

FUNDAMENTALS OF SCIENCE AT THE FOUNDATIONS OF FAITH 2016

CREDIT HOURS: 3.0

COURSE DESCRIPTION:

One of the most powerful applications of the faith/science dialogue is to explore how the epistemology of scientific research (and the insights it yields about the nature of reality) can help to focus and structure the fundamental questions that theology poses about the doctrines of faith. Insofar as theology is a study of the creator God who is responsible for everything in the universe, it follows that *scientific research is necessarily a component of theological study*—not simply a “companion” or “sister” discipline, but an integral part of the theological endeavor. A theologian who fails to integrate science into her thinking is as neglectful of her vocation as one who chooses to ignore Christian anthropology or soteriology.

This course is built upon the premise that Catholic priests need to acquire a basic literacy in the fundamental questions about physical reality which contemporary scientists are engaging, and the answers they are uncovering. Most seminarians are largely unaware of the marked difference that exists between the way they see the world and the way that physical scientists and biologists comprehend it. Among scientific “laymen,” even those who are otherwise well-educated often rely upon a picture of the physical universe and the human species that has been little updated since their high school or college introductory science classes.

This course will familiarize pre-theologians with several important foci of contemporary research, preparing them to understand and articulate the significance of such knowledge for their theological studies, spiritual formation, and pastoral ministry. In order to form a bridge between the languages of science and theology, we will begin by exploring the concept of a “Catholic worldview.” Within such a worldview, one perceives the universe to be the product of an intelligent creator, and thus to be intelligible itself, with all natural phenomena and persons bearing the imprint of the sacramental nature of reality, which is transformed by God’s grace. If such theological language accurately describes the real world, then the theologian must be able to draw parallels between the fundamental doctrines of the Catholic faith and the fundamental principles of nature that scientists presume to be true.

Two foundational pillars of modern science will be studied: fields and genetics. The concept of the physical “field” (both classical and quantum) plays a pivotal role for our understanding of all matter and forces in nature, while the study of genetics reveals the underlying structure for all observable life forms. Additionally, the relatively new discipline of Complexity Theory will be introduced as a means for investigating the inherently relational dynamics that seem to govern the largescale structure of both inanimate matter and living organisms.

Throughout the course, students will be challenged to draw out the theological implications of the scientific methodologies and discoveries they encounter. They will also be taught methods for applying scientific epistemology to enrich the experience of Catholic spirituality (e.g., celebrating the Seven Sacraments or practicing the discernments of spirits).

LEARNING GOALS/OBJECTIVES:

1. To understand and communicate the basic elements of a Catholic worldview: how the fundamental principles of Catholic theology give particular meaning and significance to the way in which the natural world and the human person are perceived.
2. To understand and communicate the basic meaning and significance of a physical field:
 - a. the basic history of the field concept
 - b. the examples of gravitational, electromagnetic, and quantum fields
 - c. the importance of fields to the modern understanding of matter and force
3. To understand and communicate the basic meaning and significance of the science of genetics:
 - a. basic definition of gene, chromosome, genome
 - b. implications of genetics for free will and determinism
 - c. common misperceptions/exaggerations about what genetics can reveal
4. To understand and communicate the basic meaning and significance of complexity theory:
 - a. what sort of questions does complexity theory seek to address
 - b. what are some examples in which “complex behavior” is observed
 - c. what are some implications of complexity theory for the understanding of causality and determinism in the natural world or in human communities
5. To accurately identify and distinguish the central components within commonly asked questions or statements arising from the faith/science dialogue:
 - a. what issues are primarily epistemological (related to how we perceive or understand)
 - b. what issues are primarily theological (questioning qualities about God’s action or existence)
 - c. what issues are primarily scientific (questions related to the intrinsic nature of matter)
 - d. what issues are primarily ethical or social (how people use information)
6. To apply the epistemological methods of scientific inquiry to personal contemplative prayer and the experience of spiritual direction.

STRATEGIES: The course goals will be met by means of class readings and videos, and discussions based upon them. Readings listed on a given date are to be completed in preparation for the next class period. It is expected that each student will have completed all of the assigned reading in advance of class and will be prepared to contribute to the discussion. Class participation is a critical component of this course. There will be two mid-term, in-class quizzes and one 5-page paper designed to help students better integrate the fundamental tenets of faith and science. In addition, students will observe and evaluate parishioner interviews based on their concerns about the faith/science dialogue. Finally, students will have a brief, one-on-one conversation with the instructor to discuss their experiences with attempting to integrate the prayer methods introduced throughout the course into their own personal prayer.

ASSESSMENT:

1. Two quizzes will be administered (one after the unit on fields and one after the unit on genetics) to measure basic comprehension of the science of fields and genetics. Questions will be of the nature of definitions and short answers.

2. Students will select one of the following three core statements of Christian theology:

- a. God is love
- b. human beings are made in the image and likeness of a Trinitarian God
- c. through him (Christ) all things were made

they will then write a 5-page paper in which they cover the following points:

- a. discuss the contribution of your core statement to the overall Catholic worldview—how does the truth of that statement affect the way in which the physical world is perceived
- b. discuss how the language and concept of field theory and/or genetics can help to explain the full meaning of your core statement; do the scientific findings pose new questions that the core statement must address?

In their essays, students should clearly demonstrate their level of understanding of the key scientific and theological issues by using the specific language of field theory or genetics as discussed in the class sessions.

3. Students will watch taped interviews with parishioners from churches throughout the Archdiocese of Chicago (compiled by the instructor) in which they discuss questions and concerns they have regarding any aspect of the interaction between faith and science. Students will meet in small groups to evaluate the interviews. They are to identify:

- a. the fundamental *scientific* issues that are being raised (e.g., the accuracy of Galileo's astronomical observations and how well supported were his conclusions based on the quality of his data)
- b. the implicit (or explicit) *assumptions about faith* and believers that are being expressed (e.g., the conviction that the Catholic Church always feels threatened by scientific discovery)
- c. the *accuracy of the statements* being made (e.g., whether or not Galileo was actually tortured by the Inquisition)
- d. any *underlying personal attitudes or experiences* of the speakers (which they themselves explicitly allude to in their interview) which might help explain their expressed attitudes toward faith and/or science (e.g., someone might indicate that they see the Church's views toward science to be "just as backwards and close-minded as its views toward marriage")

Based upon their own observations and their small group discussion, each student will write a 2-page paper briefly summarizing what they observed and proposing how they might engage the

parishioner to help bring them to a fuller and more accurate understanding of the relationship between faith and science. This should be done either in the form of describing a follow-up, one-on-one conversation or by composing a homily to be delivered to an entire congregation.

Students will be assessed on the accuracy and fairness with which they evaluated the positions expressed in the interviews as well as on the scientific/theological accuracy and pastoral effectiveness of their proposed response (either via follow-up conversation or homily).

4. At the end of the course, each student will meet for a brief interview with the instructor (an experienced spiritual director) to discuss his experience of trying to integrate the prayer methods discussed in the class into his own personal prayer. This assessment will not be factored into the student's final grade, but is intended to give constructive feedback to help the seminarian continue to grow in his spiritual formation.

BIBLIOGRAPHY:

Albright, Carol Rausch and Joel Haugen, eds. *Beginning with the End: God, Science, and Wolfhart Pannenberg*. Chicago, IL: Open Court, 1997.

Berkson, William. *Fields of Force: The Development of a World View from Faraday to Einstein*. New York: Halsted Press, 1974.

Britannica Guide to Genetics. "Historical Background," 53-79. London: Constable and Robinson, 2009.

Carroll, Sean. "God is Not a Good Theory." [video: *The Philosophy of Cosmology Project*, 2013].

_____. "Particles, Fields, and the Future of Physics." [video: Fermilab, 2013].

"Cracking the Code of Life." [video: PBS Nova, 2001].

Eaves, Lindon. "Spirit, Method, and Content in Science and Religion: The Theological Perspective of a Geneticist." *Zygon* 24 (1989): 185-215.

Groome, Thomas H. "What's it all About? – Taking a Sacramental View." In *What Makes Us Catholic: Eight Gifts for Life*, 75-103. New York: HarperSanFrancisco, 2002.

Hefner, Philip. "Pannenberg's Fundamental Challenges to Theology and Science." *Zygon* 36 (2001): 801-808.

Jepsen, Kathryn. "Real Talk: Everything is Made of Fields." *Symmetry* (July 2013), e-journal accessed August 1, 2015, www.symmetrymagazine.org.

John Paul II. "Address to the Pontifical Academy of Sciences Plenary Session on 'The Origins and Early Evolution of Life.'" October 22, 1996.

Kuhlmann, Meinard. "Quantum Physics: What is Real?" *Scientific American* 309 (2013): 40-47.

McMullin, Ernan. "The Origins of the Field Concept in Physics." *Physics in Perspective* 4 (2002): 13-39.

_____. "Biology and the Theology of the Human." *Zygon* 28 (2013): 305-28 [originally published in *Controlling Our Destinies: Historical, Philosophical, Ethical, and Theological Perspectives on the Human Genome Project*, ed. Phillip R. Sloan, 367-93. Notre Dame, IN: University of Notre Dame Press, 2000].

Mitchell, Melanie. *Complexity: A Guided Tour*. New York: Oxford University Press, 2009.

_____. "Complexity: A Guided Tour." [video: Santa Fe Alliance for Science, 2013].

Naugle, David K. "The Wonder of Worldview II: Roman Catholicism and Eastern Orthodoxy." In *Wordview: The History of a Concept*, 33-54. Grand Rapids, MI: Wm. B. Eerdmans Publishing, 2002.

Niekerk, Kees Van Kooten and Hans Buhl, eds. *The Significance of Complexity: Approaching a Complex World Through Science, Theology and the Humanities*. Burlington, VT: Ashgate, 2004.

Pannenberg, Wolfhart. "God as Spirit—and Natural Science." *Zygon* 36 (2001): 783-94.

Peacocke, Arthur. *Theology for a Scientific Age: Being and Becoming—Natural, Divine and Human*. Minneapolis, MN: Fortress Press, 1993.

Plantinga, Alvin. "Divine Action in the World: The Old Picture." In *Where the Conflict Really Lies: Science, Religion, and Naturalism*, 65-90. New York: Oxford Univ. Press, 2011.

Polkinghorne, John. "Wolfhart Pannenberg's Engagement with the Natural Sciences." *Zygon* 34 (1999): 151-58.

_____. "Fields and Theology: a Response to Wolfhart Pannenberg." *Zygon* 36 (2001): 795-97.

_____. "The Causal Nexus of the World." In *Exploring Reality: The Intertwining of Science and Religion*, 7-37. New Haven: Yale Univ. Press, 2005.

_____. "Contextual Theology." In *Theology in the Context of Science*, 1-11. New Haven: Yale Univ. Press, 2009.

_____. "Scripture." In *The Polkinghorne Reader: Science, Faith and the Search for Meaning*, 147-58. West Conshohocken, PA: Templeton Press, 2010.

- _____. "The Demise of Democritus." In *The Trinity and an Entangled World: Relationality in Physical Science and Theology*, edited by John Polkinghorne, 1-14. Grand Rapids, MI: Wm. B. Eerdmans Publishing, 2010.
- _____. "The Nature of the Physical World." In *The Polkinghorne Reader: Science, Faith and the Search for Meaning*, 25-35. West Conshohocken, PA: Templeton Press, 2010.
- _____. "Trinitarian Theology." In *The Polkinghorne Reader: Science, Faith and the Search for Meaning*, 189-96. West Conshohocken, PA: Templeton Press, 2010.
- _____. "Insights from Science." In *Science and Religion in Quest of Truth*, 34-47. New Haven: Yale Univ. Press, 2011.
- Ridley, Matt. *Genome: The Autobiography of a Species in 23 Chapters*. New York: Harper Perennial, 2006.
- Russell, Robert John, William R. Stoeger, and Francisco J. Ayala, eds. *Evolutionary and Molecular Biology: Scientific Perspectives on Divine Action*. Vatican City State: Vatican Observatory Publications, 1998.
- Sloan, Philip R., ed. *Controlling Our Destinies: Historical, Philosophical, Ethical, and Theological Perspectives on the Human Genome Project*. Notre Dame, IN: Univ. of Notre Dame Press, 2000.
- Soskice, Janet. "Knowledge and Experience in Science and Religion: Can We Be Realists?" In *Physics, Philosophy, and Theology: A Common Quest for Understanding*, 3rd ed., edited by R. J. Russell, W. R. Stoeger, and G. V. Coyne, 173-84. Vatican City State: Vatican Observatory Foundation, 1997.
- Williams, L. Pearce. *The Origins of Field Theory*. Lanham, MD: University Press of America, 1980.

SCHEDULE AND ASSIGNMENTS:

- Class 1** Introduction and Overview
- Topic: Introduce students to the central concept that the methodologies and epistemology of modern scientific research has much to contribute to Catholic theology.
- Method: Class discussion around the current climate of the faith/science dialogue in contemporary culture and in the Catholic Church
Video: "God is not a Good Theory" (lecture by physicist Sean Carroll)

Assignment: “‘What’s it all About?’—Taking a Sacramental View” (Groome)
“The Wonder of Worldview II: Roman Catholicism and Eastern Orthodoxy”
(Naugle)

Unit I: Worldviews and the Language of Science & Faith

Class 2

Topic: Catholic worldview: sacramentality and intelligibility of the world

Method: Class discussion, lecture

Assignment: “Knowledge and Experience in Science and Religion: Can We Be Realists?”
(Soskice)
“Contextual Theology” (Polkinghorne)
“Trinitarian Theology” (Polkinghorne)

Class 3

Topic: How science can challenge and shape how we think and speak about faith, and vice versa

Method: Class discussion, lecture
Spiritual Wisdom from the Scientific Method I
-The importance of knowing initial conditions and boundary values

Assignment: “The Demise of Democritus” (Polkinghorne)

Class 4

Topic: Rethinking the “stuff” of the universe; laying out a broad vision for the historical, and current thought about the basic constituents of matter in the universe and how material bodies interact with other bodies (and what concepts such as “material body” and “interaction” even mean)

Method: Discussion of reading; lecture briefly outlining the pre-Newtonian (primarily Aristotelian) worldview understanding of matter, motion, and force

Assignment: “The Origins of the Field Concept in Physics” (McMullin)

Unit II: Fields

Class 5

Topic: Historical problem of accounting for action at a distance; nature of motion and force; Aristotelian and Newtonian worldviews

Method: Class discussion, lecture

Assignment: *Faraday, Maxwell, and the Electromagnetic Field* (Forbes & Mahon) — Introduction, Chaps. 3 & 5

Class 6

Topic: History of understanding the relationship between electricity and magnetism; evolution of “action at a distance” principle; early understanding of the concept of a physical field

Method: Class discussion, lecture

Assignment: *Faraday, Maxwell, and the Electromagnetic Field* (Forbes & Mahon) — Chaps. 6 & 10

Class 7

Topic: Development of the concept of “lines of force”—from epistemology to ontology; how science advances by applying analogical/metaphorical reasoning (comparing electromagnetic force lines to fluid mechanics)

Method: Class discussion, lecture

Assignment: *Faraday, Maxwell, and the Electromagnetic Field* (Forbes & Mahon) — Chaps. 11, 12, & 13

Class 8

Topic: Maxwell’s revolutionary development of the unified electric-magnetic field theory

Method: Class discussion, lecture
Spiritual Wisdom from the Scientific Method II
-State your beginning hypothesis: we do not go to prayer as a “blank slate”

Assignment: *Faraday, Maxwell, and the Electromagnetic Field* (Forbes & Mahon) — Chaps. 14 & 17

Class 9

Topic: Maxwell's equations and the legacy of the transition from the mechanical to the field paradigm

Method: Class discussion, lecture

Assignment: "Real Talk: Everything is Made of Fields" (Jepsen)
"Quantum Physics: What is Real?" (Kuhlmann)
"The Nature of the Physical World" (Polkinghorne)

Class 10

Topic: The modern field paradigm as the foundation for understanding matter and forces

Method: Class discussion, lecture
Video: "Particles, Fields, and the Future of Physics" (Sean Carroll)

Assignment: "God as Spirit—and Natural Science" (Pannenberg)
"Pannenberg's Fundamental Challenges to Theology and Science" (Hefner)

Class 11

Topic: Theology and Fields: the Pannenberg/Polkinghorne Dialogue

Method: Class discussion, lecture

Assignment: "Wolfhart Pannenberg's Engagement with the Natural Sciences" (Polkinghorne)
"Fields and Theology: a Response to Wolfhart Pannenberg" (Polkinghorne)

Class 12

Topic: Theology and Fields: the Pannenberg/Polkinghorne Dialogue (cont'd.)

Method: Class discussion, lecture
Spiritual Wisdom from the Scientific Method III
-Data are necessary in order to draw meaningful conclusions
-Pitfalls to avoid when interpolating/extrapolating from data sets

Assignment: "Scripture" (Polkinghorne)

Class 13

Topic: Scriptural accounts of God's actions in the world; what are the means by which God acts in the Bible?; are God's actions efficacious? when and why does God choose to act (or not act)?

Method: Guest lecture by USML scripture scholar
Class discussion

Assignment: "Divine Action in the World: The Old Picture" (Plantinga)

Class 14

Topic: Contemporary theological accounts of God's action in the physical world; Church understanding of miracles; how does God physically make a difference in the world today?

Method: Guest lecture by USML systematic theologian
Class discussion

Assignment: Study for quiz

Class 15

Topic: Unit II quiz; pastoral assessment of faith/science dialogues among parishioners

Method: Watch and analyze filmed interviews with parishioners concerning faith and science

Assignment: "Historical Background" (*Britannica Guide to Genetics*)

Unit III: Genetics**Class 16**

Topic: History and current status of the Human Genome Project

Method: Video: "Cracking the Code of Life" [NOVA]
Class discussion

Assignment: *Genome*: Preface, Introduction, Chap. 1 (Ridley)

Class 17

Topic: History of genetics and overview of the relevant biology

Method: Class discussion, reaction to video, lecture
Spiritual Wisdom from the Scientific Method IV
-Interpreting results and drawing conclusions from experimentation

Assignment: *Genome*: Chaps. 2 & 3 (Ridley)
John Paul II. "Address to the Pontifical Academy of Sciences Plenary Session on
"The Origins and Early Evolution of Life." October 22, 1996.

Class 18

Written assessments of parishioner interviews are due today.

Topic: How species are made; when/how did life become human; is there a "missing link"; the dependence of a species on its genetic structure; the singular qualities of the double helix structure

Method: Class discussion, lecture

Assignment: *Genome*: Chaps. 4 & 5 (Ridley)

Class 19

Topic: Genetic code: freedom and determinism; significance of environmental and nurturing influences; the dilemma of Huntington's disease

Method: Class discussion, lecture

Assignment: *Genome*: Chaps. 6 & 7 (Ridley)

Class 20

Topic: Behavioral genetics and evolutionary psychology; are we genetically coded toward our capacity for faith and reason? do humans have genetically-engrained instincts?; how does the brain shape language (and thus, culture)?

Method: Class discussion, lecture

Assignment: *Genome*: Chaps. "X&Y" & 11 (Ridley)

Class 21

Topic: Intra-genome competition and conflict at the molecular level that can shape sexual behavior (as well as many other behaviors); the objective science and wild exaggerations concerning the relationship between genes and personality type; interplay between genetic makeup and social environment in influencing behaviors

Method: Class discussion, lecture

Assignment: *Genome*: Chaps. 12 & 14 (Ridley)

Class 22

Topic: From egg to chicken—the greatest “miracle” of biology: how an undifferentiated blob of matter (fertilized egg) grows into a complex organism with thousands of individually functioning parts; the blueprint of life; embryo development from the genome; “immortal” cell lines; the genetics of aging

Method: Class discussion, lecture

Assignment: *Genome*: Chaps. 17 & 22 (Ridley)

Class 23

Topic: mutations and cancer; the genetics of dying; genes, determinism and fatalism; the illusion of full responsibility for one’s actions; the reciprocal interaction between environmental and genetic influences as a classic model of a chaotic system

Method: Class discussion, lecture
Spiritual Wisdom from the Scientific Method V
-Paradigm shifts: willingness to rethink your understanding of God

Assignment: “Spirit, Method, and Content in Science and Religion: The Theological Perspective of a Geneticist” (Eaves)
“Biology and the Theology of the Human” (McMullin)

Class 24

Topic: Comparisons of the epistemology employed in genetics and in theology; the double helix as an “icon” of biology; two Christian responses to the advances of the genetic understanding of the human person: Pope John Paul II and Arthur Peacocke (scientist/theologian).

Method: Class discussion, lecture

Assignment: Study for quiz

Class 25

Method: Unit III exam

Assignment: *Complexity: A Guided Tour*: Preface, Chaps. 1 & 7 (Mitchell)

Unit IV: Complexity**Class 26**

Topic: Introduction to complexity theory; ways of defining complexity

Method: Video: “Complexity: A Guided Tour” by Melanie Mitchell
Class discussion, lecture

Assignment: *Complexity: A Guided Tour*: Chaps. 15 & 16 (Mitchell)

Class 27

Topic: The science of networks: definitions and applications

Method: Class discussion, lecture

Assignment: *Complexity: A Guided Tour*: Chaps. 17 & 18 (Mitchell)

Class 28

Topic: Two significant examples of complexity analysis: (1) the mystery of how living organisms scale with size; (2) how evolution produces such large variations via apparently small, gradual, mutations

Method: Class discussion, lecture

Assignment: “The Causal Nexus of the World” (Polkinghorne)
“Insights from Science” (Polkinghorne)

Class 29

Topic: Bringing it all together: does science provide any evidence for teleology in the natural world?

Method: Class discussion, lecture

Assignment: Work on paper

Class 30 Final papers due by noon.