

TENTATIVE SYLLABUS

Building Blocks of the Solar System (460:116)

Instructor: Professor Katherine R. Bermingham, Department of Earth and Planetary Sciences

Email: katherine.bermingham@rutgers.edu

Phone: +1 848-445-0922

Office: WL-301

Course Description: What is the Solar System made of? How did it and the planets form? Why does the Solar System contain life? In the context of learning about the role of chemistry in the evolution of our world, these and other fundamental questions in planetary science will be discussed.

Learning Goals: Students will

- 1) Learn what scientific reasoning is and how to distinguish between it and speculation.
- 2) Learn about the chemical processes associated with the origin of matter.
- 3) Examine Solar System formation theory and learn how the chemical characteristics of elements shaped the evolution of chemically diverse planets.
- 4) Evaluate chemical requirements for life to assess why life evolved on Earth.
- 5) Evaluate space missions in their ability to address fundamental questions about the evolution of the Solar System and life.
- 6) Learn about career options in planetary science.

This course satisfies SAS Core Curriculum Goals: Areas of inquiry NS Natural Sciences: “GOAL NS-1” Understand and apply basic principles and concepts in the physical and biological sciences.

Prerequisites: None. The course is accessible to a wide range of students. However, it is expected that students possess the standard knowledge of a high school graduate, including proficient comprehension of written and spoken English, basic algebra, and basic chemistry. Prospective students can contact instructor to clarify if they possess the required level of chemistry.

Class format: In-person lecture with discussion

Basis for grade: 8 quizzes (35%); midterm exam (30%); final exam (35%). A: 90-100; B+: 85-90; B: 80-85; C+: 75-80; C: 70-75; D: 60-70; F: <60.

Homework: There will be weekly homework exercises based on the lectures and assigned readings. The homework exercises will not be graded, but homework questions will be included in quizzes and exams. All reading assignments and exercises will be posted on Canvas.

Texts: Excerpts from these books will be provided in class

- *Destiny or Chance Revisited* (S.R. Taylor) 2009 Cambridge University Press (DOC).

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- *Solar System Evolution* (S.R. Taylor) 2001 Cambridge University Press (SSE).
- These textbooks will be supplemented by current literature from peer reviewed journals (e.g., *Nature*, *Science*, *Geochemical Perspective Letters*, *Geochimica et Cosmochimica Acta*, *Earth and Planetary Science Letters*). This is required because the rapid evolution of planetary science each year demands that the fundamental concepts presented in textbooks be updated by peer-reviewed literature. This helps to ensure students are taught the most up to date concepts.

Course Policies: The rules related to exams, attendance, and integrity are provided below and are supplemented by Rutgers University policies.

Exams & Quizzes: Exams and quizzes must be taken as scheduled, otherwise a failing grade will be given. Exceptions are limited to officially verified emergencies that prohibit participation in assessment, or instructor preapproved request (such as school-sanctioned athletic matches or religious observances) to reschedule. Rare cases of extreme emergency preventing timely communication are to be discussed with the Undergraduate Director and/or Department Chair.

Attendance: All students must attend all classes, arrive on time, remain in class until the end of the class period, and participate in class discussions. Instructors may require signed attendance sheets and may count attendance as part of the grade. Reasonable accommodations for excused absences (as defined by Rutgers University policy) will be provided where appropriate. For an absence to be excused, timely notification is required via official Rutgers University communication portals. Cell phones must be turned off in class. If policy is not adhered to, you will be asked to leave and be deducted grade points.

Communication: As per Rutgers University policy, all out-of-class communication must be conducted via your official Rutgers email and/or Canvas. You will be able to view your scores for quizzes and exams on Canvas.

Academic Integrity: Our department endorses a no-tolerance cheating and plagiarism policy. If you are caught cheating, the instructor may fail you and request disciplinary action.

Attitude and behavior: As per Rutgers University policy, instructors and students must display the appropriate respect and consideration for each other and the pursuit of knowledge at the university level. If not, individuals will be dismissed from the course with a failing grade.

Your Rights: We are all human and instructors and students both make mistakes. If you feel that you have been treated unfairly, contact the Undergraduate Program Director or the Department Chair.

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Date	Topic	Reading Assignment	Quiz
Week 1	1. Introduction to Planetary Science, the course, and course expectations. (What is planetary science? Why study it? How to study it?)		
	2. Overview of Solar System formation: Role of chemistry in the composition and collapse of molecular clouds to form a star, protoplanetary disk, and the planets.	https://spaceplace.nasa.gov/solar-system-formation/en/ and https://en.wikipedia.org/wiki/Formation_and_evolution_of_the_Solar_System	
Week 2	3. Origin of the Universe and the elements: Where matter comes from; how are isotopes and elements made (nucleosynthesis); how to build a star and stardust.	DOC: Chapter 2 (pp 26 – 42) SSE: Chapter 2	
	4. Periodic table and the chemistry of the elements: What are the elements in our Solar System and why this selection? Learn how to define the geochemical and cosmochemical characteristics of elements.	DOC: Chapter 2 (pp 42 – 46) SSE: Chapter 3 (3.3) Chapter 4 (4.1 – 4.4)	
Week 3	5. Stars and disks: Why do stars form with debris disks and what are their chemical compositions? (ALMA observations)	DOC: Chapter 2 (p 46) SSE: Chapter 4 (4.5 – 4.7) https://www.almaobservatory.org/en/home/	Quiz 1: Material from weeks 1-3
Week 4	6.-7. Formation of planets: Theory of planetary accretion and the effect of the chemical characteristics of elements.	DOC: Prologue (pp 1 – 8); Chapter 3	
	8. Exoplanets: Chemical composition and diversity. (observation vs. theory)	DOC: Chapter 4 https://exoplanets.nasa.gov/	Quiz 2: Material from weeks 3-4
Week 5	9. Prepare and review for exam		
	10. Mid-term exam – covering material from weeks 1-5		
Week 6	11. Review exam results		
	12. The chemical history of our Solar System, the Kuiper Belt, and comets.	DOC: Chapter 5 (pp 129 – 149)	
Week 7	13. Asteroid Belt & meteorites: Insights into the chemical composition of the protoplanetary disk.	DOC: Chapter 5 (pp 154 – 1161) SSE: Chapter 6 (6.1 – 6.6; 6.8)	
	14. Meteorites: Chondrites and Achondrites.	SSE: Chapter 6 (6.1 – 6.6; 6.8)	
Week 8	15. Mercury: Chemical profile of the planet: Bulk composition? Water? (MESSENGER mission)	SSE: Chapter 11 (11.1)	Quiz 3: Material from weeks 6-7
	16. Venus: Earth's twin?	SSE: Chapter 12 (12.1)	
Week 9	17. Earth and the Moon: Formation of the two-body system; differentiation of the bodies; bulk compositions/surface compositions.	DOC: Chapter 6	Quiz 4: Material from weeks 7-8
	18. Earth and the Moon: Late-stage accretion; why is one wet(ter) and one dry(er)?	DOC: Chapter 6	

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Week 10	19. Mars: When did it form and what is the bulk composition/surface composition? How does it compare to Earth?	EES: Chapter 11 (11.2)	Quiz 5: Material from weeks 8-9
	20. Missions to Mars: Why it is our next frontier?	https://mars.nasa.gov/mars-exploration/missions/?page=0&per_page=99&order=date+desc&search=	
Week 11	21. The gas giants Jupiter and Saturn: What are they made of and how do we know this?	SSE: Chapter 8	Quiz 6: Material from weeks 9-10
	22. The gas giants Jupiter and Saturn: How did they shape the evolution of the Solar System?	SSE: Chapter 8 + current peer reviewed literature	
Week 12	23. The ice giants Neptune and Uranus.	SSE: Chapter 8	Quiz 7: Material from weeks 10-11
	24. Pluto: What is the composition? Is it a planet? (New Horizons mission)	SSE: Chapter 10 (10.1) https://www.nasa.gov/mission_pages/newhorizons/main/index.html	
Week 13	25. Habitable worlds: What makes a planet habitable? What is the role of a planet's chemical history in defining its habitability?	SSE: Chapter 15 or DOC Chapter 7	
	26. Career opportunities in Space Science.	https://www.nasa.gov/careers https://www.esa.int/About_Us/Careers_at_ESA https://www.spacex.com/careers	Quiz 8: Material from weeks 12-13
Week 14	27/28. Make-up; prepare and review for exam		
Week 15	Final exam - covering all material		

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How to do well: Student is able to

GOAL NS-1 <i>Understand and apply basic principles and concepts in the physical sciences</i>			
<u>OUTSTANDING</u>	<u>GOOD</u>	<u>SATISFACTORY</u>	<u>UNSATISFACTORY</u>
<p>Fully and clearly explains and applies basic scientific principles with specificity and sophistication.</p> <p>Provides in-depth description of the scientific method and its distinctive value; critically differentiates it from other approaches.</p>	<p>Explains and applies basic scientific principles and concepts fully and clearly.</p> <p>Fully describes the scientific method and its distinctive value; differentiates it from other approaches.</p>	<p>Explains and applies basic scientific principles and concepts fully and clearly.</p> <p>Fully describes the scientific method and its distinctive value; differentiates it from other approaches.</p>	<p>Fails to explain or identify and apply basic scientific principles and concepts.</p> <p>Fails to demonstrate an ability to describe the scientific method and its difference from other approaches. Relies on opinion rather than analysis.</p>

GOAL NS-2 <i>Explain and be able to assess the relationship among assumptions, method, evidence, arguments, and theory in scientific analysis</i>			
<u>OUTSTANDING</u>	<u>GOOD</u>	<u>SATISFACTORY</u>	<u>UNSATISFACTORY</u>
<p>Clearly identifies and explains relationships among assumptions, method, evidence, arguments, and theory in scientific analysis, demonstrating a depth of understanding.</p> <p>Draws inferences that are consistent with the data; is specific and detailed in support of conclusions.</p> <p>Analysis of outcomes demonstrates superior understanding.</p>	<p>Identifies and explains relationships among assumptions, method, evidence, arguments, and theory in scientific analysis.</p> <p>Draws inferences that are consistent with the data.</p> <p>Offers an analysis of outcomes that is thorough and without errors that detract from analysis or conclusions.</p>	<p>Satisfactorily outlines relationships among assumptions, method, evidence, arguments, and theory in scientific analysis.</p> <p>Summarizes the purpose and findings of the research.</p> <p>Description of outcomes and/or support is satisfactory.</p>	<p>Fails to accurately identify and explain relationships among assumptions, method, evidence, arguments, and theory in scientific analysis.</p> <p>Does not summarize or interpret the results or purposes of the research.</p> <p>Does not draw conclusions consistent with the data.</p> <p>Inadequate summary of results that involves significant errors.</p>

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Student Wellness Services <http://codu.co/cee05e>

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS) (848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901 <http://health.rutgers.edu/medical-counseling-services/counseling/>

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offer a variety of services that include individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA) (848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 www.vpva.rutgers.edu/

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Disability Services (848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 <https://ods.rutgers.edu/>

The Office of Disability Services works with students with a documented disability to determine the eligibility of reasonable accommodations, facilitates and coordinates those accommodations when applicable, and lastly engages with the Rutgers community at large to provide and connect students to appropriate resources.

Scarlet Listeners (732) 247-5555

<https://rutgers.campuslabs.com/engage/organization/scarletlisteners>

Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.

Report a Concern: <http://health.rutgers.edu/do-something-to-help/>