university of groningen

faculty of mathematics and natural sciences

Appendices for the Bachelor's degree programme(s) in Astronomy

Appendix I Learning outcomes of the Bachelor's degree programme (Article 1.3.a)

A. Generic learning outcomes – Knowledge

A1. Bachelor's graduates have general knowledge of the foundations and history of mathematics, natural sciences and technology, in particular those of their own discipline.

A2. Bachelor's graduates have mastered the basic concepts of their own discipline (see Appendix 1 for further specification) to a certain extent and are familiar with the interrelationships of these concepts within their own discipline as well as with other disciplines.

A3. Bachelor's graduates have in-depth knowledge of several current topics within their own discipline.

A4. Bachelor's graduates are familiar with the quantitative character of the fields of mathematics and natural sciences and have an understanding of the methods used in these fields, and particularly within their own discipline, including computer-aided methods.

A5. Bachelor's graduates have sufficient knowledge and understanding of mathematics and natural sciences to successfully complete a follow-up Master's degree programme in their own discipline.

A6. Bachelor's graduates are aware of the societal, ethical and social aspects involved in the fields of mathematics and natural sciences.

B. Generic learning outcomes – Skills

B1 (Research) Bachelor's graduates are able to draw up a research question, design, plan and conduct research and report on it independently with a certain degree of supervision. Bachelor's graduates are able to evaluate the value and limitations of their research and assess its applicability outside their own field.

B2 (Designing) Bachelor's graduates are able to translate a problem, in particular a design problem, into a plan of approach and – taking into account the requirements of the client and/or technical preconditions – find a solution.

B3 (Gathering information) Bachelor's graduates are able to gather relevant information using modern means of communication and to critically interpret this information.

B4 (Collaborating) Bachelor's graduates are able to collaborate in teams (including multidisciplinary teams) on technical-scientific problems.

B5 (Communicating) Bachelor's graduates are able to communicate orally and in writing in academic and professional contexts, with both colleagues and others. They are familiar with the relevant means of communication.

B6 (Reflecting) Bachelor's graduates are able to assess their own actions and those of others in a natural sciences context, bearing in mind the social/societal and ethical aspects.

B7 (Learning skills) Bachelor's graduates are able to apply learning skills that enable them to pursue a follow-up degree and acquire knowledge in new fields with a high level of autonomy.

B8 Additional subject-specific skills are listed in Appendix 2.

Appendix 1.1 Degree programme-specific learning outcomes - Basic Knowledge

The bachelor's graduate in Astronomy

1. has some knowledge of the historical development of the astronomical worldview
2. is familiar with the principles of positional astronomy,
3. masters the basic astrophysics of planets, stars and galaxies, interstellar medium and cosmology,
4. knows the basic principles concerning conducting astronomical observations in different wavelength regimes and processing the obtained observational data,
5. has a thorough knowledge of theoretical astrophysics,
6. has a thorough knowledge of general mathematics (calculus, linear algebra, complex analysis, error analysis, and statistics).
7. has a thorough knowledge of general physics (classical mechanics, electromagnetism, quantum physics, thermodynamics, statistical physics, wave phenomena, oscillations and optics, matter: structure and interactions)
8. (minor) has a deeper knowledge of subjects within their own discipline or a broad general knowledge of a different discipline.

Appendix 1.2 Degree programme-specific learning outcomes – Skills

The bachelor's graduate in Astronomy

1. is on an elementary level able to obtain, analyse, and presents observations in different wavelength regimes of objects like stars, galaxies, and star forming regions,
2. is able to conduct basic astronomical observations with an optical telescope,
3. is familiar with the use of computers and computing in astronomy research:
    - has experience in working with astronomical observations and/or astronomical simulations
    - is able to write software in a common programming language.

Appendix II Majors and Minors of the degree programme (Article 2.1.2)

The programme consists of the major Astronomy (90 ects) and a minor (30 ects). The student can participate in either the minor Astronomy, the minor Instrumentation & Informatics or a Faculty or University Minor.

Appendix III Course units in the propaedeutic phase

- **List of course units; Article 3.1.1**
- **Course units with one or more practicals; Article 3.2**
- **Compulsory order of examinations; Article 8.2**

Course unit name	ECTS	Practical	Entry requirements
Mechanics and Relativity	10	X	
Physics Laboratory 1	5	X	
Calculus 1	5	X	
Choice: ▪ Physics of the Quantum Universe ▪ Physics of Modern Technology ▪ Introduction to Energy & Environment 1 ▪ Medical Physics ▪ Introduction to Astronomy	5		
Linear Algebra 1	5	X	
Electricity and Magnetism	10	X	
Calculus 2	5		
Introduction to Programming	5	X	
Mathematical Physics	5		
Observational Astronomy	5	X	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Appendix IV Course units in the post-propaedeutic phase

- **List of course units (Article 6.1.1)**
- **Course units with one or more practicals (Article 6.2.1)**
- **Compulsory order of examinations; (Article 8.2)**

Course unit name	ECTS	Practical	Entry requirements
Electricity and Magnetism II	5		
Observational Astronomy	5	X	
Quantum Physics 1	5		
Complex Analysis	5		
Statistical Physics	5		
Waves and Optics	5	X	
Science, Ethics, Technology, and Society	5		
Statistical and Numerical Methods	5	X	
Structure of Matter 1	5		
Physics of Galaxies	5		
Physics of Stars	5		
Quantum Physics 2	5		
Minor	30	Depending on the minor	Depending on the minor
Astrophysical Hydrodynamics	5		
Astroparticle Physics	5		
Interstellar Medium	5		
Bachelor Research Project (Astronomy)	15	X	Passed 135 ECTS of the Bachelor's degree programme

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Minor Astronomy

The Minor comprises of 30 ECTS and is a coherent and deepening package of course units.

Course unit name	ECTS	Practical	Entry requirements
Cosmology	5		
Advanced Mechanics	5		
Radio Astronomy	5	X	
Choice: - Statistical Signal Processing - Atoms and Molecules - Nuclear Energy - Stellar Structure and Evolution (biennial, 16/17) - Basic Detection Techniques (biennial, 17/18) - High Energy Astrophysics (biennial, 17/18) - Space Mission Technology (biennial, 17/18) - Onderwijs en Communicatie (Dutch)	5	 X X	 See the programme-specific appendices IV and V of the Teaching and Examination Regulation.

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Minor Instrumentation and Informatics

The Minor comprises of 30 ECTS and is a coherent and deepening package of course units.

Course unit name	ECTS	Practical	Entry requirements
Control Engineering	5	X	
Materials Science and Engineering	5	X	
Principles of Measurement Systems	5		
Statistical Signal Processing	5		
Choice: - Radio Astronomy - Cosmology - Space Mission Technology (biennial, 17/18) - Basic Detection Techniques (biennial, 17/18) - Astronomical Data Science (biennial, 16/17) - Onderwijs en Communicatie (Dutch)	5	 X X X	 See the programme-specific appendices IV and V of the Teaching and Examination Regulation

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Appendix V Entry requirements (Article 10.1)

A. HBO (university of applied science) propaedeutic certificate

1. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	**Subjects at VWO (pre-university) level**	Requirement: Dutch as a Second Language (programme II) for non-native speakers of Dutch
B Biology	wia or wib + na+sk+bio	Yes
B Pharmacy	wia or wib + na+sk	Yes
B Computing Science	wib	
B Artificial Intelligence	wia or wib	
B Physics	wib+na	
B Chemistry	wib+na+sk	
B Astronomy	wib+na	
B Mathematics	wib	
B Chemical Engineering	wib+na+sk	
B Industrial Engineering and Management Science	wib	
B Applied Physics	wib+na	
B Applied Mathematics	wib	

wia = Mathematics A; wib = Mathematics B; na = Physics; sk = Chemistry; bio = Biology

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

3. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

B. Foreign qualifications (EEA)

1. Any certificate that grants access to a university in a European country will also grant access to Dutch universities.

2. The same requirements that also apply to candidates with an HBO (university of applied science) propaedeutic certificate will apply to these candidates in the entrance examination as defined in Article 7.28.3 of the Act (see A).

3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

4. In addition, candidates are required to be competent in English: an IELTS score of 6.5, a TOEFL score of 580 (paper-based), of 237 (computer-based) or of 92 (internet-based) or equivalent.

5. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

C. Foreign qualifications (German)

1. German candidates must have a Zeugnis der Allgemeinen Hochschulreife ('Abitur').

2. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	
B Biology	wi (LK or GK) na (LK or GK) sk (LK or GK) bio (LK or GK) (at least one subject at Leistungskurs level)
B Pharmacy B Life Science and Technology B Chemistry B Chemical Engineering	wi (LK or GK) na (LK or GK) sk (LK or GK) (at least one subject at Leistungskurs level)
B Computing Science B Mathematics B Applied Mathematics B Artificial Intelligence	wi (LK)
B Physics B Astronomy B Applied Physics	wi (LK) na (LK or GK)
B Industrial Engineering and Management Science	wi (LK or GK) na (LK or GK) (at least one subject at Leistungskurs level)

wi= Mathematics; na = Physics; sk = Chemistry; bio = Biology
LK = Leistungskurs level; GK = Grundkurs level followed until end of Class 13 or Class 12 (if Gymnasium education lasts 12 years).

3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

4. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

D. Foreign qualifications (International Baccalaureate)

1. The following requirements apply to the entrance examination as defined in Article 7.28.3 of the Act:

Degree programme	**from 2010/2011**
B Biology	Biology (SL or HL) Maths (SL or HL) Physics (SL or HL) Chemistry (SL or HL) two of these subjects at HL
B Pharmacy B Life Science and Technology B Chemistry B Chemical Engineering	Maths (SL or HL) Physics (SL or HL) Chemistry (SL or HL) two of these subjects at HL
B Computing Science B Mathematics B Applied Mathematics	Maths HL
B Artificial Intelligence	Maths SL **or** Maths HL
B Physics B Astronomy B Applied Physics B Industrial Engineering and Management Science	Maths HL Physics HL

SL = Standard Level, HL = Higher Level

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

3. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

E. Foreign qualifications (non-EEA)

1. A non-European certificate that according to NUFFIC and/or NARIC standards is equivalent to a Dutch VWO certificate will grant access to university in the Netherlands.

2. The same requirements that also apply to candidates with an HBO (university of applied science) propaedeutic certificate will apply to these candidates in the entrance examination as defined in Article 7.28.3 of the Act (see A).

3. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

4. In addition, candidates are required to be competent in English: an IELTS score of 6.5, a TOEFL score of 580 (paper-based), of 237 (computer-based) or of 92 (internet-based) or equivalent.

5. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

F. Entrance examination

1. The following requirements apply to the entrance examination as defined in Article 7.29 of the Act:

Degree programme	**Nature and Health VWO level**	**or**	**Nature and Technology VWO level**
B Biology	en, wia or b, sk, bio, na		en, wib, na, sk, bio
B Pharmacy	en, wia or b, sk, bio, na		en, wib, na, sk
B Life Science and Technology	en, wib, sk, bio, na		en, wib, na, sk
B Computing Science	en, wib, sk, bio		en, wib, na, sk
B Artificial Intelligence	en, wia of b, sk, bio		en, wib, na, sk
B Physics	en, wib, sk, bio, na		en, wib, na, sk
B Chemistry	en, wib, sk, bio, na		en, wib, na, sk
B Astronomy	en, wib, sk, bio, na		en, wib, na, sk
B Mathematics	en, wib, sk, bio		en, wib, na, sk
B Chemical Engineering	en, wib, sk, bio, na		en, wib, na, sk
B Industrial Engineering and Management Science	en, wib, sk, bio		en, wib, na, sk
B Applied Physics	en, wib, sk, bio, na		en, wib, na, sk
B Applied Mathematics	en, wib, sk, bio		en, wib, na, sk

en = English; wia = Mathematics A; wib = Mathematics B; na = Physics; sk = Chemistry; bio = Biology

2. Non-native speakers of Dutch who wish to be admitted to the Bachelor's degree programmes in Biology, Life Science and Technology, or Pharmacy must also have passed the State Examination in Dutch as a Second Language, Programme II (NT2-II).

1. The Faculty Committee for Special Admissions will determine whether deficiencies have been compensated satisfactorily.

Appendix VI Clustering of Bachelor's degree programmes (Article 4.3.6 and Article 4.4.2)

Degree programme CROHO code	Name of degree programme	Clustered with CROHO code	Name of degree programme
56286	B Life Science and Technology	56860 56157	B Biology B Pharmacy
56860	B Biology	56286 56157	B Life Science and Technology B Pharmacy
56157	B Pharmacy	56860 56286	B Biology B Life Science and Technology
56980	B Mathematics	56965	B Applied Mathematics
56965	B Applied Mathematics	56980	B Mathematics
50206	B Physics	56962 50205	B Applied Physics B Astronomy
56962	B Applied Physics	50206 50205	B Physics B Astronomy
50205	B Astronomy	56962 50206	B Applied Physics B Physics
56857	B Chemistry	56960	B Chemical Engineering
56960	B Chemical Engineering	56857	B Chemistry

Appendix VII Admission to the post-propaedeutic phase Article 5.1.1

The following candidates will be admitted to the post-propaedeutic phase:

- Holders of a propaedeutic certificate of the degree programmes in:
  - Astronomy
  - Physics
  - Applied Physics

Appendix VIII Contact hours propaedeutic phase (Article 2.4)

Bachelor's year 1	
Structure contact hours	**Contact hours per year**
Lectures	346
Tutorial	288
Practicals	140
Tutoring	8
Supervision during an internship	0
Examinations	45
Other structured hours	50

Appendix IX University Minors of the faculty of Mathematics and Natural Sciences Article 7.5.1

1. Neurosciences Minor:
   - Neuroscience (18 ECTS)
   - Behavioral Neuroscience (6 ECTS)
   - Neuroscience essay (6 ECTS)

   People, Planet, Profit Minor:
   - Overview and Coherence People Planet Profit (10 ECTS)
   - People Planet Profit paper (5 ECTS)
   - Multidisciplinary Cooperation (5 ECTS)
   - Project Sustainability (10 ECTS)

   Astronomy in Space and Time*:
   - Astrobiology (5 ECTS)
   - Cosmic Origins (5 ECTS)
   - The Evolving Universe (5 ECTS)

   * This university minor is not allowed for students of the degree programmes of Physics, Applied Physics and Astronomy

2. The Programme Committee for the Bachelor's degree programmes in Biology and Life Science & Technology also has authority in the field of the Neurosciences Minor and/or its course units.

   The Programme Committee for the Master's degree programme in Energy & Environmental Sciences also has authority in the field of the People, Planet, Profit Minor and/or its course units.

   The Programme Committee for the Bachelor's degree programme in Astronomy also has authority in the field of the Astronomy through Space and Time Minor and/or its course units.

3. The Board of Examiners for the Bachelor's degree programmes in Biology and Life Science & Technology and the Master's degree programmes in Biology, Ecology & Evolution, Marine Biology and Molecular Biology & Biotechnology also has authority in the field of the Neurosciences Minor and/or its course units.

   The Board of Examiners for the Master's degree programme in Energy & Environmental Sciences also has authority in the field of the People, Planet, Profit Minor and/or its course units.

   The Board of Examiners for the Bachelor's degree programme in Astronomy also has authority in the field of the Astronomy through Space and Time Minor and/or its course units.

4. These Teaching and Examination Regulations also apply in their entirety to the Minors in Neurosciences, People, Planet, Profit and Astronomy in Space and Time and/or their course units.