Undergraduate Curricula for the 21st Century at the Pennsylvania State University

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• Overview of undergraduate degree programs at PSU
• Thinking behind the different degree programs
• Description of new Geobiology BS program
Undergraduate Programs at Penn State

Geosciences BS — 68 majors
Geosciences BA — 5 majors
Earth Sciences BS — 23 majors
Geobiology BS — 15 majors
Geosciences BS/MS — 0

111 total majors

New as of last year
Undergraduate Programs at Penn State

Why do we offer so many degree programs?

• Recruitment purposes
• Diverse student clientele with diverse goals
• Our science is evolving, becoming more interdisciplinary

Who pursues these different degrees? Where are the students headed?
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**Geoscience BS**
- Oil & Gas
- Environmental consulting
- Other
- Higher education

**Geoscience BA**
- Environmental law
- Other
- Secondary education

**Earth Science BS**
- Secondary education
- Environmental consulting
- Higher education
- Other

**Geobiology BS**
- Higher education
- Environmental consulting
- Other
- Medical School
Principal Components of Degree Programs

**Geoscience BS**
- 6 core classes
- 2 sem. Physics, Calc., Chem, 1 sem Bio
- Senior Thesis
- Field Camp

**Earth Science BS**
- Intro and advanced course in Geosc, Geog., Meteo.
- Internship
- Minor in related field
- 2 sem. Physics, Calc., Chem, 1 sem Bio

**Geoscience BA**
- Reduced core classes
- More humanities & foreign lang.
- 5 sem. total Phys., Chem, Bio, Math

**Geobiology BS**
- 6 core classes
- 2 sem. Physics, Calc., Chem, 2 sem Bio
- Senior Thesis
- Field Camp

Large number of electives in each program enables students to pursue special interests.
What is our core composed of?

Earth Materials (*Mineralogy & Petrology*)

*Geochemistry* (local fieldwork integrated into labs)

Physical Processes/*Geophysics* (*weekly writing assignment*)

*Geobiology* (5-day field trip + long paper)

*Earth History* (an upper level, integrative, everything class)

*Structural Geology* (2 weekend field trips, local mapping labs)

*Field Camp* (includes extensive writing & quantitative computing)
Overview of Geobiology BS Program
Key Motivations

- Large number of faculty in biogeochemistry, geomicrobiology and paleobiology
- College and department that foster innovation in curriculum design
- Students looking for different path into environmental, museum, law, policy and medical fields
- Huge cadre of biology majors on campus
Role of microbes in weathering

Susan Brantley
Microbes, genomics, geochemistry, cave formation

Jenn Macalady
ANME-2 $\delta^{13}C = -96\%$ down to

DSS $\delta^{13}C = -20$ to $-70\%$

ANME-1 $\delta^{13}C = -83\%$

Dissolved inorganic carbon $\delta^{13}C = -27\%$

Filamentous Bacteria $\delta^{13}C = -41$ to $-57\%$

Water column biomass $\delta^{13}C = -20$ to $-22\%$

Methane $\delta^{13}C = -49.5\%$

Total Organic Carbon $\delta^{13}C = -30.8\%$

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Biogeochemistry, isotopes, climate proxies

D/H signals in plant waxes
Reflect surface water values, climate signals and plant types

River water

Kate Freeman

C29 n-alkane

Individual plant waxes

Latitude (N)

\( \delta^H (\%) \)

\( -300 \) \( -250 \) \( -200 \) \( -150 \) \( -100 \) 

C3

C4
Geobiology Curriculum

Required Biology Courses
• BIOL 110 Basic concepts and biodiversity
• BIOL 220W Populations and communities

Required Geosciences Courses
• GEOSC 001 Physical Geology
• GEOSC 201 Earth Materials
• GEOSC 204 Geobiology
• GEOSC 310 Earth History
Curriculum, continued

Additional Core Courses (one geo and one bio)

- GEOSC 202 Chemical processes
- GEOSC 203 Physical processes
- BIOL 230W Molecules and cells
- BIOL 240W Function and development of organisms
- MICRB 201 Introductory Microbiology
Curriculum, continued

Field Experience (3 credits)
- GEOSC 472a Summer Field Camp (1st 3 weeks)
- BIOL 444 Field ecology of the Central Appalachian Highlands

Senior Thesis
- GEOSC 494W Senior Thesis Writing & Presentation
- GEOSC 496 Thesis research
Curriculum

Advanced Geobiology Electives (15 credits)
Evolution, Paleobiology and Geology Track
- GEOSC 465 Structural Geology
- GEOSC 424 Paleontology
- GEOSC 439 Stratigraphy
- GEOSC 420 Paleobotany
- GEOSC 425 Micropaleontology
- GEOSC 474 Astrobiology
- ANTH 401 Human Evolution: the material record
- BIOL 428 Population Genetics
- BIOL 405 Molecular evolution
Curriculum

Advanced Geobiology Electives (15 credits)

Biogeochemistry Track
- GEOSC 452 Hydrogeology
- GEOSC 419 Organic Geochemistry of Natural Waters and Sediments
- GEOSC 412 Water resources
- GEOSC 413W Techniques in geochemistry
- GEOSC 410 Marine biogeochemistry
- GEOSC 475W Global Biogeochemical Cycles
- BIOL 435 Ecology of Lakes and Streams
- BIOL 406 Symbiosis
- SOILS 412W Soil Ecology
- BIOL 419 Ecological and environmental problem solving
Summary:

A curriculum is more than just a list of classes that are content-delivery devices.

A curriculum is the means to an end.

What is that end?
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A curriculum is more than just a list of classes that are content-delivery devices.

A curriculum is the means to an end.

What is that end?

It is the development of students who can pose questions, solve problems, and communicate results, utilizing geologic knowledge and concepts.

And there's more...
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So our curricula must change, without losing sight of the fundamental goals we are trying to accomplish — the training of capable, flexible, creative scientists.
Proposed Earth Science Policy BS Degree

- Global Change Focus (Geoscience, Geography, Meteorology)
- Calculus, Statistics, Computer Science, Modeling
- Policy or Law Internship
- Collaborations with Liberal Arts Departments and Law School
- Slated to begin in Fall 2009
3+2 Dual Degree Program with Fort Valley State University (FVSU)

- HBCU in Fort Valley, GA with a national recruiting pipeline beginning in the 9th grade
- Students receive Chemistry or Math BS at FVSU in 3 years, then a Geosciences BS at PSU in 2 years
- Possibly receive MS in Geoscience after 1 year by converting senior thesis to MS project
- Funded by Industry
- Program at Penn State and UT-Austin
- Each school has 5 current students
- New PSU 3+2 program in Petroleum Engineering