

## **IS 212. Early Modern Science Spring 2021**

**Instructors:** Ewa Atanassow; Maria Avxentevskaya; Noa Levin; Katalin Makkai; Ross Shields; Aaron Tugendhaft

**Guest Lecturers:** Jonathan Beere; Lorraine Daston; Faysal Bibi

**Course Times:** Tues/Thurs 10:45–12:15 or Mon/Fri 14:00–15:30

**Email:** [a.tugendhaft@berlin.bard.edu](mailto:a.tugendhaft@berlin.bard.edu) (Aaron Tugendhaft, Coordinator)

**Office Hours:** Set by individual instructors

### **Description**

What is science? How does it inform our relationship to the world around us? What role does it play in living a good human life? This course examines the meaning and history of modern science by looking closely at its beginnings and evolution in the early modern period.

Retracing the developments that defined the principles, methods and frameworks of natural science as it exists today, we shall explore its philosophical foundations, practical procedures and their political and cultural ramifications. We will attend to theoretical debates regarding the relationship between science, religion and politics; the connection between experience, experiment, and knowledge; the unity or plurality of the sciences themselves; and the historical development of such terms as “observation,” “description,” and “fact.”

Our efforts will be divided into four units: First, we will encounter the basic principles of Aristotelian science and study how their reception in medieval Arabic thought generated debates about the relationship between philosophy and divine revelation. Next, through Bacon and Descartes, we will consider the early modern rejection of Aristotle and discuss the intellectual debate between the positions that solidified as “rationalism” and “empiricism.” The third unit focuses on how Galileo developed a new understanding of space, matter, and motion, and why this generated tensions between him and the Catholic Church. Finally, in the closing unit, we consider how the phenomenon of life presents a challenge to the early modern anti-teleological mechanical philosophy, focusing on Goethe’s botanical work.

### **Readings**

Bacon, Francis. 2000. *The New Organon*. Edited by Lisa Jardine and Michael Silverthorne. Cambridge University Press. (ISBN: 978-0521564830)

Descartes, René. 1998. *Discourse on Method*. Translated by Donald A. Cress. Hackett Publishing. (ISBN: 978-0872204225)

Galileo. 2012. *Selected Writings*. Translated by William R. Shea and Mark Davie. Oxford University Press. (ISBN: 978-0199583690)

Goethe, Johann Wolfgang von. 2009. *The Metamorphosis of Plants*. Introduction and photography by Gordon L. Miller. MIT Press. (ISBN: 978-0262013093)

Course Reader (printed edition)

### **Library and Book Purchase Policies**

**Students must have a hard copy of all required texts.** A limited number of the required books are available from the library; students on financial aid have priority. Other readings will be in the reader.

## Requirements

### **Seminar Attendance and Preparation**

Regular attendance and class participation are essential to the success of this course. You must come prepared by having read the assigned materials carefully. Select supplemental readings have been included in the Reader for those seeking more context; it may often also be beneficial to look up biographical details about the authors you are reading. To aid your preparatory effort, this syllabus includes numerous study questions. Use them!

Please note: Coming late or leaving in the middle of the sessions will count as half an absence. Absences beyond two will reduce your seminar grade for the second rotation.

### **Writing Assignments**

You will be required to keep a **study journal** throughout the semester comprising at least one dated entry (up to 300 words) per week. This will be your space to keep a continuous record of your reactions to readings and seminar conversations. Here you may reflect on a passage of text, connect course material to contemporary events, or ponder how a newly encountered idea may force you to reconsider your previous opinions. Because journal entries are less formal than conventional essays, feel free to voice tentative thoughts and tie things to personal concerns. At the same time, entries must still demonstrate serious engagement with the material and be composed with rigor and precision. The journal will be collected and graded three times over the semester: on February 19, March 26, and April 23.

In conjunction with the study of Goethe's *The Metamorphosis of Plants*, you will be required to complete a **plant observation worksheet** to be handed in on May 3. Optional outings to local parks in order to observe plants together will be organized if conditions allow.

You will write one substantial **final essay** (ca. 2500 words in length) at the end of semester, due on May 21. The paper will be on a topic of your choice made in consultation with your seminar leader. Successful essays often develop an idea first articulated in the study journal. You must submit a **one-page proposal** to your seminar leader by May 9 (at the latest).

### **Academic Integrity**

Bard College Berlin maintains the staunchest regard for academic integrity and expects good academic practice from students in their studies. As such, instances in which students fail to meet the expected standards of academic integrity will be dealt with under the Code of Student Conduct, Section 14.3 (Academic Misconduct) in the Student Handbook.

### **Policy on Late Submission of Papers**

Please note the following policy from the Student Handbook on the submission of essays: essays that are up to 24 hours late will be downgraded one full grade (from B+ to C+, for example). Instructors are not obliged to accept essays that are more than 24 hours late. Where an instructor agrees to accept a late essay, it must be submitted within four weeks of the deadline and cannot receive a grade of higher than C. Thereafter, the student will receive a failing grade for the assignment.

### **Grade Breakdown**

Study Journal (3 x 10%): 30%  
Plant Observation Worksheet: 10%  
Final Essay Proposal: 5%  
Final essay (ca. 2500 words): 25%  
Class Participation (2 x 15%): 30%.

### **Submission Deadlines, at a glance**

Study Journal: 1) Friday, February 19; 2) Friday, March 26; 3) Friday, April 23  
Plant Observation Worksheet: Monday, May 3  
Final Essay Proposal: Sunday, May 9  
Final Essay: Friday, May 21

Seminars will be held during two different time slots (Tu/Th 10:45-12:15 and Mo/Fr 14:00-15:30). Students are expected to attend all joint sessions regardless of whether they are held during the time slot that corresponds to their seminar. Mark your calendars accordingly!

SPECIAL CONSIDERATIONS FOR SPRING 2021: Some students might need to begin the semester remotely due to travel restrictions caused by the pandemic. In addition, all students and instructors must refrain from in-person attendance if they are feeling ill. Instructors should make efforts to offer alternatives to in-person attendance where needed, including remote participation or asynchronous options.

\*\*\*

## **Course Overview, with study questions**

### **1. Method in Aristotle and Abrahamic Aristotelianism**

In this first unit, we take our first steps by exploring the sort of scientific knowledge that existed before the rise of early modern science and the epistemological, metaphysical, and theological commitments that came along with this old Aristotelian model, through a particular focus on the “Abrahamic Aristotelianism” of the medieval period.

#### **Study Questions:**

- What was the essence of the old Aristotelian model of scientific knowledge? What counted as “scientific knowledge” according to this model and what were its limits?
- What is at stake in the debate about the putative “incoherence” of natural philosophy between al-Ghazali and Ibn Rushd?
- What does Ibn Rushd want to accomplish with his *Decisive Treatise*? Who is it for?

### **2. Modern “Scientific Method”: Empiricism and/or Rationalism**

Following upon our engagement with the Aristotelianism that had become orthodox science in the late medieval period, we turn to examine the ways in which the concept of “science” changed with the rise of early modern thought and how thinkers such as Bacon and Descartes believed it was possible to arrive at “scientific facts” or truth. We will be interested in the epistemological and metaphysical assumptions on which their approaches rested, but

also the practical aims they set for science. We will study these questions by comparing and contrasting the old Aristotelian science, as it was received, preserved, and extended in the medieval period, with the two new scientific models as put forth by Bacon and Descartes.

**Study Questions:**

- What did Bacon think human beings could gain by pursuing science according to his method? Why have they failed to accomplish this in the past?
- What relationship does Descartes posit between humans and nature in the *Discourse*?
- How do Descartes and Bacon importantly agree? Where do they meaningfully differ?
- What did Hooke claim to accomplish with his microscopic observations? What are Cavendish's main objections to Hooke and the new science generally?

**3. Galileo: The "First Modern Scientist"?**

The third unit begins with a discussion about terrestrial motions and the geocentric worldview. Our primary sources will be Galileo's telescopic observations announced in *A Sidereal Message* (1610) and his defense of heliocentrism in *Dialogue Concerning the Two Chief World Systems* (1632). We will discuss his attitude towards the Ptolemaic-Aristotelian worldview and assess three aspects of the Copernican debate: the mathematical, the physical (or natural philosophical) and the theological-scriptural. We will also consider Brecht's rethinking of the relationship between science and politics in his *Life of Galileo*.

**Study Questions:**

- What was Galileo's reason for doing science? How does it compare to what Bacon and Descartes thought science was for?
- What were the main challenges of the Copernican "revolution" in planetary theory? What was Galileo's attitude toward tradition and natural inquiry?
- What lessons about individual and institutional supporters of scientific work can be gleaned from the letters written by and around Galileo? How or why does this matter?

**4. Observing Living Things: The (In)Sufficiency of Efficient Causation**

Finally, we turn to the phenomenon of life and the challenge it presents to the mathematical and mechanistic explanations that are often associated or even equated with science in the contemporary sense. We will focus on Goethe's work in botany, which was criticized by his contemporaries for reintroducing final causes. Following Goethe's suggestion that nature should be observed under an open sky, and not reproduced in a laboratory, students will be asked to get outside and carefully observe plants in their environment.

**Study Questions:**

- How, if at all, does Goethe's poem contribute to his work in *Metamorphosis of Plants*?
- How does Goethe's explanation of organic form raise challenges for Linnaeus' taxonomic system? What is at stake in different ways of organizing knowledge?
- Does the *Metamorphosis of Plants* follow the methodology proposed in "The Experiment as Mediator of Subject and Object"? How does this method differ from the methods proposed by Bacon and Descartes?
- What do Humboldt and Arendt think the consequences of modern science have been on our ability to live a meaningful human life? Where do they agree and disagree?

Feb 1	<b>Joint Session: Jonathan Beere on Aristotle [Tu]</b> *Aristotle, <i>Physics</i> II.1-3, 7; III.1-2; VIII.1 [*Rovelli, “Aristotle’s Physics: A Physicist’s Look”]	*Aristotle, <i>Posterior Analytics</i> , I.1, 2, 18, 24, 31, 33; II.19
Feb 8	*Al-Ghazali, <i>The Incoherence of the Philosophers</i> , Introduction; Discussions 10 & 17 [*Ragep, “Islamic Culture and Natural Sciences”]	*Ibn Rushd, <i>The Incoherence of the Incoherence</i>
Feb 15	*Ibn Rushd, <i>Decisive Treatise, determining the Nature of the Connection between Religion and Philosophy</i>	<b>Joint Session: Katja Krause on Life Sciences [Th]</b> *Ibn Rushd, <i>On Animals</i> , XII, paragraphs 1-12 *Albertus Magnus, <i>On Animals</i> , III, paragraphs 140-141
Feb 22	*Francis Bacon, <i>The New Atlantis</i> *Selection of maps and images [*Wootton, “Inventing Discovery”]	<b>Joint Session: Lorraine Daston on Francis Bacon [Th]</b> Bacon, <i>New Organon</i> , Front Matter (pp. 2-13)
Mar 1	Bacon, <i>New Organon</i> , I.1-68 (pp. 33-56) [*Genesis 1-3]	Bacon, <i>New Organon</i> , I.69-end (pp. 56-101) <i>William Harvey and the Circulation of Blood</i> (video)
Mar 8	Bacon, <i>New Organon</i> , II.1-21 (pp. 102-36) [*Lorraine Daston, “The Empire of Observation”]	<b>Joint Session: Maria Avxentevskaya on Machines [Fr]</b> *Wilkins, <i>Mathematicall Magick</i> , II.3-4 & illustrations <i>Mechanical Marvels</i> (video)
Mar 15	Descartes, <i>Discourse on Method</i> , Parts 1-2	Descartes, <i>Discourse on Method</i> , Parts 3-4
Mar 22	Descartes, <i>Discourse on Method</i> , Parts 5-6	*Robert Hooke, <i>Micrographia</i> , Observations 1, 2, & 54 *Margaret Cavendish, <i>Observations upon Experimental Philosophy</i> , Front Matter *Margaret Cavendish, <i>The Blazing World</i> (selection)
Mar 29	<b>Spring Break</b>	<b>Spring Break</b>
Apr 5	Galileo, <i>A Sidereal Message</i> (SW, pp. 1-32) *Selection of images [*Koyré, “Galileo and the Scientific Revolution”]	Galileo, <i>The Assayer</i> (SW, pp. 115-121) Galileo, <i>Two World Systems</i> (SW, pp. 122-149)
Apr 12	Galileo, <i>Two World Systems</i> (SW, pp. 231-270)	Galileo, <i>Two World Systems</i> (SW, pp. 270-308)
Apr 19	Galileo, <i>Letter to Castelli</i> (SW, pp. 55-61) Galileo, <i>Letter to Grand Duchess Christina</i> (SW, pp. 61-94) Bellarmine, <i>Letter to Foscarini</i> (SW, pp. 94-96)	<b>Joint Session: Brecht’s Life of Galileo (screening) [Th]</b> Galileo Trial Documents (SW, pp. 360-392) [*Sister Maria Celeste, <i>Letters to Her Father Galileo</i> ] [*Brecht, “A Short Organum for the Theater”]
Apr 26	<b>Joint Session: Faysal Bibi on Paleontology [Tu]</b> *Cuvier, <i>Essay on the Theory of the Earth</i> , chs. 1-7 [*Elizabeth Kolbert, “The Lost World: The Mastadon’s Molars”]	*Linnaeus, “Regnum Vegetabile” *Goethe, “On Linnaeus” Goethe, <i>Metamorphosis of Plants</i> (Poem; §§1-59) [*Goethe, “Metamorphose der Pflanzen”]
May 3	Goethe, <i>Metamorphosis of Plants</i> (§§60-121)	*Goethe, “The Experiment as Mediator of Subject and Object” [* Nina Amstutz, “Caspar David Friedrich and the Anatomy of Nature”]
May 10	*Alexander von Humboldt, <i>Cosmos</i> , vol. 1, ch. 1 * <i>Naturgemälde</i> by Goethe and Humboldt	*Hannah Arendt, “The Conquest of Space and the Stature of Man”

Items marked with an asterisk (\*) are in the Course Reader; those in brackets are recommended but not required. “SW” = Galileo, *Selected Writings*.