive monochromatic plane waves. Concepts of wave vector, wavelength, frequency and period.
Principal phenomenological laws (Fick, Fourier and diffusion equations). Energy, mass, etc. balance within an elementary volume.

Linear algebra

Calculation of a determinant, diagonalization of a matrix, concepts of eigenvalues and eigenvectors of a linear operator.

Trigonometry

Definitions and properties of the basic trigonometric functions (sine, cosine, tangent, cotangent).
Common trigonometric formulas ($\cos 2x = \cos^2 x - \sin^2 x$; $\sin 2x = 2 \sin x \cos x$; $\sin \alpha + \sin \beta = 2 \sin [(\alpha + \beta) / 2] \cos [(\alpha - \beta) / 2]$; $\cos \alpha + \cos \beta = 2 \cos [(\alpha + \beta) / 2] \cos [(\alpha - \beta) / 2]$, etc.).
Fourier series of a regular enough periodic function.

I. MECHANICS

Newtonian mechanics

Newton's laws: the principle of inertia, the principle of action and reaction, the fundamental equation of dynamics.
Galilean relativity. Concept of non-inertial reference frames and forces referred to as « inertia » forces (in particular, in the case of linear acceleration and uniform rotation frames) Angular momentum theorem. Kinetic energy theorem. Momentum theorem.

A two particle system. Central force motion, bound states, scattering states.
Expressions for the velocity and the acceleration of a material point in cylindrical and spherical co-ordinates.
Concept of potential energy. Independence on the path of the work done by a potential- derived force.
Conservation of mechanical energy of an isolated material system in the case of conservative forces.
Conservation of angular momentum in the case of central forces. First and second Kepler's laws (the law of conical sections and the law of areas).
Conservation of momentum in the case of an isolated system. Elastic and inelastic collision problems. Concept of a centre of mass of a system.
Expressions for the potential, kinetic and total energy of a particle in the case of a circular trajectory.

Mechanics of solids

Rigid bodies (non-deformable solids). Solids rotating about a fixed axis. Moment of inertia of a rigid body. Expression for the kinetic energy of a rigid body as a sum of a translational term of its centre of mass and of a rotational term referred to the centre-of-mass reference frame (Koenig's theorem). The problem of the compound pendulum.

Statics and mechanics of fluids

Euler's description (the concept of a velocity field) of a fluid. Concepts of flow density, mass flow rate and volume flow rate. Mass balance. Equation of the conservation of mass in its local form.
Definitions of a stationary flow, of an incompressible flow, of a non-rotational flow.
Perfect flows: Euler's equation, Bernoulli's relationship on incompressible and homogeneous flows.
Calculation of the resulting force of the pressure forces exerted upon an object, in fluid statics. The Archimedes' principle (the buoyancy force applied to an object immersed in a fluid).

Applications of mechanics

Lorentz force (force exerted on a charged particle in constant electric and magnetic fields). Trajectory of a charged particle in a static and uniform magnetic field.
Linear oscillations; damped harmonic oscillations. Forced oscillations, resonance.

II. ELECTRIC CIRCUITS

Electric voltage. Kirchoff's laws of knots and meshes. Electric current. Ohm's law. Superposition theorem.
Basic circuit components: resistor, capacitor, coil. Their impedances in sinusoidal regime. Transient regime of charging and discharging a capacitor.
Sinusoidal currents and voltages. Maximum value, rms (root mean square) value. Impedances in series and in parallel.
Study of resonances in circuits in sinusoidal regime. *RLC* circuit. Relation to resonance in mechanics.

III. ELECTRICITY AND MAGNETISM

Electrostatics

Coulomb's law. The concept of electric field. Electrostatic field **E**. Circulation and flow of **E**. Gauss' theorem. Symmetry properties of **E**.

Electrostatic potential ϕ and Poisson's equation.

Calculation of **E** and ϕ for a simple charge distribution ρ . Electrostatic potential between the plates of a planar capacitor.
Concept of electric dipole, field created by a dipole at large distances, interaction energy of a permanent dipole with the electric field. Definition of the electric polarization vector. Electric field in a conductor at equilibrium. Equipotential surfaces.
Electric field in the vicinity of a metal surface.
Coulomb's law between two charges immersed in a homogenous linear and isotropic dielectric medium.

Magnetostatics

Magnetic field **B**. Symmetry properties of **B**.
Magnetic field created by a thin wire carrying a current (Biot-Savart law), the two Maxwell equations (the divergence of **B** and Ampère's law), vector potential **A**.
Non-unicity of the electrostatic potential ϕ and the vector potential **A**, unicity of the electric field **E** and the magnetic field **B**.
Circulation of **B**. Relationship between the circulation of **B** and the encircled currents (theorem of the total current).
Calculation of **B** created by straight wires and circular loops. Field along the axis of a circular loop and of a coil (solenoid) having a circular cross-section.
Magnetic dipole and magnetic moment **M**. Expression for the interaction energy between a magnetic moment and a magnetic field **B**.
Flux of **B**. Electromagnetic induction phenomenon, Faraday's law, Lenz' rule.

Electromagnetic waves

Electromagnetic waves in vacuum.
Maxwell's equations in vacuum. Progressive harmonic plane waves as solutions of the Maxwell's equations in vacuum. Frequency, wavelength, wave vector. The concept of phase velocity.

Transversality of the electric and magnetic fields.
The state of polarization state an electromagnetic wave. Linear and circular polarizations. Volume density of the electromagnetic energy, Poynting vector.
Concept of wave packet. Group velocity.

Electromagnetic waves in matter (linear and isotropic medium).

Macroscopic **E** and **B** fields. Constitutive relationships complementing Maxwell's equations. Frequency-dependent complex dielectric constant $\varepsilon(\omega)$.

Concepts of complex refraction index, dispersion and absorption.
Microscopic models describing the material polarization of the medium: Drude model, model of the elastically bound electron (Lorentz model).

IV. OPTICS

Geometric optics

Concept of light ray. Reflection and refraction by a plane mirror. Snell-Descartes' laws. Limit angle. The total reflection phenomenon.
Spherical mirrors, lenses, conjugation and magnification relations.

Wave optics

Reflection and refraction of a harmonic progressive polarized plane wave at the interface between two dielectric media. Proof of Snell-Descartes laws.
Concept of optical path**.** Interference between two totally coherent waves. Michelson's interferometer. Thin slabs. Fabry-Pérot cavity.
Diffraction at infinity. Huyghens-Fresnel principle. Diffraction by a rectangular slit. Diffraction at infinity by two slits (Young's slits), by a row of slits.

V. THERMODYNAMICS

Thermodynamic state functions: internal energy, entropy, enthalpy, free energy, free enthalpy, as well as their differentials.
Extensive and intensive variables, thermodynamic equilibrium. Heat capacities at a constant volume and at a constant pressure.

Perfect gas

Perfect monoatomic gas model. Maxwell-Boltzmann distribution of velocities for a monoatomic perfect gas. The equipartition theorem.
Collisions against a wall.
Relationship between pressure and mean square velocity.
Perfect gas in a field of forces having a potential energy $V(\mathbf{r})$. The barometric formula. Limitations of the perfect gas model. Real gases. The van der Waals gas.

First and second principles of thermodynamics

First principle. Internal energy *U*. Heat transfer. Work exchanged by a system. The work of pressure forces. Enthalpy and Joule-Thomson expansion. The enthalpy of a perfect gas.
Second principle. The entropy *S*. Entropy balance. Reversible and irreversible processes. Thermodynamic definition of temperature.
The entropy of a perfect gas (for a condensed and idalatable phase). Heat machines. Dithermal cycle. Efficiency. Carnot's theorem.
Equilibrium between the phases of a pure substance.
Triple point, critical point, enthalpy and entropy of phase changes. Clapeyron's formula.
Free energy and free enthalpy: definitions and differentials. Chemical potential.
The perfect gas case. Equilibrium between two phases. Generalization, Gibbs' phase rules.

Computer Science : recommended background knowledge

Fundamental Concepts

Sequential search in a one-dimensional array. Dictionary.
Algorithms operating on a sequential structure using nested loops.
Use of modules and libraries.
Binary search algorithms.
Recursive functions.
Greedy algorithms.
Pixel matrices and images.
Sorting algorithms.

Programming Methods and Algorithm Analysis

Instruction and expression. Side effects.
Specification of input data and output/return values.
Annotation of a block of instructions with a precondition, a postcondition, and an invariant property.
Assertion.
Explanation and justification of design or programming choices.
Termination. Partial correctness. Total correctness. Invariant.
Test suite associated with a program.
Computational complexity.

Number Representation

Representation of positive integers using fixed-size words.
Representation of signed integers using fixed-size words.
Python’s arbitrary-precision integers.
Distinction between real, decimal, and floating-point numbers.
Representation of floating-point numbers using fixed-size words.
Concepts of mantissa and exponent.
Precision of floating-point computations.

Graph Basics, Shortest Paths

Graph terminology (directed graph, undirected graph; vertex/node; arc, edge; loop; in-degree and out-degree; path between two vertices; cycle; connectivity in undirected graphs).
Graph weighting. Labels on arcs or edges.
Graph traversing algorithms.
Finding the shortest path in a weighted graph with positive weights.

Dictionaries and Dynamic Programming

Dictionaries, keys, and values.
Use of dictionaries in Python programming.
Dynamic programming. Optimal substructure property. Overlapping subproblems.
Bottom-up computation or memorization. Reconstruction of an optimal solution from computed information.

Algorithms for Artificial Intelligence and Game Study

k-nearest neighbors algorithm using Euclidean distance.
k-means algorithm.
Two-player reachability games on a graph. Strategy. Winning strategy. Winning position.
Determination of winning positions using attractor computation. Construction of winning strategies.
Concept of heuristics. Minimax algorithm with a heuristic.

Life Sciences: recommended background knowledge

Cell Biology – Biochemistry

- Structure of the cell: nucleus, intracellular compartments, cytoskeleton, plasma membrane, intercellular junctions
- DNA: structure, organization
- DNA: transcription, control of gene expression, replication, repair, recombination, DNA mutations and phenotypic consequences
- RNA
- Proteins: synthesis, intracellular transport, sorting, processing, secretion
- Enzymes, biological catalysts (enzyme kinetics, Michaelis-Menten vs. allosteric enzymes)
- Cellular bioenergetics (carbohydrate and lipid metabolism, mitochondria, cellular respiration vs. fermentation)
- Cell signaling (diversity of receptors, nature of ligands, examples of signaling pathways: MAPK, Jak/STAT, nuclear receptors…)
- Cell cycle (mitosis and its regulation)
- Meiosis and gamete production
- Stem cells, processes of cell differentiation, tissue regeneration
- Cell death

Animal Physiology

- Body compartments (Gibbs–Donnan effect, Starling principle….)
- Membrane potential (Nernst equation, electrochemical potentials, membrane permeabilities and the Goldman–Hodgkin–Katz (GHK) equation)
- Transmembrane transport (enthalpy, Carnot's law, diffusion, active transport)
- Physiology of the synapse
- Autonomic nervous system
- Buffer systems and pH regulation
- Regulation of cell volume
- Excitation–contraction coupling
- Integrated bioenergetics
- Thermoregulation
- Hormones and hormonal regulation
- Physiology of organ systems (circulatory, respiratory, renal...)
- Physiological adaptation to altitude / exercise

Microbiology

- Organization of bacterial genomes (chromosomal and extrachromosomal information, information exchange…)
- Concept of the microbiota and bacterial ecology
- Viruses (e.g., HIV, COVID, influenza) – replication cycles – antiviral strategies
- Concept of the metagenome

Chemistry: recommended background knowledge

Structure of Matter

- Structure of atoms and molecules
- Trends in properties across the periodic table of elements
- Lewis structures and electron delocalization
- Geometry and polarity of chemical species
- Intermolecular interactions

Quantum Chemistry

- Atomic and molecular orbitals
- Linear Combination of Atomic Orbitals (LCAO) method
- Fragment orbital interactions
- Molecular orbital energy diagrams
- Orbital model of the metal–ligand bond

Chemical Thermodynamics

- Evolution of a system toward an equilibrium state: determination of the equilibrium state
- Influence of parameters on the extent of reaction to optimize yield
- Applications of the First and Second Laws of Thermodynamics
- Chemical potential, enthalpy, entropy, Gibbs free energy, standard-state properties, osmosis
- Liquid–vapor phase transitions of pure substances and binary mixtures

Chemical Kinetics

- Macroscopic kinetics (analysis and interpretation of experimental data)
- Simple rate laws (zero-, first-, and second-order), overall order, apparent order, half-life
- Arrhenius law (Arrhenius equation)

Solution Chemistry

- Acid–base, dissolution, precipitation, and complexation reactions
- Oxidation–reduction (redox) reactions (thermodynamics, kinetics, Nernst equation)
- Potential–pH (Pourbaix) diagrams

Organometallic Chemistry

- Structure of organometallic complexes
- Study of their stability in aqueous solution
- Catalytic activity of complexes
- Catalytic cycles

Organic Chemistry

- Structure and stereochemistry
- Reactivity models based on electrostatic interactions and frontier molecular orbitals
- Main reactions: nucleophilic additions to C=O groups (including organometallic additions), additions to C=C bonds, nucleophilic substitutions (SN1/SN2), addition–elimination reactions of carboxylic acids and their derivatives; enols, enolates, and related species; activation or protection of functional groups
- Spectroscopic characterization techniques: UV–Visible spectroscopy, IR (Infrared) spectroscopy, and ^1H NMR (Proton Nuclear Magnetic Resonance) spectroscopy.