

Undergraduate Curriculum in Biology

Case Western Reserve University

Fall Courses

*114: Principles of Biology
*116: Introduction to Anatomy and Physiology I

302: Human Learning and the Brain (o, DS)
336: Aquatic Biology (p/e)
339: Aquatic Biology Lab (L)
351: Principles of Ecology (p/e)
351L: Principles of Ecology Laboratory (L)
364: Research Methods in Evolutionary Biology (p/e, DS)
398: Modern Human Biological Variation (p/e)

301: Biotechnology Lab: Genes and Genetic Engineering (L)
311: Survey of Bioinformatics:
311A: Technologies in Bioinformatics
311B: Data Integration in Bioinformatics
311C: Translational Bioinformatics
312: Introductory Plant Biology (p/e) (tentative Fall 2018)

305: Herpetology (L) (even)
309: Biology Field Studies (L) — Costa Rica
318: Introductory Entomology (o -OR- L)
321: Design and Analysis of Biological Experiments (QL)
333: The Human Microbiome (o, DS)
345: Mammalian Diversity and Evolution (L) (odd)
346: Human Anatomy (o)
353: Ecophysiology of Global Change (L)
362: Principles of Developmental Biology (o) (on hiatus)
373: Introduction to Neurobiology (o -OR- QL as of Fall 2014; o previous versions)
374: Neurobiology of Behavior (o, DS)
379: Transformative Animal Models in Modern Biology (o) (DS)

@306: Mathematical Analysis of Biological Models

BREADTH, LABS, and SAGES

c/m cell and molecular
o organismal
p/e population and ecology
L laboratory
QL quantitative laboratory
DS SAGES Departmental Seminar
CAP SAGES Senior Capstone

* Indicates courses that do not count towards any Biology degree or minor
@ Indicates courses for the B.S. in Systems Biology

214 / 214L
GENES, EVOLUTION, and ECOLOGY
(lecture / lab)
(Fall; Summer/Spring as available)

215 / 215L
CELLS and PROTEINS
(lecture / lab)
(Spring; Summer/Fall as available)

216 / 216L
DEVELOPMENT and PHYSIOLOGY
(lecture / lab)
(Fall; Summer/Spring as available)

326
GENETICS
(lecture)
(Spring and Fall)
Prerequisite: BIOL 214

Summer Courses

302: Human Learning and the Brain (o, DS)
309: Biology Field Studies (L) — Kelley's Island
312: Introductory Plant Biology (p/e)
330: Human Genetics (o) (Prereq: BIOL 326)
343: Microbiology (c/m)

Schedule and courses offered are subject to change without notice!

UNDERGRADUATE SEMINARS

369: Evolutionary Biology Capstone (CAP)
394: Seminar in Evolutionary Biology (p/e)

Spring Courses

*117: Introduction to Anatomy and Physiology II
225: Evolution (p/e)
*240: Personalized Medicine
307: Evolutionary Biology of the Invertebrates (p/e) (odd)

223: Vertebrate Biology (L)
302: Human Learning and the Brain (o, DS)
352: Ecology and Evolution of Infectious Diseases (QL)

303: From Black Box to Toolbox: How Molecular Biology Moves Forward (c/m, DS) (on hiatus, returns Spring 2019)
308: Molecular Biology: Genes and Genetic Engineering (c/m)
314: Taming the Tree of Life: Phylogenetic Comparative Methods — from Concept to Practical Application (CAP)
316: Fundamental Immunology (c/m)
325: Cell Biology (c/m)
327: Functional Genomics (QL) (on hiatus, returns Spring 2019)
328: Plant Genomics and Proteomics (c/m) (on hiatus, returns Spring 2019)
334: Structural Biology (c/m)
343: Microbiology (c/m)
344: Laboratory for Microbiology (L)

309: Biology Field Studies (L) — Namibia
315: Quantitative Biology Laboratory (QL)
322: Sensory Biology (o)
324: Introduction to Stem Cell Biology (c/m) (on hiatus, returns Spring 2019)
338: Ichthyology (o -OR- L)
340: Human Physiology (o)
342: Parasitology (c/m)
346: Human Anatomy (o)
357: Backyard Behavior (CAP)
358: Animal Behavior (p/e -OR- L)
365: Evo-Devo: Evolution of Body Plans (c/m, DS)
368: Topics in Evolutionary Biology (p/e)

@300: Dynamics of Biological Systems (QL)
@304: Fitting Models to Data: Maximum Likelihood Methods and Model Selection (QL)
@319: Applied Probability and Stochastic Processes for Biology
@378: Computational Neuroscience

UNDERGRADUATE RESEARCH

388: Undergraduate Research in Biology
388S: Undergraduate Research (CAP)
389: Selected Topics in Biology
389S: Selected Topics in Biology (CAP)
390: Advanced Undergraduate Research
396: Research in Evolutionary Biology

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(Handout Rev. 11/01/2017)
(Course Map Rev. 11/01/2017)

SUMMARY OF BIOLOGY COURSE/DEGREE REQUIREMENTS

Biology Major (B.A.)

Core sequence lectures (214, 215, and 216) and labs (214L, 215L, and 216L)	12 hr
*Courses in two of these three areas (see course lists on page 3):	typically 6 hr
Cell and molecular biology	
Organismal biology	
Population biology/ecology	
Genetics (326)	3 hr
* Two laboratory courses (see list on page 3)	4–8 hr
* Electives (any BIOL at the 200 level or higher, <u>except</u> 240 or 390)	typically <u>3–6 hr</u>
(Additional math, chemistry, and physics — 32 hr)	
Total	30 hr

B.S. in Biology

Core sequence lectures (214, 215, 216) and labs (214L, 215L, 216L)	12 hr
** Courses in two of these three areas (see lists on page 3):	typically 6 hr
Cell and molecular biology	
Organismal biology	
Population biology/ecology	
Genetics (326)	3 hr
One quantitative biology laboratory (300, 304, 315, 321, 327, 352, 373)	3–4 hr
** One additional laboratory course (see list on page 3)	2–4 hr
** Electives (any BIOL at the 200 level or higher, <u>except</u> 240)	typically 3–6 hr
Undergraduate research (388S and 390)	<u>6 hr</u>
(Additional math, chemistry, physics, and computer programming — 41 hr)	
Total	39 hr

B.S. in Systems Biology

Core sequence (214, 215, 216, 300, and 306)	15 hr
Approved subspecialty track (two courses in any one of the following areas)	6 hr
Neuroscience (322, 373, 374, 378, NEUR 402)	
Bioinformatics and Genetics (301, 308, 311ABC, 326, 327, 328, EECS 458, EECS 459)	
Ecology and Evolutionary Biology (305, 307, 318, 336, 338, 345, 351, 353, 358, 364, 365, 368, 471, 472)	
Cellular and Molecular Biology (308, 316, 324, 325, 333, 334, 342, 343, 344, 362, 365)	
Biology electives (any BIOL at the 200 level or higher, <u>except</u> 240 and 390)	9 hr
Approved systems electives (two courses from a list of BIOL, EBME, EECS, MATH, and STAT)	<u>6 hr</u>
(Undergraduate research strongly recommended — 388S and 390)	
(Additional math, chemistry, physics, computer programming, computer science, and statistics — 43 hr)	
Total	36 hr

Biology Minor

Core sequence: any two of BIOL 214/214L, 215/215L, or 216/216L	8 hr
Any BIOL courses at the 200 level or higher, <u>except</u> 240	<u>8 hr</u>
Total	16 hr

* Altogether, at least 12 hr of these courses must be at the 300 level or higher; minimum 15 hr required.

** Altogether, at least 11 hr of these courses must be at the 300 level or higher; minimum 17 hr required.

Breadth Requirement: Major Areas in Biology

Students in the B.A. and B.S. Biology degree programs must take at least one of the following 3-credit or 4-credit courses from two of the following three major areas. This insures broad exposure to different fields in Biology. The Breadth Requirement does not apply to the Systems Biology B.S. degree program.

Note: Only courses listed here may be used to satisfy the Breadth Requirement. Non-listed courses may count as Biology electives, depending upon degree program. No 100-level course may be used in any Biology degree program. BIOL 390 does not count towards the 30 hours of BIOL needed for the B.A. Biology degree.

Cell and Molecular Biology (c/m)	Organismal Biology (o)	Population Biology/Ecology (p/e)
303: From Black Box to Toolbox: How Molecular Biology Moves Forward (SAGES DS) (3)	302: Human Learning and the Brain (breadth and SAGES DS) (3)	225: Evolution (3)
308: Molecular Biology: Genes and Genetic Engineering (4)	318: Introductory Entomology (breadth or lab) (4)	307: Evolutionary Biology of the Invertebrates (odd years only) (3)
316: Fundamental Immunology (4)	322: Sensory Biology (3)	312: Introductory Plant Biology (3)
324: Introduction to Stem Cell Biology (3)	330: Human Genetics (3)	336: Aquatic Biology (3)
325: Cell Biology (3)	333: The Human Microbiome (breadth and SAGES DS) (3)	351: Principles of Ecology (3)
326: Genetics (only for entering classes before Fall 2014) (3)	338: Ichthyology (effective Spring 2015, breadth or lab) (4) (Spring 2014 and earlier, breadth only) (3)	358: Animal Behavior (breadth or lab) (4) (on hiatus)
328: Plant Genomics and Proteomics (3)	340: Human Physiology (3)	364: Research Methods in Evolutionary Biology (breadth and SAGES DS)
334: Structural Biology of Proteins, Enzymes and Nucleic Acids (3)	346: Human Anatomy (3)	368: Topics in Evolutionary Biology (3)
342: Parasitology (3)	362: Principles of Developmental Biology (3) (on hiatus)	394: Seminar in Evolutionary Biology (3)
343: Microbiology (3)	373: Introduction to Neurobiology (effective Fall 2014, breadth or quantitative lab) (3) (Fall 2013 and earlier, breadth only)	398: Modern Human Biological Variation (3)
365: Evo-Devo: Evolution of Body Plans (breadth and SAGES DS) (3)	374: Neurobiology of Behavior (breadth and SAGES DS) (3)	
	379: Transformative Animal Models in Modern Biology (3) (SAGES DS)	

Laboratory Classes

Numbers in parentheses indicate the number of credit hours. Note: Some courses may count as either a breadth requirement or a laboratory (but not both). BIOL 346, 388, 388S, and 390 do not count as laboratories.

Fall	Spring	Summer
301: Biotechnology Laboratory (lab) (3)	223: Vertebrate Biology (lab) (3)	309: Biology Field Studies (lab) (3) — Costa Rica
305: Herpetology (lab) (even years only) (4)	300: Dynamics of Biological Systems (quant lab) (3)	339: Aquatic Biology Laboratory (lab) (2)
309: Biology Field Studies (lab) (3) — Costa Rica	304: Fitting Models to Data: Maximum Likelihood Methods and Model Selection (quant lab) (3)	
318: Introductory Entomology (lab or organismal breadth) (4)	309: Biology Field Studies (lab) (3) — Namibia	
321: Design and Analysis of Biological Experiments (quant lab) (3)	315: Quantitative Biology Laboratory (quant lab) (3)	
339: Aquatic Biology Laboratory (lab) (2)	327: Functional Genomics (quant lab) (3)	
345: Mammalian Diversity and Evolution (lab) (odd years only) (4)	338: Ichthyology (lab or organismal breadth) (effective Spring 2015) (4)	
351L: Principles of Ecology Laboratory (lab) (2)	344: Microbiology Laboratory (lab) (3 effective Spring 2016, 2 previously)	
353: Ecophysiology of Global Change (lab) (4)	352: Ecology and Evolution of Infectious Diseases (quant lab) (3)	
373: Introduction to Neurobiology (quant lab or organismal breadth) (effective Fall 2014) (3)	358: Animal Behavior (lab or organismal breadth) (4)	

BACHELOR OF ARTS DEGREE IN BIOLOGY
SUGGESTED SEQUENCE OF COURSES – FALL START (recommended)
(effective Fall 2014 entering class)

Freshman Year

FALL	SPRING
SAGES First Year Seminar (4)	SAGES University Seminar (3)
MATH 125 Mathematics I (4)	MATH 126 Mathematics II (4)
CHEM 105 Principles of Chemistry I (3)	CHEM 106 Principles of Chemistry II (3)
BIOL 214 + BIOL 214L Genes, Evolution, and Ecology (3 + 1)	CHEM 113 Principles of Chemistry Laboratory (2)
PHED ### Physical Education Activities (0)	BIOL 215 + BIOL 215L Cells and Proteins (3 + 1)
	PHED ### Physical Education Activities (0)

Sophomore Year

FALL	SPRING
BIOL 216 + BIOL 216L Development and Physiology (3 + 1)	BIOL Elective (3) OR BIOL 326 Genetics (3)
CHEM 223 Introductory Organic Chemistry I (3)	CHEM 224 Introductory Organic Chemistry II (3)
CHEM 233 Organic Chemistry Laboratory I (2)	SAGES Departmental Seminar (3)
SAGES University Seminar (3)	GER Course (3)
GER Course (3)	Open Elective (3)

Junior Year

FALL	SPRING
BIOL 326 Genetics (3) OR BIOL Elective (3)	BIOL Elective (3)
BIOL Laboratory (2–4)	BIOL Laboratory (2–4)
PHYS 115 Introductory Physics I (4)	PHYS 116 Introductory Physics II (4)
GER Course (3)	GER Course (3)
Open Elective (3)	Open Elective (3)

Senior Year

FALL	SPRING
BIOL Elective (3) OR SAGES Capstone (3)	SAGES Capstone (3) OR BIOL Elective (3)
Open Elective (3)	BIOL Elective (3) if needed OR Open Elective (3)
Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)

BACHELOR OF ARTS DEGREE IN BIOLOGY
SUGGESTED SEQUENCE OF COURSES – SPRING START (trailer)
(effective Fall 2014 entering class)

Freshman Year

FALL	SPRING
SAGES First Year Seminar (4)	SAGES University Seminar (3)
MATH 125 Mathematics I (4)	MATH 126 Mathematics II (4)
CHEM 105 Principles of Chemistry I (3)	CHEM 106 Principles of Chemistry II (3)
CHEM 113 Principles of Chemistry Laboratory (2)	BIOL 214 + BIOL 214L Genes, Evolution, and Ecology (3 + 1)
PHED ### Physical Education Activities (0)	PHED ### Physical Education Activities (0)
Open Elective (3)	

Sophomore Year

FALL	SPRING
BIOL 215 + BIOL 215L Cells and Proteins (3 + 1)	BIOL 216 + BIOL 216L Development and Physiology (3 + 1)
CHEM 223 Introductory Organic Chemistry I (3)	BIOL Elective (3)
CHEM 233 Organic Chemistry Laboratory I (2)	CHEM 224 Introductory Organic Chemistry II (3)
SAGES University Seminar (3)	SAGES Departmental Seminar (3)
GER Course (3)	GER Course (3)

Junior Year

FALL	SPRING
BIOL 326 Genetics (3) OR BIOL Elective (3)	BIOL Elective (3) OR BIOL 326 Genetics (3)
BIOL Laboratory (2–4)	BIOL Laboratory (2–4)
PHYS 115 Introductory Physics I (4)	PHYS 116 Introductory Physics II (4)
GER Course (3)	GER Course (3)
Open Elective (3)	Open Elective (3)

Senior Year

FALL	SPRING
BIOL Elective (3) OR SAGES Capstone (3)	SAGES Capstone (3) OR BIOL Elective (3)
Open Elective (3)	BIOL Elective (3) if needed OR Open Elective (3)
Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)

BACHELOR OF SCIENCE DEGREE IN BIOLOGY
SUGGESTED SEQUENCE OF COURSES – FALL START (recommended)
(effective Fall 2014 entering class)

Freshman Year

FALL	SPRING
SAGES First Year Seminar (4)	SAGES University Seminar (3)
MATH 125 Mathematics I (4)	MATH 126 Mathematics II (4)
CHEM 105 Principles of Chemistry I (3)	CHEM 106 Principles of Chemistry II (3)
BIOL 214 + BIOL 214L Genes, Evolution, and Ecology (3 + 1)	CHEM 113 Principles of Chemistry Laboratory (2)
PHED ### Physical Education Activities (0)	BIOL 215 + BIOL 215L Cells and Proteins (3 + 1)
	PHED ### Physical Education Activities (0)

Sophomore Year

FALL	SPRING
BIOL 216 + BIOL 216L Development and Physiology (3 + 1)	BIOL 326 Genetics (3)
CHEM 223 (or 323) Introductory Organic Chemistry I (3)	CHEM 224 (or 324) Introductory Organic Chemistry II (3)
CHEM 233 Organic Chemistry Laboratory I (2)	ENGR 131 Elementary Computer Programming (3)
SAGES University Seminar (3)	Open Elective (3)
GER Course (3)	GER Course (3)

Junior Year

FALL	SPRING
BIOL Elective (3) OR BIOL Laboratory (2–4)	Quantitative Biology Laboratory Course (3–4) — Select from BIOL 300, 304, 315, 321, 327, 352, or 373
Advanced Mathematics or Statistics Course (3) — Select from MATH 201 or 304; or STAT 312/312R	SAGES Departmental Seminar (3)
PHYS 115 Introductory Physics I (4)	PHYS 116 Introductory Physics II (4)
BIOL Elective (3)	BIOL Elective (3)
GER Course (3)	GER Course (3)

Senior Year

FALL	SPRING
BIOL 388S Undergraduate Research — SAGES Capstone (3)	BIOL 390 Advanced Undergraduate Research (3)
CHEM 301 Introductory Physical Chemistry (3)	BIOL Elective (3)
BIOL Elective (3)	BIOL Elective (3) if needed OR Open Elective (3)
BIOL Laboratory (2–4) if needed OR Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)

BACHELOR OF SCIENCE DEGREE IN BIOLOGY
SUGGESTED SEQUENCE OF COURSES – SPRING START (trailer)
(effective Fall 2014 entering class)

Freshman Year

FALL	SPRING
SAGES First Year Seminar (4)	SAGES University Seminar (3)
MATH 125 Mathematics I (4)	MATH 126 Mathematics II (4)
CHEM 105 Principles of Chemistry I (3)	CHEM 106 Principles of Chemistry II (3)
CHEM 113 Principles of Chemistry Laboratory (2)	BIOL 214 + BIOL 214L Genes, Evolution, and Ecology (3 + 1)
PHED ### Physical Education Activities (0)	PHED ### Physical Education Activities (0)
GER Course (3)	GER Course (3)

Sophomore Year

FALL	SPRING
BIOL 215 + BIOL 215L Cells and Proteins (3 + 1)	BIOL 216 + BIOL 216L Development and Physiology (3 + 1)
CHEM 223 (or 323) Introductory Organic Chemistry I (3)	CHEM 224 (or 324) Introductory Organic Chemistry II (3)
CHEM 233 Organic Chemistry Laboratory I (2)	ENGR 131 Elementary Computer Programming (3)
SAGES University Seminar (3)	Open Elective (3)
GER Course (3)	GER Course (3)

Junior Year

FALL	SPRING
BIOL 326 Genetics (3)	Quantitative Biology Laboratory Course (3–4) — Select from BIOL 300, 304, 315, 321, 327, 352, or 373
Advanced Mathematics or Statistics Course (3) — Select from MATH 201 or 304; or STAT 312/312R	SAGES Departmental Seminar (3)
PHYS 115 Introductory Physics I (4)	PHYS 116 Introductory Physics II (4)
BIOL Elective (3)	BIOL Elective (3)
Open Elective (3)	Open Elective (3)

Senior Year

FALL	SPRING
BIOL 388S Undergraduate Research — SAGES Capstone (3)	BIOL 390 Advanced Undergraduate Research (3)
CHEM 301 Introductory Physical Chemistry (3)	BIOL Elective (3–4)
BIOL Elective (3)	BIOL Elective (3) if needed OR Open Elective (3)
BIOL Laboratory (2–4) if needed OR Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)

BACHELOR OF SCIENCE IN SYSTEMS BIOLOGY
SUGGESTED SEQUENCE OF COURSES (non-prehealth students)
(effective Fall 2015 entering class)

Freshman Year

FALL	SPRING
BIOL 214 Genes, Evolution, and Ecology (3)	BIOL 215 Cells and Proteins (3)
MATH 121 Calculus for Science and Engineering I (4)	MATH 122 Calculus for Science and Engineering II (4)
CHEM 105 Principles of Chemistry I (3)	CHEM 106 Principles of Chemistry II (3)
CHEM 113 Principles of Chemistry Laboratory (2)	Open Elective (3)
SAGES First Year Seminar (4)	SAGES University Seminar (3)
PHED ### Physical Education Activities (0)	PHED ### Physical Education Activities (0)

Sophomore Year

FALL	SPRING
BIOL 216 Physiology and Development (3)	BIOL 300 Dynamics of Biological Systems (3)
PHYS 121 General Physics I (4) OR §EECS 132 Introduction to Programming in Java (3)	PHYS 122 General Physics II (4) OR §PHYS 121 General Physics I (4)
MATH 223 Calculus for Science and Engineering III (3)	MATH 224 Elementary Differential Equations (3)
SAGES University Seminar (3)	Open Elective (3)
GER Course (3)	GER Course (3)

Junior Year

FALL	SPRING
BIOL 306 Mathematical Analysis of Biological Models (3)	STAT 312/312R Basic Statistics for Engineering and Science (3)
EECS 302/MATH 304 Discrete Mathematics (3)	EECS 233 Introduction to Data Structures (3)
EECS 132 Introduction to Programming in Java (3) OR §PHYS 122 General Physics II (4)	BIOL Elective (3)
BIOL Elective (3)	SAGES Departmental Seminar (3)
GER Course (3)	GER Course (3)

Senior Year

FALL	SPRING
SAGES Capstone (3) (recommended BIOL 388S Undergraduate Research — SAGES Capstone)	BIOL Elective (3) (recommended BIOL 390 Advanced Undergraduate Research)
BIOL Subspecialty Elective (3)	BIOL Subspecialty Elective (3)
Systems Elective (3)	Systems Elective (3)
Open Elective (3)	Open Elective (3)
Open Elective (3)	Open Elective (3)

BACHELOR OF SCIENCE IN SYSTEMS BIOLOGY
SUGGESTED SEQUENCE OF COURSES (prehealth students)
(effective Fall 2015 entering class)

Freshman Year

FALL	SPRING
BIOL 214 Genes, Evolution, and Ecology (3)	BIOL 215 Cells and Proteins (3)
MATH 121 Calculus for Science and Engineering I (4)	MATH 122 Calculus for Science and Engineering II (4)
CHEM 105 Principles of Chemistry I (3)	CHEM 106 Principles of Chemistry II (3)
CHEM 113 Principles of Chemistry Laboratory (2)	GER Course (3)
SAGES First Year Seminar (4)	SAGES University Seminar (3)
PHED ### Physical Education Activities (0)	PHED ### Physical Education Activities (0)

Sophomore Year

FALL	SPRING
BIOL 216 Physiology and Development (3)	BIOL 300 Dynamics of Biological Systems (3)
BIOL 216L Physiology and Development Laboratory (1)	BIOL 215L Cells and Proteins Laboratory (1)
CHEM 223 Introductory Organic Chemistry I (3)	CHEM 224 Introductory Organic Chemistry II (3)
CHEM 233 Introductory Organic Chemistry Laboratory I (2)	MATH 224 Elementary Differential Equations (3)
MATH 223 Calculus for Science and Engineering III (3)	EECS 132 Introduction to Programming in Java (3)
SAGES University Seminar (3)	GER Course (3)

Junior Year

FALL	SPRING
BIOL 306 Mathematical Analysis of Biological Models (3)	STAT 312/312R Basic Statistics for Engineering and Science (3)
PHYS 121 General Physics I (4)	PHYS 122 General Physics II (4)
EECS 302/MATH 304 Discrete Mathematics (3)	EECS 233 Introduction to Data Structures (3)
BIOC 307 Introduction fo Biochemistry: From Molecules to Medical Science (4)	SAGES Departmental Seminar (3)
GER Course (3)	GER Course (3)

Senior Year

FALL	SPRING
SAGES Capstone (3) (recommended BIOL 388S Undergraduate Research — SAGES Capstone)	BIOL Elective (3) (recommended BIOL 390 Advanced Undergraduate Research)
BIOL Subspecialty Elective (3)	BIOL Subspecialty Elective (3)
Systems Elective (3)	Systems Elective (3)
Open Elective (3)	BIOL Elective (3)
BIOL Elective (3)	Open Elective (3)