

Summary of 2014/15 Senate Actions and Resolutions

Twenty-Nine Senate Actions were passed by the Faculty Senate during the 2014/15 academic year. Their dispositions and Senate Resolutions are listed below.

Senate Actions

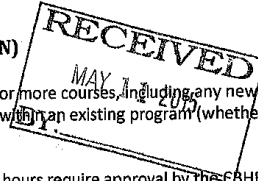
SA 1-14/15	Approved	New Program: Diversity Studies Minor
SA 2-14/15	Approved	New Program: Graduate Certificate in Cybersecurity
SA 3-14/15	Approved	New Program: Graduate Certificate in Finance
SA 4-14/15	Approved	New Program: Graduate Certificate in Administrative Studies
SA 5-14/15	Approved	Approval of AGR 320 to Revised General Education Program
SA 6-14/15	Approved	Program Change: General Education Program Change
SA 7-14/15	Approved	Program Deletion: M.A. in Theatre
SA 8-14/15	Approved	New Program: MS in Cybersecurity
SA 9-14/15	Approved	New Program: Master of Arts in Teaching and Learning
SA 10-14/15	Approved	New Program: Graduate Certificate in Teaching and Learning
SA 11-14/15	Approved	New Program: Graduate Certificate in Teacher Leadership
SA 12-14/15	Approved	New Program: Specialist in Education, Teacher Leadership
SA 13-14/15	Approved	New Interdisciplinary Program: Bachelor of General Studies
SA 14-14/15	Approved	New Program: Bachelor of Science in Theatre
SA 15-14/15	Approved	New Program: Bachelor of Science in Dance
SA 16-14/15	Approved	New Program: Graduate Certificate in Public Health & Homeland Security
SA 17-14/15	Approved	New Program: Graduate Certificate in Public Health Administration
SA 18-14/15	Approved	New Program: Graduate Certificate in Public Health Core
SA 19-14/15	Disapproved	Senate Action on Equated Hours and Compensation
SA 20-14/15	Approved	New Program: Graduate Certificate in Literacy

SA 21-14/15	Approved	Program Deletion: Library Science Minor
SA 22-14/15	Approved	New Program: Master of Science in Child Life Studies
SA 23-14/15	Approved	New Program: Graduate Certificate in Elementary Mathematics Specialist
SA 24-14/15	Approved	New Program: Graduate Certificate in Conservation Education
SA 25-14/15	Approved	New Program: Graduate Certificate in Community Corrections
SA 26-14/15	Approved	New Program: History Bachelor of Science
SA 27-14/15	Approved	New Program: Sustainability Minor
SA 28-14/15	Approved	New Program: Forensic Child Psychology Undergraduate Certificate
SA 29-14/15	Approved	Senate Action on Adopting Electronic Curricular Format

Senate Resolutions

SR 1-14/15	Resolution in Honor of Dr. Ryan Giedd 2013-2014 Faculty Senate Chair
SR 2-14/15	Resolution in Honor of Ms. Kathryn Gibson Secretary of the Faculty, 2013-2014
SR 3-14/15	Resolution in Honor of Dr. Jeremy Chesman 2013-14 Faculty Senate Parliamentarian
SR 4-14/15	Resolution Conferring Honorary Doctorate upon Mr. Thomas Strong
SR 5-14/15	Resolution Conferring Honorary Doctorate upon Mrs. Elise Crain
SR 6-14/15	Senate Resolution on Faculty Leave and Support
SR 7-14/15	Senate Resolution on Springfield's Civil Rights Ordinance
SR 8-14/15	Senate Resolution on Tenurable Faculty

Missouri State University
Curricular Proposal – New Program
(MAJOR, OPTION, MINOR, CERTIFICATE, OR CERTIFICATION)



This form is to be used for internal Missouri State approval of any proposal for a new program involving two or more courses, including any new graduate program, new undergraduate major (whether comprehensive or non-comprehensive), new option within an existing program (whether graduate or undergraduate), new minor, new certificate, or new certification program.

New graduate programs, new undergraduate majors, and certificate programs involving more than 18 credit hours require approval by the CBHE as well as approval through the Missouri State curricular process. CBHE applications for such programs are processed through the Office of Institutional Research. All proposals for new programs requiring CBHE approval should progress through the Missouri State curricular process accompanied by a draft of the required CBHE documentation.

Department CLSE Date December 10, 2014

Attach on separate sheets (1) statement of rationale and objectives, (2) estimated costs for first five years, and (3) complete catalog description (including new courses and course changes pending approval). [Note: For new programs requiring CBHE approval, CBHE forms NP, PS, and PG will satisfy #1 and CBHE form FP will satisfy #2.]

Special Education Director

PROPOSED PROGRAM Graduate Certificate: Director of Special Education

Major Comprehensive Major Option Minor Certificate Certification Academic Rules Other

Degree Applicability Added certification for K-12 School Administrators

General Education Courses Required N/A Total Hours _____

General Education Courses Recommended N/A Total Hours _____

Requirements (including Admission) and Limitations for Specific Degree Admission Requirements: Masters or Education Specialist in Educational Administration; A written "Statement of Purpose" containing long-term goals of leadership; Reference from immediate supervisor regarding performance; A copy of appropriate teacher certificate or eligibility for certification by a state agency as a K-12 building- or district-level administrator; 3.5 GPA in graduate degree program; Interview with EAD advisor prior to admission.

Courses Required in Department EAD 884 Internship: Special Ed Director-Part I; EAD 885 Internship: Special Ed Director-Part II; EAD 787 Administration of Special Programs; SPE 782 Advanced Diagnosis & Remediation of Students; SPE 792 Adv. Diag./Remediation-Lab

Total Hours 14

Courses Required in Other Departments N/A

Total Hours _____

Prerequisites for Required Courses SPE 715 Foundations in Special Education, or equivalent

Recommended Electives in Department N/A

Total Hours _____

Recommended Electives in Other Departments N/A

Total Hours _____

Limitations on Electives _____

DEPARTMENT Route according to ART VI, SEC 3B(1-4) of Bylaws of the Faculty Senate. Attach New Program Resource Information form (FS-302a/06) and forward three typed, originally signed forms to one of the following (please mark all that apply). If the program needs to go through more than one committee/council, forward one additional form for each additional council/committee marked.

- College Council** (Send all new undergraduate programs through College Council as first step before forwarding either to PEC, CGEIP, or directly to Faculty Senate)
- Professional Education Committee** (All proposals affecting BS and MS in Education and Educational Specialist degrees)
- Committee on General Education and Intercollegiate Programs** (All general education and multi-college programs)

ROUTING

1. COLLEGE COUNCIL (ART VI, SEC 3B)

APPROVED After dean review/comment, forward two signed copies of final action to the Secretary of the Faculty for disposition, or forward appropriate number of copies to next committee level for approval.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment(s) _____
Signature _____ Date _____
Chairperson

2. DEAN OF THE COLLEGE (ART VI, SEC 5)

REVIEWED Return to College Council Chair within ten days of receipt for disposition.

Comment(s) _____
Signature _____ Date 2/6/15
Dean of the College

3. PROFESSIONAL EDUCATION COMMITTEE (ART III, SEC 9)

APPROVED Forward two signed copies of final action to the Secretary of the Faculty for disposition, or forward three signed copies to next committee level for approval.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment(s) _____
Signature _____ Date 3/25/15
Chairperson

4. COMMITTEE ON GENERAL EDUCATION AND INTERCOLLEGIATE PROGRAMS (ART IV, SEC 2)

APPROVED Forward two signed copies of final action to the Secretary of the Faculty for disposition, or forward three signed copies to next committee level for approval.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment(s) _____
Signature _____ Date _____
Chairperson

5. GRADUATE COUNCIL (ART V, SEC 3, OR ART VI, SEC 3B)

APPROVED Forward two signed copies of final action to the Secretary of the Faculty for disposition.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment(s) _____
Signature _____ Date 5/6/15
Chairperson

6. FACULTY SENATE (ART VI, SEC 9)

APPROVED
 DISAPPROVED

Comment(s) _____
Signature _____ Date _____
Chairperson

7. PROVOST (ART I, SEC 6; ART VI, SEC 9)

RECOMMENDED TO PRESIDENT
 NOT RECOMMENDED TO PRESIDENT

Comment(s) _____
Signature _____ Date _____
Provost

8. PRESIDENT

APPROVED
 DISAPPROVED

Comment(s) _____
Signature _____ Date _____
President

FS-2006

NEW PROGRAM RESOURCE INFORMATION

Program Title and Degree: Certificate: Special Education Director

Department: Counseling, Leadership and Special Education

Attach on separate sheets (1) statement of rationale and objectives, (2) estimated costs for first five years, and (3) complete catalog description (including new courses and course changes pending approval).

[Note: For new programs requiring CBHE approval, CBHE forms NP, PS, and PG will satisfy #1 and CBHE form FP will satisfy #2.]

1. Is another program being deleted or altered? Yes No
2. If this program affects other departments or colleges, has a memo showing how it will affect them been attached to the proposal? Yes No
3. What justification is being provided to support this proposal? (Current research, accreditation, certification or licensing requirements, other.) certification endorsement
4. If your response to #3 refers to existing or potential student demand, please indicate the activities undertaken to estimate or verify the potential or existing demand for this new program. DESE requirement for endorsement as a Special Education Director
5. What are the present/future projected enrollments for this program?
1st year 8 3rd year 10
In five years, how many students must be: 8-10
a) declared minors to justify this new minors continuation
b) declared majors to justify this new majors continuation
6. Which of the following would be needed to implement the proposed program? (Check all that apply.) Individuals responsible for specific areas outside of your college must be consulted.
Additional library holdings? Yes No
Additional technology or other supplies? Yes No
Additional or remodeled facilities? Yes No
Additional travel funds? Yes No
Additional faculty? Yes No
Additional support staff? Yes No
Other additional expenses? (travel expense to site) Yes No
7. Have the individuals responsible for allocation of these resources been contacted to ensure the availability of these resources by the time the program is implemented?
 Yes No Yes, but cannot ensure availability

8. Referring to question 6, if additional faculty are not required, please provide a statement as to how faculty will be made available to teach proposed new courses, if any, or to manage increased enrollments in existing courses which are to be included in the proposed new program.

Internship hours will be added to the pool of internship for that semester and divided to create a load for existing staff. However, an administrator with experience as Director of Special Education may be required as per course one semester per year if no current EAD or SPE faculty member has these credentials.

Dr. Janice Duncan, GLS Director - qualified

9. If the responses to question 1 and any parts of question 6 other than additional faculty are "no," please provide a statement as to how the department/school (or center or college) will manage the enrollment figures provided in question 5.

Course load assignment

The signature of the individuals listed below ensures that the items above have been addressed and the resources needed will be made available when the program is implemented.

Janice J. Duncan
Department head

[Signature]
College Dean

NEW PROGRAM RESOURCE INFORMATION**PROGRAM:** EDUCATIONAL ADMINISTRATION**DEGREE:**

GRADUATE CERTIFICATE IN EDUCATIONAL ADMINISTRATION: SPECIAL EDUCATION DIRECTOR

STATEMENT OF RATIONALE AND OBJECTIVES

The Department of Counseling, Leadership, and Special Education, Educational Administration, currently offers coursework leading to a Department of Elementary and Secondary Education (DESE) certificate for building level principals at the elementary and secondary level. This coursework requires 36 semester hours to complete. Students then take the SLLA Assessment and are recommended for certification by EAD department as a principal. DESE requires that the Master's Degree be in the field of Leadership at the elementary or secondary level to be certified in the state of Missouri.

Candidates for certification as Special Education Director from Southwest Missouri are limited to universities from Central, Northern, or Eastern regions of Missouri that are able to certify based upon additional coursework beyond a Masters Degree in Educational Administration (ELE or SEC Principal). The nature of the proposed program not only meets a statewide need, but meets Missouri State University's public affairs mission in serving the PK-12 school districts.

The request for this Graduate Certificate and DESE endorsement is to reinstate and update the Special Education Director (K-12) certification program of study that DESE has on file for the Missouri State University EAD Program. The Special Education Director (K-12) certification program was discontinued several years ago at Missouri State University, due to expected changes in statewide certification; however, the Special Education Director (K-12) certification has been continued statewide and is now reaching a point of critical need.

This Graduate Certificate and DESE K-12 endorsement is designed for students with a Masters Degree, or higher, in Educational Administration, who are also seeking certification as a Special Education Director. The EAD Program is receiving an average of 6-8 requests per year for endorsement of Special Education Director and currently requests that this program be reinstated to meet the demand for endorsement, as well as serving the needs of the K-12 districts in the State of Missouri. The Graduate Certificate will be an enhancement to the MSED/EdS in Educational Administration and serve as a recruitment tool for graduate students in this field of study.

All courses, except EAD 884 ^{and EAD 885} Internship: Special Education Director, are currently offered as required coursework in either the Master of Science in Education: EAD or Master of Science in Special Education: SEACT programs. Therefore, these students will enhance and increase the enrollment of existing courses at no additional cost to the programs involved. Expenses will be minimal, due to only the addition of ~~one 2-hour~~ ^{two 1-hour} courses requiring supervision.

ESTIMATED COSTS FOR FIRST YEARS

Year One	Travel to cohort site
Year Two	Travel to cohort site
Year three	Travel to cohort site
Year Four	Travel to cohort site
Year Five	Travel to cohort site

Graduate Certificate in Educational Administration Special Education Director

Program description

A 14-credit hour Missouri State University Graduate Certificate Educational Administration: Special Education Director is available to post-Masters individuals or as an added component of the Masters degree in Educational Administration (Elementary or Secondary Principal emphasis). The certificate is also offered to students who have completed an Education Specialist in Education Administration (Elementary, secondary, or Superintendent emphasis). The Graduate certificate provides students with Department of Elementary and Secondary Education certification as Special Education Director (K-12) while acquiring advanced knowledge and skills in the fields of educational administration and special education. Coursework is designed to reflect State and National standards with demonstrated mastery of competencies through research-based projects.

Admission criteria

To be considered for the program, a student must apply and be admitted to the Graduate College. A student must also have a Masters of Education Specialist Degree in Educational Administration. Candidates must submit a written "Statement of Purpose" containing long-term goals of leadership; a professional reference from immediate supervisor regarding performance; and a copy of appropriate teacher certificate of eligibility for certification by a state agency as a K-12 building- or district-level administrator; documentation of 3.5 GPA in graduate degree program. Candidates will also be required to complete an individual interview with their advisor prior to admission.

Required courses

Course Code	Course Title	Credit hours
EAD 787	Administration of Special Programs	3 hrs
SPE 782	Advanced Diagnosis & Remediation of Students*	3 hrs
SPE 792	Advanced Diagnosis & Remediation of Students – Lab	2 hrs
SPE 671	Clinical Practicum in Special Education	1 hr
SPE 780	Contemporary Issues in Special Education *	3 hrs
EAD 884	Internship: Special Education Director – Part I	1 hr
EAD 885	Internship: Special Education Director – Part II	1 hr

*offered via internet

GPA requirements

Attain a grade point average of at least 3.50 on all graduate course work at Missouri State University.

Effective September 1, 1986
 Previous revision September 1, 2006
 Revised August 1, 2014 September 18, 2013

MISSOURI STATE UNIVERSITY

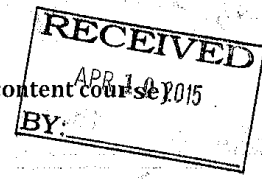
Program of Study for Special Education Director (K-12)

Certification Requirements	College Course Number and Title	Sem. Hrs.
D. A course in Psychology and Education of the Exceptional Child (choose 1)	SPE 310, 340, 715	3
E. Completion of a master's degree in educational leadership	MSED-EAD	
F. Curriculum for Educational Leaders**		
1. Specific Courses: *These must be separate graduate courses of at least two (2) semester hours.		
a. Foundations of Educational Administration -including components of career and special education	EAD 751	3
b. Special education administration	EAD 767	3
c. Differentiating instruction in the general education curriculum (choose 1)	EAD 745, ELE 710	3
d. School Supervision	EAD 786	3
2. Directed field experiences in Special Education Administration of at least two (2) semester hours	EAD 884 (1 hr) and 885 (1 hr)	2
3. Knowledge and/or competency in each of the following areas:		
a. Instructional management systems;	EAD 780	3
b. School law including components of regular/career/special education;	EAD 785	3
c. Teaching-learning processes; (choose 1)	ELE 610, SEC 704 (601), EAD 746	3
d. Public relations;	EAD 784	3
e. Educational measurements; (choose 1)	SPE 782, 792, 671	3
f. Evaluation of teachers and human resource management	EAD 781	3
g. School business and facilities management	EAD 782	3
h. Philosophy of regular/career/special education;	SPE 780	3
i. Administration and coordination of special programs and service;	EAD 787	3
j. Administration and coordination of school activities programs; (choose 1) and	EAD 752/753	3
k. Instruction in communication skills (reading, writing, spelling, listening, speaking	EAD 784	3

Note: DESE will not evaluate transcripts for administrative certificates.

Revised Fall 2014
 First Submitted Fall 2009

Missouri State University
CURRICULAR PROPOSAL
NEW COURSE (or new REGULAR SECTION of an existing variable content course)



Department: Physics, Astronomy, and Materials Science Date January 22, 2015

Check one: New COURSE New REGULAR (i.e. permanent) SECTION of an existing variable content course. If a new regular section of an existing variable topics course, to what existing course is it to be attached? _____

Course Code AST Course Number 112 Course Title Life in the Universe

PROPOSED CATALOG DESCRIPTION

General Education Course. (Breadth of Knowledge—Natural World—Life Sciences). 3(3-0).
An exploration of how life came to be on the planet Earth, prospects for detecting it on other worlds and what that detection, or non-detection, means to humanity. Topics include the origin of elements in the Universe and how they form the building blocks of life, how conditions favorable for life evolve on planets, how life evolves, biodiversity, recent discoveries of exoplanets, and possible effects on society.

PURPOSE OF COURSE

With thousands of planets discovered around other stars, the potential of detecting alien life (intelligent or not), and the consequences of those detections or non-detections, is something this generation will have to address. The big question, "Are we alone in the Universe?" will be answered within our students' lifetime, and most likely within the next few decades. This course will inform and educate our students about this timely topic to better prepare them for the amazing discoveries ahead. This course allows students to partially fulfill the Breadth of Knowledge-Natural World requirements in the General Education Program. Also see the attached pages.

RELATIONSHIP TO OTHER DEPARTMENTS

The undergraduate course catalog lists an intersession course titled Astrobiology (BMS455) which has not been offered in many years. This course is similar, but more in depth and leans more towards the astronomical impacts on evolution, aliens, and the human experience. Students are now required to take a course under the Life Sciences division of the Breadth of Knowledge-Natural World component of General Education. AST 112 Life in the Universe will be an additional offering in this component with material that is interdisciplinary, exciting, dynamic, and which addresses some of the oldest questions posed by human beings.

DEPARTMENT: Route according to ART VI, SEC 3B(1-4) of Bylaws of the Faculty. Attach New Course Resource Information form (FS 00a/05) and forward three typed, originally signed forms to one of the following (please check all that apply and send to first council/committee marked). If the course needs to go through more than one council/committee forward one additional form for each additional council/committee marked.

- College Council (All new course proposals numbered 100-599 must go through College Council first. After approval, College Council will forward appropriate number of copies to the next committee/ council or directly to the Faculty Senate if no further committee approval is needed.)
- Professional Education Committee (Considers all new courses affecting BS and MS in Education and Educational Specialist degrees)
- Committee on General Education and Intercollegiate Programs (Considers all general education and multi-college new course proposals)
- Graduate Council (Considers all 600-, 700-, and 800-level new courses)

If the course needs to go through more than one council/committee, forward one additional form for each additional council/committee marked.

Signature [Handwritten Signature] Date 1-27-15
Department Head

(Routing on Reverse Side)

FS New Course - 4/10/2014

ROUTING

COLLEGE COUNCIL (ART VI, SEC 3B)

APPROVED After dean review/comment, forward two signed copies of final action to the Secretary of the Faculty for disposition, or forward appropriate number of copies to next committee level for approval.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment (s) _____
Signature Paul Robinson Date 2-10-15
Chairperson

DEAN OF THE COLLEGE (ART VI, SEC 5)

REVIEWED Return to College Council Chair within ten days of receipt for disposition.

Comment (s) OK
Signature T. Jahnke Date 2/16/15
Dean of the College

PROFESSIONAL EDUCATION COMMITTEE (ART III, SEC 9)

APPROVED Forward two signed copies of final action to the Secretary of the Faculty for disposition, or forward three signed copies to next committee level for approval.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment (s) _____
Signature _____ Date _____
Chairperson

COMMITTEE ON GENERAL EDUCATION AND INTERCOLLEGIATE PROGRAMS (ART IV, SEC 2)

APPROVED Forward two signed copies of final action to the Secretary of the Faculty for disposition, or forward three signed copies to next committee level for approval.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment (s) _____
Signature BA Swearingen Date 4-8-15
Chairperson

GRADUATE COUNCIL (ART V, SEC 3, OR ART VI, SEC 3B)

APPROVED Forward two signed copies of final action to the Secretary of the Faculty for disposition.

DISAPPROVED Return one signed copy of final action to the appropriate Department Head.

Comment (s) _____
Signature _____ Date _____
Chairperson

FACULTY SENATE (ART VI, SEC 9)

APPROVED
 DISAPPROVED

Comment (s) _____
Signature _____ Date _____
Chairperson

PROVOST (ART I, SEC 6; ART VI, SEC 9)

RECOMMENDED TO PRESIDENT
 NOT RECOMMENDED TO PRESIDENT

Comment (s) _____
Signature _____ Date _____
Provost

PRESIDENT

APPROVED
 DISAPPROVED

Comment (s) _____
Signature _____ Date _____
President

FS-2005

NEW COURSE RESOURCE INFORMATIONDepartment Physics, Astronomy, and Materials ScienceDate January 20, 2015Course Number and Title AST 112 Life in the UniverseAnticipated Average Enrollment 100Maximum Enrollment Limit 130Faculty Load Assignment 3 Equated Hours1 Is another course being deleted? No If so, give course number and title.

2 What will this course require in the way of:

Additional library holdings? None.Additional computer resources? None. Access to current computer labs is sufficient.Additional or remodeled facilities? None.Additional equipment or supplies? None, this is not a lab course.Additional travel funds? None.Additional faculty--general vs specialized? None.Other additional expenses? None.

3 If additional faculty are not required, how will faculty be made available to teach this course?

The Physics, Astronomy, and Materials Science Department is adjusting its astronomy course offerings in response to the revised General Education Program. Condensing the current offerings allows for the inclusion of this new course.

List names of current faculty qualified to teach this course:

Becky Baker, Bob Patterson (taught a shorter version as a special course), Peter Plavchan (taught a version at UCLA), and Mike Reed.

4 What is the anticipated source of students for this course? (If from within the department, will students be taking this course in addition to or in place of other courses? If from outside the department, which courses in other departments would most likely be affected?)

This is a General Education course. The source of students is the same as for current introductory astronomy courses, namely, the entire student body.

5 Other comments:

AST 112 Life in the Universe - Sample Syllabus

Purpose: This is a general education life science course covering the evolution of life in the Universe and prospects and impacts of extraterrestrial life. This course meets the Life Science General Goal: Students will understand basic concepts of living things, the nature of scientific knowledge, and relevance of biological knowledge to human affairs. The Specific Learning Outcomes are 1) Understand living systems by describing their nature, organization and evolution. 2) Understand and use the processes by which scientific knowledge of living things is generated. 3) Develop knowledge of living things through hypothesis testing and gain the ability to draw defensible conclusions regarding living things. 4) Make logical connections between key concepts in the life sciences and describe the interaction between human lives and other living things. 5) Understanding the human species as a biological organism. And 6) Understand the ways the environment impacts humanity and how human actions affect the environment. Other learning outcomes for this course are: 1) To understand how the Universe evolved to become hospitable for life; 2) To understand how Earth-based life developed, 3) evolved, and 4) was affected by astronomical events; 5) To understand the relationships between humans, other life, and their environments, including 6) terraforming; 7) To understand discoveries within our solar system and of exoplanets in relation to where life could exist; and 8) To examine the possible effects on society and humanity with acquired knowledge of whether or not alien life exists. The learning outcomes for this course will be evaluated using tests, focus group discussions, quizzes, homework, a questionnaire, and group projects.

Course design: The course will use the Drake Equation as a focus and will include the following sections:

- 1) History of the Universe with a focus on chemical production and energy which leads to a Universe where humans and other aliens could exist.
- 2) History of life on Earth as our only example of life within the Universe.
- 3) The biology and chemistry of life- conditions for life, including extremophiles.
- 4) Prospects for diversity of life.
- 5) Current exoplanet research in relation to where life could exist and how to find out whether there is alien life.
- 6) Impacts on society whether there is or isn't alien life.

Student Success: The mission of Missouri State University is to develop educated persons. In this class, we will use the following instructional methods which support student learning and success: 1) small (focus) group discussions; 2) peer instruction; 3) clickers; and 4) group projects.

Materials: The texts for this course are *Life in the Universe* by Bennett and Shostak and *How Life Began: Evolution's Three Geneses* by Meinesz. These are the only texts you will need for this course. However, this is a very dynamic and evolving area of science and so (some) lecture notes, useful links, and other material will be posted on the web.

AST 112 Life in the Universe - Sample Schedule

<i>Week</i>	<i>Dates</i>	<i>Topics</i>	<i>Chapters</i>
1-3	August (M,W,F)	<ul style="list-style-type: none"> • Course overview, the scientific search for life in the universe. • Ancient astronomy, basic astronomy. • Formation of the solar system 	1 - 3
4-5	September (M,W,F)	<ul style="list-style-type: none"> • Cosmology, the origins of the Universe • Matter, Energy & Light • The Habitability of Earth 	4 - 5
6-8	September (M,W,F)	<ul style="list-style-type: none"> • Appearance of life on Earth & Evolution • Searching for Life in the Solar System & in particular Mars 	6 - 8
9-11	October (M,W,F)	<ul style="list-style-type: none"> • <u>Midterm Exam (Chapters 1-8)</u> • Search for life in the solar system: Jupiter and beyond • The Life Cycle, Classification of Stars, Nature of Habitability and the search for habitable worlds around other stars 	9
12-14	November (M,W,F)	<ul style="list-style-type: none"> • The Habitable Zone and Earth's Fate • Climate Change and Global Warming • Exoplanets 	10-11
15-16	December (M,W,F)	<ul style="list-style-type: none"> • Search for Intelligent Life (SETI) • Interstellar travel and Fermi Paradox • <u>Final Exam (in class, cumulative)</u> 	12,13

AST 112 Life in the Universe - Sample Outline

Chapter 1

Extraterrestrial life: life beyond Earth

Extrasolar planets: planets orbiting stars other than our sun

Habitable worlds: worlds that contain the basic necessities for life

Organic molecules for life. Must look for simple organisms)

SETI: search for extraterrestrial intelligence

Chapter 2

Greeks on Extraterrestrial life

Atomists: believed Earth and the heavens made from infinite number of indivisible atoms of each of the four elements

Belief in extraterrestrial life

Natural to assume that the same processes that created our world could also have created others

Aristotelians: the four elements were confined to the realm of Earth, while heavens were made of distinct element ether World must be unique, so no other worlds exist

A scientific model must make testable predictions about natural phenomena that would force us to revise or abandon the model if the predictions do not agree with observations.

Paradigm

Scientific Theory

Chapter 3

Astronomical Definitions)

Star, planet, extrasolar planet, habitable planet, moon or satellite, asteroid, comet, solar system, star system, galaxy, universe or cosmos

Expanding Universe

Evidence comes from the overall chemical composition of the universe – calculations that run the expansion backwards led scientists to predict that the universe was about $\frac{1}{4}$ hydrogen and $\frac{1}{4}$ helium, which observations closely match.

Star Stuff

When we say that Earth and life are made from "star stuff", what we really mean is that the elements that make up the Earth and life were made from the fusion of helium and hydrogen inside stars larger than our sun.

Accretion and terrestrial planet formation

Jovian Planet Formation

Chapter 4

Geology: the study of earth, or any world with a solid surface

Rock analysis

Mineralogical analysis

Chemical analysis

Isotopic analysis

Radiometric dating

Most reliable way to determine the age of a rock, fossil, or other solid object

Radioactive decay always occurs at a specific and measurable rate that is different for every radioactive isotope.

Idea is to determine the age of a rock from the ratio of parent and daughter atoms within it, which depends only on the decay rate and the length of time over which the decay has been occurring.

Geological time scale

4 Eons

Hadean - oldest!

Archean- 2.5 to 3.85 bya

Proterozoic- 540 mya to 2.5 bya

Phanerozoic- Present to 540 mya

3 eras

Paleozoic (old life)

Mesozoic (middle life)

Cenozoic (recent life)

Eras divided into periods

Age of Earth

Oldest intact earth rocks date to about 4 bya

Radiometric dating shows that tiny mineral grains of zirconium silicate (zircons) date to 4.4 bya

Rocks on moon date to 4.4 bya

Maximum age set by dating formation of solar system as a whole via meteorites that are 4.57 bya

Key geological definitions

The Hadean Earth and the Dawn of Life

Atmosphere

Possible to inhabit earth after 100 myrs. Many modern day microbes survive in absence of oxygen.

However, lots of volcanic eruptions.

Possible Sterilizing impacts

Impact of object 10-20 km thought to have caused the extinction of dinosaurs 65 mya

Asteroid of 350-400 km would vaporize the oceans and raise global surface temperature to 2000 deg C

No way to know if anything this big happened during hadean period

Greenhouse effect makes earth habitable

Global average temperature: average temperature of the entire planet

Green house effect

Regulating Earth's temperature

The Carbon dioxide cycle

Chapter 5

Properties of Life

Order: exhibit some sort of order in the molecules or the arrangement of the atoms

Reproduction: reproduce or are products of reproduction

Growth and development

Energy utilization

Response to the environment

Evolutionary adaptation

Species: groups of organisms that are genetically distinct from other groups

Genus: the *generic* category to which an organism belongs, which will be *specified* by the species

Mechanisms for Evolution

Fact 1: overproduction and competition for survival

Fact 2: individual variation.

Fact 3: the inescapable conclusion: unequal reproductive success

"Natural selection"

Cells

Cells: microscopic units in which the living matter inside is separated from the outside world by a barrier called a membrane

All pass on their hereditary information with DNA

Earth life is carbon based

Life on earth made of 20 different elements

Oxygen, carbon, hydrogen, and nitrogen make up 96% of mass of typical living cells

Silicon based life – 3 strikes!

Bonds formed by silicon significantly weaker than carbon bonds. i.e. more fragile, making complex molecules too fragile to form the structural components of living cells

Silicon does not normally form double bonds, which carbon does. This limits the variety of molecular structures

Carbon can be mobile in the environment in the form of gaseous carbon dioxide, but silicon dioxide is a solid

Molecular components of cells

Carbohydrates: provide energy to cells, cellular structure

Lipids: store energy for cells. Can spontaneously form membranes in water, trapping other organic molecules inside the membrane – important for early earth

Proteins: key evidence of common ancestor of life!!

Some serve as structural elements, enzymes are crucial to all important biochemical reactions (including copying of DNA), catalyst facilitates a chemical reaction or accelerates it

Built with large chains of amino acids – this is important evidence that all life on earth shares a common ancestor

Nucleic acids: DNA, RNA (carries instructions to DNA)

3 Domains of Life on Earth

Bacteria

Archaea

Eukarya

4 Metabolic Classifications

Photoautotrophs: get energy from plants and carbon from carbon dioxide in the environment
plants

Chemoautotrophs: get energy from chemical reactions and carbon from environmental carbon dioxide
Need neither sun nor food to survive. Archaea in hot springs are an example.

Photoheterotrophs: get energy from sun and carbon from consuming other organisms or their remains
Much rarer. Found in lakes, rivers, hot springs, and some aquatic environments with very high salt concentrations

Chemoheterotrophs: get energy from chemical reactions and carbon from consuming other organisms
Water and the Metabolism

Metabolism requires that organic chemicals be readily available for reactions, and liquid water allows organic chemicals to float within the cell

Metabolism requires a means for transporting chemicals to and within cells

Water plays role in many of the metabolic reactions within cells, i.e. necessary for the reactions that store and release energy in ATP= adenosine triphosphate

ATP is used to store and release energy – every living cell uses it!

What kinds of conditions can life survive?

Extremophiles: organisms that survive in extreme environments

Endoliths (within rocks) special interest for Mars. Live within rocks, chemoautotrophs

Thermophiles: organisms that survive in extremely hot water

Many from Archaea domain.

A lot of hyperthermophiles are anaerobic (live without oxygen)

Psychrophiles: cold-loving organisms

Chapter 6

Stromatolites: rocks that are characterized by a distinctive, layered structure.

Photosynthesize and those below use the waste products of the photosynthesized microbes.

Evidence that they date back as far as 3.5 bya

Microfossils

Difficult to find because old rocks are often destroyed with time, altered by geological processes

3.5-3.2 bya: fossilized cells, up to debate.

2.7-3 bya: particular molecules that almost certainly indicate biological origin

Isotopic Evidence

The Miller-Urey Experiment

Other Sources of Organic Materials

RNA World

Possibility of Migration

Chapter 7

Water's role on Earth

Potential liquids for life

Ammonia, methane, and ethane remain liquid within reasonable temperatures

Advantages of water

Environmental requirements for habitability

Must have a source of molecules from which to build living cells

Must have a source of energy to fuel metabolism

Must have a liquid medium – most likely liquid water – for transporting the molecules of life

Chapter 8

Mars invading popular culture

Conditions on Mars

Temperature well below freezing, atmospheric pressure of 1% of Earth's, 40% of Earth's gravity, days are 40 minutes longer than on earth

Lack of surface liquid water

Geological History

Evidence of water on Mars

Channels almost certainly carved by running water 2-3 bya

Must have had much warmer and thicker atmosphere at one point

Martian water today

Climate

How Mars changed

Habitability

Has elements for life: energy for life (sunlight), chemical energy (underground volcanoes), just needs liquid water

Life on Mars – 3 Viking experiments

However, no measurable level of organic molecules in the Martian soil at all.

Methane detected

Comes from either comet impacts, volcanic activity, or life

Meteorites

Chapter 9

Jovian Moons

Jupiter: Io, Ganymede, Callisto

Europa

Evidence for an ocean

Life on Europa?

Source of elements to build living organisms: rock/water combo probably has all elements needed

Source of energy for growth and metabolism: unknown

If volcanism in deep water vents, then possible. However, on earth, most of energy still filters down from life above.

Total energy available is less than available on earth

Liquid medium for transporting molecules of life?

Saturn

Titan

Atmosphere

Possibility of life

Strong evidence of liquid hydrocarbons, but since methane and ethane are colder than liquid water, chemical reaction rates would be slower, so outlook for biology is bleak.

Synchronous rotation of the moons

Tidal Heating

Chemical energy

Need disequilibrium to initiate a chemical reaction

Reduction: process of accepting electrons

Oxidation: process of losing electrons

Electron transport chains: chains of redox reactions used for photosynthesis and other life processes

Amino Acids

Building blocks from proteins

Molecules containing an amine group, a carboxylic acid group and a side chain that varies between different amino acids.

These molecules contain the key elements of carbon, hydrogen, oxygen, and nitrogen.

Handedness

In nature, you see both right and left handed amino acids, but most amino acids in life are left handed

Chapter 10

Habitable zone

Range of distances from a star at which a planet could potentially have surface temperatures that would allow for abundant liquid water

3 factors

Life outside habitable zone?

Venus

Runaway Greenhouse effect

Global warming

Increasing CO₂

Evidence from tree rings and ice cores

Consequences of global warming

Chapter 11

Star's "Life Cycle"

Types of Stars

Multi-star systems

Binary star systems

Detecting planets

Directly

Indirectly

Precise measurements of stellar properties (position, brightness, or spectra) may indirectly reveal the effects of orbiting planets

Gravitational Tugs

Astrometric Technique

Doppler Technique

Transits

Gravitational Lensing

Hot Jupiters

Most of the discovered planets are around size of Jupiter or Saturn (can't detect smaller planets as well yet) and most either have close orbits to the star or highly elliptical orbits

Formation

Planets likely formed in outer regions of their solar systems (Jovian traits), but migrated when waves in the nebula caused these young planets to spiral slowly toward their star.

Habitability

Unlikely these would be habitable, but maybe moons would be

Theoretical work suggests that the migration of hot Jupiters could affect inner solar system seriously, i.e. swallow terrestrial worlds or fling less massive planets inward toward its star or outward to interstellar space

Impact rates and Jupiter

Many trillions of comets orbit the sun (Oort Cloud) at distances beyond Pluto

If Jupiter did not exist, the comets might have remained in the part of the solar system where they could pose a danger to Earth.

Climate stability

Plate tectonics important for climate stability due to its role in CO2 cycle

Earth's tilt is fairly static due to the gravitational tugs from Moon. If there were no moon, Earth's rotation would be greater affected by other planets, causing large swings in tilt.

Chapter 12

Drake Equation

Equation that lays out the factors that are important in determining the number of transmitting civilizations

Does not give us an actual number because we don't know that values of all variables

$$N_{\text{civilizations}} = N_{\text{HP}} \times f_{\text{life}} \times f_{\text{civ}} \times f_{\text{now}}$$

N_{HP} = habitable planets, f_{life} = fraction of HP that have life, f_{civ}
 = fraction of life with civilization capable of interstellar communication, f_{now}
 = fraction of these that have civ now capable of this

Measuring Intelligence

Encephalization Quotient (EQ)

Plot of brain mass vs. body mass, where EQ=1 means typical allotment of mental ability for creatures of their size

Dolphins = 5, chimps = 2.5, humans = 7

EQs for dolphins and whales improved drastically around 35 mya when developed eco-location
 An elevated social position for dolphins and primates often allows you to have 1st choice in mates, so clever, high-ranking individuals will tend to produce clever, high-ranking offspring.

SETI

Send frequency of 1420 MHz b/c it is the frequency at which neutral hydrogen gas produces natural radio static

Categories of signals

Signals used for local communication on the world where intelligent beings live

Signals used for communication b/w a civilization's home world and some other site, such as a colony or spacecraft on another world

International signal beacons, purposely designed to get the attention of other societies

Chapter 13

Messages abroad

Because spacecraft themselves should survive unscathed for millions of years in the near-vacuum of interstellar space, we have included messages in case any extraterrestrial beings someday find them

Escape velocity

11 km/s to overcome Earth's gravity

Limitations of chemical rockets

Requires a mass ratio (mass of fully fueled rocket to empty rocket) of 39 to reach escape velocity

Spacecraft for interstellar flight

Nuclear fission, Ion engine, Solar sails, Ramjets and Relativity

Fermi Paradox

The idea that neither we nor our planet is in any way special suggests that someone should have colonized the galaxy by now.

The idea of a galactic civilization implies that we should be surrounded by evidence of this civilization -- but aside from unconvincing claims of extraterrestrial UFOs, no such evidence exists.

It should have been possible for Earth-like planets to be born at least 5 billion years before our own planet.

Possible solutions

We are alone

Civilizations are common, but no one has colonized the galaxy

Von Neumann machines

General idea of self-replicating machines would allow us to explore much farther and wider than we could by going to other worlds ourselves.

Also, these machines could function after journeys through space that take centuries to millennia.

This course is about Life in the Universe wrapped in the context of the Drake Equation. This equation includes factors for 1) how the Universe produced the conditions (chemistry and energy) amenable to life; 2) the conditions which we know are favorable to life (chemicals which are important for life, the developments of proteins to DNA to higher organisms), the prospects for life in other conditions (extremophiles on Earth, silicon-based life, buoyant life on non-Terrestrial planets), the generation and spread of biological materials, and recent results concerning the abundance of planets; 3) evolution of life and astronomical impacts upon evolution; 4) the propensity of life to develop civilizations which emit signals outside of their ecosystem; 5) and the survivability of such civilizations. Beyond the Drake Equation, the class will also consider the impact on current societies whether there is or isn't alien life.

Life Science Goals of understanding basic concepts of living things addressed in #2 & 3; nature of scientific learning in #1; and relevance of biological knowledge to human affairs in #4 & 5.

This course is multidisciplinary in that it draws extensively from astronomy, physics, chemistry, biology and geology. It is timely because only recently could astronomers begin to estimate the numbers and conditions of extrasolar planets, and space exploration has revealed other likely places for life within our own solar system. Most likely, during the lifetimes of our current student population, we will (at least statistically) know whether alien life exists or not!