

SCIENCE, THEOLOGY AND THE FUTURE

Institution: Loyola Marymount University

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We begin with a critical examination of stereotypical assumptions about the relationship between the natural sciences and Christian theology. Through role playing, we highlight what are popularly assumed to be irreconcilable tensions between the disciplines. We then encourage students to examine the stereotype in light of: (1) less familiar details from the history of astronomy through Einstein and Hubble (especially the complex Galileo case); and (2) a nuanced account of scientific and theological methods. Finally, we introduce Ian Barbour's typology of four ways of relating science and religion as a guide for critical reflection. This typology, as well as John Haught's modified version, provides structure to the entire remainder of the course. We next proceed to examine eleven topics in science and religion, using the following approach:

First, the students learn in class about a scientific development and possible related scientific controversies. Development of the necessary theory can be minimized because all students will have fulfilled basic science prerequisites.

The students, who have been divided into groups of four or five, are then sent home to read about theological responses to the scientific development under consideration. In addition to the general reading, one distinctive response is assigned to each group (e.g. Charles Birch on purpose in the evolution of the universe), which the group must try to locate within Barbour's or Haught's typology. The group then composes a one-page account of their finding, with a supporting rationale. Well-founded student modifications of the typologies used in class are welcomed as contributions to the ongoing refinement of our understanding of the relationship between science and religion.

This group homework assignment then becomes the basis for classroom discussions and exercises. (Three well-known guest scholars will also be invited into the debate.) The following topics, involving a range of natural sciences, are included in the course: The Big Bang Theory The Evolution of the Universe Chemical Evolution Biological Evolution Current Debates on Evolution Ecological Principles and Problems Ecological Sustainability Neuroscience, Computer Science, and the Human Soul Genetic Engineering Genetics and Human Behavior The Future of the Universe Specific scientific and theological questions related to these topics are discussed in the course syllabus. The course is structured so as to cover a range of perspectives, scientific and well as theological, on each topic. Presentations, classroom exercises, and assignments are aimed at balance, honoring the Jesuit ideal of education through an open

process of engaged discovery. We view the classroom as a student-centered learning environment in which we employ a variety of active learning techniques. This view requires that we, as faculty, relinquish some control of the classroom to the students and that we follow facilitator, delegator, as well as personal model teaching styles. In doing so, we also take a pedagogical approach that is consistent with the most significant features of this particular course: exploring questions of meaning, helping science majors reflect on the relationship between their scientific backgrounds and theology, and maximizing the added potential gained from team-teaching. Within the basic structure outlined at the beginning of the "Topics" section, we will utilize a variety of teaching methods. Scientific advances and theory may be presented in a traditional lecture format, but as mini-lectures of no more than 15 minutes in length. These will be followed by formative assessments, such as pair-sharing (two students compare notes on what they have learned), jigsaw groups, concept mapping, and roundtable discussions. Theological reflection will start with the group reading assignments described above. In class, the process of reflection will continue through group discussions (both small and large group format), panel discussions, debates, and role playing. At the end of each session, students will be asked to write a reflection page on the insights they have gained. Students will be required to take a midterm and a final examination. These will include identification of appropriate terminology as well as short essay questions devised to apply knowledge learned through critical thinking. To help integrate the topics of the course, each study group will be assigned a final project that involves building a web page. The web page must show links between related concepts and approaches and draw on materials from the entire semester. The types of links developed by the students will show the level at which they have engaged the questions of the course.

COURSE ASSESSMENT

All courses taught at Loyola Marymount University are subject to student evaluation by means of a standard form distributed and collected by the Office of the Academic Vice President (see enclosed). In addition, we will assess the outcomes of this particular course for science majors by carrying out our own, more detailed, pre- and post-evaluations. We will distribute surveys on perceptions of science, theology, and the interaction between the two fields. In the post-evaluation we will also ask if and how the course has affected the way in which the students do science. ***** The Natural Science program and the Department of Theological Studies are pleased to offer an interdisciplinary course examining the relationship between Science and Theology. The course is for science and engineering majors (or by consent of instructor). Enroll early, class size is limited.

Objectives: To acquaint the student with some of the history of the Science-Religion debate. Develop the method-ologies used in both Science and Theology. Present modern scientific findings and theories and examine how these influence theological thought as well as the dialog between Science and Theology.

Content: A variety of topics will be presented with readings from scholars in areas of both Science and Theology. Topics will include: • History: the Galileo case - Science vs Religion? • Methodologies in Science and Theology • The Big Bang, Creation Myths, and the Evolution of the Universe • Chemical Evolution, Reductionism, and the Beginnings of Life • Evolution vs Creation Science • Ecology, the Environment, Sustainability - Cosmological or Humanistic Theology • Neuroscience, Artificial Intelligence, and the Human Soul • Genetic Engineering, Cloning, Genetic Testing, Human Behavior - Free Agency • The Fate of the Universe - The Fate of Mankind

Course Format: Emphasis on a

Student-Centered Learning Environment including mini-lectures, cooperative learning groups, class discussions, debates, role playing, and individual reflection.

COURSE OBJECTIVES At the dawn of a new millennium, this course explores advances in scientific knowledge and their repercussions for Christian theology. By covering a broad range of topics as well as vantage points, the course facilitates a nuanced understanding of the ways in which science and theology are related.

REQUIRED TEXTS

Fackre, Dorothy and Gabriel. *Christian Basics: A Primer for Pilgrims*. Grand Rapids: Eerdmans, 1991.

Hatton, John and Paul Plouffe, *Science and Its Ways of Knowing*. Upper Saddle River: Prentice Hall, 1997.

Haught, John. *Science and Religion: From Conflict to Conversation*. New York: Paulist Press, 1995.

Hawking, Stephen W. *A Brief History of Time: From the Big Bang to Black Holes*. London: Bantam Press, 1988.

Hazen, Robert and James Trefil. *Science Matters*. New York: Anchor Books, 1990.

The Bible (any edition; translations will be compared in class). Readings on reserve in the Charles von der Ahe Library.

COURSE REQUIREMENTS

Examinations: Midterm: February 23 Final: Week of May 3-7

Reading Application Papers (Group Assignment): The class will be divided into groups of four or five students. Each group must hand in twelve one-page papers related to specific theological readings assigned throughout the semester. Specific guidelines will be given at the beginning of the semester. Each paper is worth a maximum of ten points. This score is assigned to each member of the group.

Class Reflection Papers: At the end of each class, you will be asked to write a brief reflection paper (thirty in total). Each paper is worth a maximum of three points. The four lowest scores (including missing papers) will be dropped.

Final Project: Web Page Design (Group Assignment): Your main project for this course involves the joint preparation of a web page that integrates the questions pursued in the course. Each group will be constructing their web page throughout the semester. The final product is due on the last day of class. Instructions will be given early in the semester.

Attendance/Participation: Participation points will be assigned every class period. If you are absent, you receive 0 points. If present, you receive either 1 or 2 points, depending upon your level of participation. The four lowest participation scores will be dropped.

GRADING The following criteria will be used to determine grades (as applicable to each particular assignment): • accuracy in representing readings and other resources • thoroughness in addressing all aspects of the assignment • clarity and coherence of argument • creativity and resourcefulness • grammar, spelling, and organization The final grade will be composed as follows: Final Examination = 100 pts Midterm Examination = 100 pts Reading Application Papers (12x10pts) = 120 pts Class Reflection Papers (30x3pts; drop four papers) = 78 pts Final Project—Creation of Web Page = 150 pts Participation (30x 2pts; drop four classes) = 52 pts _____ Total Points = 600 pts Points will be converted to letter grades by means of a weighted curve.

ACADEMIC HONESTY A student who is discovered cheating in relation to an examination will receive the grade of F for the test. At the professors' discretion, this student may also be suspended from the course and receive a grade of F for the entire semester. A student who has committed plagiarism in a written assignment (including plagiarism from electronic sources) will receive the grade of F for the assignment.

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COURSE OUTLINE

Jan.12 Introduction Class session includes short video on advances in science up to the time of Galileo (e.g. "The Day the Universe Changed," Program 5: "Science Revisits the Heavens.")

PART I: HISTORY AND METHODOLOGY

Jan. 14 The Galileo Case reading: Galileo, "Dialogue on the Two Chief World Systems" Galileo, "Letter to the Grand Duchess Christina" "The Galileo Affair," Scientific American (August 1982): 132-43 Barbour, Religion and Science, 9-17 recommended: Santillana, The Crime of Galileo Langford, Galileo, Science, and the Church Brooke, Science and Religion, Ch. 3 Drees, Religion, Science, and Naturalism, 55-63 Biagioli, Galileo, Courtier

Jan. 19 From Galileo to Einstein reading: Newton, "Mathematical Principles of Natural Philosophy" (sel.) "Newton's Discovery of Gravity," Scientific American (March 1981): 166-181 Darwin, The Origin of Species, ed. Appleman, 35-131 recommended: Lindberg and Numbers, eds., Beginnings of Western Science

Jan. 21 Methods in Science reading: Hatton and Plouffe, Science and Its Ways of Knowing, 3-6; 11-24; 25-36; 51-57; 67-74; 81-86 Barbour, Religion and Science, 106-10; 115-19; 125-27 recommended: Popper, The Logic Of Scientific Discovery Hempel, Philosophy of Natural Science

Jan. 26 Methods in Theology reading: Haught, Science and Religion, Ch. 2 Barbour, Religion and Science, 110-15; 119-24; 127-36 recommended: Barbour, Religion and Science, Ch. 1 McFague, The Body of God, 136-50 _____, Models of God, 29-45

Jan. 28 Ways of Relating Science and Religion reading: Barbour, Religion and Science, Chs. 4 and 6 recommended: Haught, Science and Religion, Ch. 1 Drees, Religion, Science and Naturalism, Ch. 1 White, History of the Warfare of Science with Theology in Christendom Moore, Post-Darwinian Controversies, Ch. 1

PART II: TOPICS

Feb. 2 The Big Bang Theory: Scientific Aspects reading: Hawking, *A Brief History of Time*, Chs. 1-3 Hazen and Trefil, *Science Matters*, 147-52 Hatton and Plouffe, *Science and Its Ways of Knowing*, 75-80 Kolb, "The Big Bang Origin of the Universe" 55-76 in Matthews and Varghese, *Cosmic Beginnings and Human Ends* From our historical treatment of astronomy in the introduction of the course, we move to the Big Bang theory and its variations as a current scientific account of the beginning of our universe.

Feb. 4 The Big Bang Theory: Theological Reflection reading: Haught, *Science and Religion*, Ch. 5 recommended: Barbour, *Religion and Science*, Ch. 8 Swimme and Berry, *The Universe Story*, Ch. 1 Jastrow, *God and the Astronomers* Peacocke, *Creation and the World of Science* Bultmann, *Jesus Christ and Mythology*, 60-73 Modern cosmology gives new force to some old questions: Was the world created? Was it created from nothing? Does it continue to be created? These questions matter, because creation narratives play a fundamental role in Christian theology (esp. Gen 1-2). We will examine to what extent modern cosmological accounts of the origin of the universe throw light on the matter.

Feb. 9 The Evolution of the Universe: Scientific Aspects reading: Hazen and Trefil, *Science Matters*, 134-46; 153-55; Chs. 4 and 5 Hawking, *A Brief History of Time*, Chs. 3, 4, and 8 Next, we discuss the early development of the universe through the formation of stars, as understood through basic laws of physics. Changes in chemical composition (from H and He to more complex elements) as well as structure (galaxies, supernovas, stars) are explained and illustrated with a variety of audiovisual materials.

Feb. 11 The Evolution of the Universe: Theological Reflection reading: Haught, *Science and Religion*, Ch. 8 recommended: Haught, *Science and Religion*, Ch. 7 Polkinghorne, *Science and Providence* Schindler, ed., *Beyond Mechanism* Murphy and Ellis, *On the Moral Nature of the Universe*, Ch. 9 Swimme and Berry, *The Universe Story*, Chs. 2-4 Monod, *Chance and Necessity* Scientific theories about the evolution of the universe reinvolve another old and perplexing question: Does the universe have a purpose? Christians are likely to ask this question with an eye to the traditional idea of divine providence.

Feb. 16 Chemical Evolution: Scientific Aspects reading: Hazen and Trefil, *Science Matters*, Chs. 13 and 14 Ponnampertuma, "The Origin, Evolution, and Distribution of Life in the Universe," 91-107 in Matthews and Varghese, *Cosmic Beginnings and Human Ends* We subsequently narrow our focus to the formation of planets, including the emergence of life. The scientific account involves brief treatments of plate tectonics, volcanism, climatic regimes (including the role of chaos theory in modeling), and rock cycles. Key topics are the emergence of amino acids and modern reconstructive experiments, as well as the recent controversy over the possibility of life on Mars.

Feb. 18 Chemical Evolution: Theological Reflection reading: Haught, *Science and Religion*, Ch. 6 recommended: Swimme and Berry, *The Universe Story*, 81-100 Barbour, *Religion and Science*, 215 The possible chance occurrence of life on our planet, as well as the possibility of extraterrestrial life, raise the question: Is life on Earth anything special? Christians who are accustomed to think of earthly (and particularly human) life as unique in God's eyes face a challenge. Others find themselves awe-struck by the sheer emergence of life, however and wherever it happened.

Feb. 23 MIDTERM EXAMINATION

Feb. 25 Biological Evolution: Scientific Aspects reading: Ayala, "Darwin's Revolution," 1-17 in Campbell and Schopf, eds., *Creative Evolution Numbers*, "Creationism in 20th Century America," *Science* 218 (Nov.1982): 338-354 From the emergence of life on Earth, we move on to consider its development. Following the Darwinian model of mutation and natural selection, we present a current picture of basic evolutionary history through the existing diversity of species, including the development of homo sapiens sapiens.

Mar. 2-4 SPRING BREAK

Mar. 9 Biological Evolution: Theological Reflection reading: Haught, *Science and Religion*, Ch. 3 Gen 1-9 recommended: Whitcomb and Morris, *The Genesis Flood* Brueggemann, *The Book of Genesis* Theissen, *Biblical Faith: An Evolutionary Response* Gilkey, *Creationism on Trial Since Darwin* published his *Origin of Species*, many Christians have wondered whether evolution rules out God's existence. The question is particularly acute for those who value a literal interpretation of the biblical creation accounts.

Mar. 11 Current Debates on Evolution: Scientific Aspects reading: Barbour, *Religion and Science*, 221-30 Dawkins, *The Blind Watchmaker* (sel.) Gould, *Eight Little Piggies* (sel.) Evolutionary theory continues to develop. We discuss current modifying and rival theories, especially Gould's punctuated equilibrium model vs. Dawkins' neo-Darwinistic approach. In addition, the Gaia hypothesis of coevolution (biota shaping their environment; symbiosis in addition to competition) is briefly introduced.

Mar. 16 Current Debates on Evolution: Theological Reflection reading: John Paul II, "Truth Cannot Contradict Truth" Gould, "Nonoverlapping Magisteria," *Natural History* 3 (1997): 16ff. Joseph, *Gaia: The Growth of an Idea*, Ch. 3 recommended: Swimme and Berry, *The Universe Story*, Chs. 6-8 Ruether, *Gaia and God* Peacocke, *God and the New Biology* Tourney, *God's Own Scientists: Creationists in a Secular World* While some debates are settling down, evolutionary theory also continues to cause new religious upheaval. For example, the Gaia hypothesis has led some to wonder whether the Earth is a living, divine being. The Christian notion of sacramentality as well as Christian suspicion of nature religions come into play here.

Mar. 18 Ecological Principles and Problems: Scientific Aspects reading: Hazen and Trefil, *Science Matters*, Ch. 18 Margulis and Dolan, "Gaia: Cosmic Beginnings, Nonhuman Ends," 187-204 in Matthews and Varghese, *Cosmic Beginnings and Human Ends* From the development of diverse life forms on Earth, we move on to consider the modes and requirements of their co-existence. Central is the concentration and circulation of energy in ecosystems. Students learn about various models of ecosystem development and sustainability, human impact on ecosystems, and conflicting scientific predictions about the effects on ecosystems of such factors as overpopulation, global warming, the thinning of the ozone layer, water pollution, and hazardous waste.

Mar. 23 Ecological Principles and Problems: Theological Reflection reading: Haught, *Science and Religion*, Ch. 9 recommended: White, "The Historical Roots of Our Ecologic Crisis" Dubos, *A God Within* Young, *Healing the Earth*, Ch. 8 Scientific awareness of ecological principles and problems raises the question whether the traditional Christian view of humans at the apex of earthly creation has contributed to the environmental crisis.

Mar. 25 Ecological Sustainability: Scientific Aspects reading: Ruckelshaus, "Toward a Sustainable World," *Scientific American* (Sept. 1989): 166-75 Kates, "Sustaining Life on the Earth," *Scientific American* (Oct. 1994): 114-25 Responding to the environmental crisis, many scientists now include ecological sustainability as a value guiding scientific inquiry. However, definitions of sustainability and concomitant predictions for responsible human activity vary widely.

Mar. 30 Ecological Sustainability: Theological Reflection reading: John Paul II, "The Ecological Crisis: A Common Responsibility" Dodson Gray, "Critique of Dominion Theology" recommended: Rasmussen, *Earth Community/Earth Ethics* Pannenberg, *Toward a Theology of Nature* Berry, *Dream of the Earth* Kaufman, *In the Face of Mystery* The goal of sustainability is also beginning to permeate theological reflection. Many Christians draw a connection between sustainability and the traditional notion of stewardship. Some, however, wonder whether the stewardship model is too hierarchical and pretentious to be helpful.

Apr. 1 Neuroscience and Computer Science: Scientific Aspects reading: Kaku, *Visions*, Chs. 2-5 Hubel, "The Brain," *Scientific American* 241 (Sept. 1979): 241: 45-52 From the interdependence of life forms within ecosystems, we move to the historically significant distinction between life forms on the basis of brain development. Students learn about recent research efforts to map the human brain and to parallel its operations through computer technology. Studies of brain development in certain nonhuman mammals (e.g. chimpanzees, dolphins) are also highlighted.

Apr. 6 Neuroscience and Computer Science: Theological Reflections reading: Haught, Science and Religion, Ch. 4 recommended: Drees, Religion, Science and Naturalism, 173-89 Russell, "Theological Implications of AI" Midgley, Utopias, Dolphins, and Computers Murphy, Portraits of Human Nature McFague, The Body of God Scientific efforts in neuroscience and computer science raise the uneasy question: Is the Human Soul Reducible to Chemistry? If Christian salvation is a matter of the soul, then clearly much is at stake. Moreover, theologians who rather stress the material dimension of salvation also tend to be uncomfortable with complete reductionism.

Apr. 8 Genetic Engineering: Scientific Aspects reading: Hazen and Trefil, Science Matters, Ch. 16 Kaku, Visions, Chs. 7-12 We subsequently proceed to investigate advances in genetic engineering. Topics range from the cloning of plants and animals to medical applications and the Human Genome Project.

Apr. 13 Genetic Engineering: Theological Reflection reading: Cole-Turner, The New Genesis (sel.) _____, Human Cloning (sel.) Fackre, Christian Basics, Ch. 2 recommended: Mooney, Theology and Scientific Knowledge, Ch. 5 Peters, Playing God Keller, A Feeling for the Organism The recent advances and promises of genetic engineering have led many Christians to wonder, Does genetic engineering involve the sin of pride? At the heart of this question is the meaning of human co-creation in relationship with God. This issue, as it turns out, raises serious questions of justice as well.

Apr. 15 Genetics and Human Behavior: Scientific Aspects reading: Steen, DNA and Destiny: Nature and Nurture in Human Behavior (sel.) Hamer, The Science of Desire (sel.) Next we investigate biological research related to the human ability to exhibit and control desires and emotions, especially sexual attraction, altruism, and aggression. Controversies surrounding sociobiology and certain studies in molecular biology (e.g. the "gay gene" discovery,) not only illustrate difficulties of definition, but also the socio-political context of scientific inquiry.

Apr. 20 Genetics and Human Behavior: Theological Reflection reading: Fackre, Christian Basics, Ch. 6 Karl Rahner, Theological Investigations, 179-96 John J. McNeill, "Homosexuality: Challenging the Church to Grow" recommended: Midgley, The Ethical Primate Barbour, Religion and Science, 255-58 Wilson, Sociobiology Dawkins, The Selfish Gene Peacocke, God and the New Biology Farley, Good and Evil, Ch. 4 Do genes limit human freedom? This basic question arises in the context of growing scientific understanding of human genetic predispositions. Whichever way we answer the question, Christian ethics will forever be changed by these new insights. What is more, Christians are challenged to reflect on the very meaning of faith as a basic commitment.

Apr. 22 The Future of the Universe: Scientific Aspects reading: Hawking, A Brief History of Time, Ch. 9 Kaku, Visions, Ch. 16 Finally, we explore scientific predictions for the future of our solar system, which includes the long-range future of the Earth.

Apr. 27 The Future of the Universe: Theological Reflection reading: Fackre, Christian Basics, Ch. 7 Barbour, Religion and Science, 216-20 McFague, The Body of God, 198-202 recommended: Santmire, "The Future of the Cosmos and the Renewal of the Church's Life with Nature" Russell, "Cosmology and Eschatology: New Reasons for Hope?" Lovelock, "Gaia: A Model for Planetary and Cellular Dynamics," 94-97 Dyson, Infinite in All Directions Tipler, The Physics of Immortality Swimme and Berry, The Universe Story, Ch. 13 By all scientific accounts, our universe will in the long run cease to be hospitable to complex life forms. How do these predictions square with Christian eschatology? Some find confirmation of traditional beliefs about the end of the world, while others are challenged to rethink the Christian message of hope.

Apr. 29 Course Integration reading: Fackre, Christian Basics, Ch. 4 Polkinghorne, The Faith of a Physicist (sel.) McFague, The Body of God, Ch. 6 recommended: Torrance, Space, Time, and Incarnation Theissen, Biblical Faith, Pts. 3-4 Rahner, "Christology within an Evolutionary View of the World" (TI5) Rather than do a quick rehash of the course, we will seek to use and thereby to integrate what has been learned by tackling a rather central question: Can scientists believe in Jesus Christ?

May 3-7 FINAL EXAMINATION