ROY E. MOON DISTINGUISHED LECTURESHIP IN SCIENCE 1977-2001

Silver Moon

ANGELO STATE UNIVERSITY AND
WEST TEXAS MEDICAL ASSOCIATES
CELEBRATE

25

YEARS OF BRINGING THE
WORLD'S TOP SCIENTISTS TO
ANGELO STATE UNIVERSITY

Angelo State University and the Roy E. Moon Distinguished Lectureship in Science

Over the last quarter century, the Roy E. Moon Distinguished Lectureship in Science has brought to Angelo State University and West Texas some of the greatest scientific minds of our time. These scholars have literally changed our lives through the application of their discoveries in medicine, chemistry, genetics, biology and other fields. The lecturers have included 11 Nobel laureates, one of whom received two Nobel prizes, an accomplishment matched by only one other scientist in history.

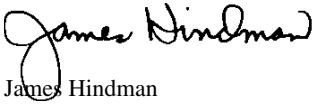
This publication not only celebrates the Moon Distinguished Lectureship and the numerous contributions the annual lectureship has made to the intellectual curiosity of our students and faculty as well as the general public, but also serves as an acknowledgement to those who have made the lectureship possible.

First and foremost, we thank the family of Roy E. Moon, M.D. He was a beloved San Angelo physician who was truly dedicated to the science of medicine and to his many patients. Dr. Moon firmly believed in educating the public about science and medicine. Consequently, the Moon Lecturer each year presents two addresses, one to students and faculty and a second for the benefit of the general public. Both lectures are important in fulfilling Dr. Moon's vision of educating the next generation of scientists and of creating a more scientifically literate public.

Secondly, we thank Dr. Moon's medical colleagues for sharing his philosophy of educating all citizens about science and for deciding to honor his memory with the annual Roy E. Moon Distinguished Lectureship in Science at Angelo State University. The ongoing support of those colleagues from West Texas Medical Associates has for 25 years provided an educational opportunity few universities of our size can match.

So, we extend our thanks to the Moon family and to West Texas Medical Associates for providing this opportunity to our community. Further we thank the public for participating in the lectureship each year.

We look forward to the opportunities that the Roy E. Moon Distinguished Lectureship in Science will present in the future for the University and for the community.



James Hindman
President
Angelo State University

Selection Committee

1977 Originators and sponsors of Lecture Program: Dr. Ralph Chase, Dr. W. Dan Cravy, Dr. O. Sterling Gillis III, Dr. Warren J. Hartmann and Dr. Jane Rider, all associated with Clinic Hospital Medical Associates, forerunner of West Texas Medical Associates.

1977 Original Selection Committee: Dr. Bernard T. Young, Chair; Dr. Joy Moon; Dr. Edgar N. Drake II; Dr. Warren J. Hartmann; and Dr. Gordon E. Welch. The Selection Committee was to be split evenly between the physicians of West Texas Medical Associates and the professors at Angelo State University.

1980 Selection Committee membership expands to six with addition of Dr. John S. Ballard III. Lecture sponsorship expanded to include entire membership of West Texas Medical Associates.

1981 Dr. Gordon E. Welch elected chair, a position he held until his 1996 retirement.

1983 Selection Committee membership expands. Members are Dr. Gordon E. Welch, Chair; Dr. Edgar N. Drake II; Dr. John T. Granaghan Jr.; Dr. Warren J. Hartmann; Dr. Joy Moon; Dr. C. Varren Parker Jr.; Dr. Fazlur Rahman; Dr. James B. Wolcott; and Dr. Bernard T. Young.

1984 Dr. Ralph Chase succeeds Dr. Warren J. Hartmann.

1986 Dr. James Neill succeeds Dr. James B. Wolcott.

1988 Dr. Patrick E. Gibson succeeds Dr. James Neill.

1992 Dr. Charles V. Bennett Jr. succeeds Dr. Ralph Chase.

1995 Dr. Jane Rider succeeds Dr. Charles V. Bennett Jr.

1996 Dr. David H. Loyd Jr. succeeds Dr. Bernard Young.

1997 Dr. Gordon E. Welch retired and was succeeded as chair by Dr. David H. Loyd Jr. and replaced on the committee by Dr. Crosby W. Jones Jr.

2000 Dr. George E. Shankle succeeds Dr. Edgar N. Drake II.

2001 Selection Committee members: Dr. David H. Loyd Jr., Chair; Dr. Patrick E. Gibson; Dr. John T. Granaghan Jr; Dr. Crosby W. Jones Jr.; Dr. C. Varren Parker Jr.; Dr. Fazlur Rahman; Dr. Jane Rider; and Dr. George E. Shankle.

Roy E. Moon Distinguished Lecturers

1977	Humberto Fernandez-Moran, M.D., Ph.D.	Biophysics
1978	Linus Pauling, Ph.D. (Nobel Laureate)	Chemistry
1979	George W. Beadle, Ph.D. (Nobel Laureate)	Biology
	W. O. Milligan, Ph. D.	Chemistry
1980	Frederick Chapman Robbins, M.D. (Nobel Laureate)	Medicine
1981	D. Carleton Gajdusek, M.D. (Nobel Laureate)	Medicine
1982	Kip S. Thorne, Ph.D.	Astrophysics
1983	Tanya M. Atwater, Ph.D.	Marine Geophysics
1984	Har Gobind Khorana, Ph.D (Nobel Laureate)	Biology & Chemistry
1985	Arthur Guyton, M.D.	Medicine
1986	Donald C. Johanson, Ph.D.	Paleoanthropology
1987	Hans Mark, Ph.D.	Physics
1988	Michael S. Brown, M.D. (Nobel Laureate)	Medicine
1989	Cyril Ponnamperuma, Ph.D.	Chemistry
1990	Leon Richard Kass, Ph.D.	Biomedical Ethics
1991	Lynn Margulis, Ph.D.	Biology
1992	Chen Ning Yang, Ph.D. (Nobel Laureate)	Physics
1993	Donald C. Johanson, Ph.D.	Paleoanthropology
1994	C. Thomas Caskey, M.D.	Molecular Genetics
1995	Eugene M. Shoemaker, Ph.D.	Astrogeology
1996	Alfred G. Gilman, M.D. (Nobel Laureate)	Medicine
1997	Thomas R. Cech, Ph.D. (Nobel Laureate)	Biochemistry
1998	Sylvia A. Earle, Ph.D.	Oceanography
1999	Keith L. Black, M.D.	Medicine
2000	F. Sherwood Rowland, Ph.D. (Nobel Laureate)	Chemistry
2001	Ferid Murad, M.D. (Nobel Laureate)	Medicine

Lecture One 1977

Dr. Humberto Fernandez-Moran, the A. N. Pritzker Professor of Biophysics at the University of Chicago, served as the inaugural Roy E. Moon Distinguished Lecturer on April 4, 1977. He spoke on "The World of Inner Space and the Future of Medicine."

Illustrated with slides and film, his lecture demonstrated that man is the bridge between microscopic atomic particles and the colossal dimensions of the stars and the galaxies.

Dr. Fernandez-Moran is credited with inventing two important scientific devices: the diamond knife and the cryogenic electron microscope. He described the use of those devices in the basic physics discoveries that led to the invention of the transistor as well as the scientific breakthroughs that led to a description of how DNA and RNA are assembled in viruses.

At the end of the program he presented to Dr. Joy Moon, widow of Dr. Roy Moon, the only existing high resolution electron micrograph of circular DNA magnified 15 million times.

Dr. Fernandez-Moran's visit also started a tradition of the University hosting a barbecue at the Lakehouse so students would have the opportunity to visit informally with each visiting scientist.

Lecture Two 1978

Dr. Linus G. Pauling, one of only two persons ever to receive two Nobel awards, delivered the second Roy E. Moon Distinguished Lecture. One of his most distinguished contributions to science was his study of protein conformation, paving the way for Watson and Crick's subsequent description of the structure of DNA.

Pauling, Research Professor at the Linus Pauling Institute of Science and Medicine, told how in 1929 he first became interested in the chemistry associated with biological specificity and how his curiosity led him to describe the features of the deformed red blood cells characteristic of sickle-cell anemia.

His subsequent research and pioneering work in determining the cause of sickle-cell anemia resulted in him being named the first recipient of the Dr. Martin Luther King Jr. Medical Achievement Award.

Dr. Pauling also delivered a public address on "Vitamin C and Cancer." He presented a series of slides indicating statistical evidence for the efficacy of vitamin C in treating cancer. At that time he was very optimistic about the possibility of the expanded use of vitamin C in the fight against cancer. He described his proposed study aimed at examining the role of vitamin C in several cancers. The American Cancer Institute had approved the study, and he was hopeful the results would be positive. In the years that have passed since that lecture, Dr. Pauling's hope for vitamin C as a cure for cancer has not been realized.

Lecture Three 1979

George W. Beadle, President Emeritus of the University of Chicago, and W. O. Milligan, Director of Research for the Robert A. Welch Foundation, were the featured speakers in the only instance in which the Lectureship has been filled by two people.

Dr. Beadle addressed the "Evolution of Cultivated Food Plants" and "Biochemistry of Inheritance." He emphasized the potential benefits of understanding how to manipulate the DNA of humans and recognized the possible negative results and their serious consequences for society. He indicated it was the responsibility of those scientists involved in the research to recognize the potential for harmful results, even when they are pursuing beneficial results.

Dr. Milligan lectured on "The Structure of the Rare-Earth Hydroxides" and "Basic Research and Modern Society." In his public lecture, Dr. Milligan emphasized that the discoveries of science will be needed to solve the future problems of society. He described the ways in which the problems facing Earth - population, food, transportation, and energy - are all related.

He predicted that societies would use the available energy resources in the order of their ease of use. He suggested that we would first deplete petroleum, then coal and finally uranium resources before we turned to solar energy. Dr. Milligan was optimistic about the way science will be used to solve the problems of society. He indicated we were just beginning the scientific age and would improve our utilization of science as we gain experience.

Lecture Four 1980

The fourth Moon Lecturer was Dr. Frederick Chapman Robbins, Dean of the School of Medicine at Case Western Reserve University and recipient of the 1954 Nobel Prize in Physiology or Medicine for isolating the poliomyelitis virus.

Dr. Robbins revealed that his research had not originally been aimed at polio, but rather at a virus suspected of causing infant diarrhea. That research used tissue from the intestinal tract, the same area under study by polio researchers. On a lark, he said his team attempted to grow the polio virus in some of their intestinal cultures. When the virus successfully grew, they shifted their research emphasis to polio. Their discovery in isolating and growing the polio virus in human tissue is considered the breakthrough that later allowed Dr. Jonas Salk to develop a polio vaccine.

The subject of his talk resonated with many in the audience due to their personal experience with San Angelo's own polio epidemic in the late 1940s and early 1950s. The first case of polio in San Angelo was in 1947, with 50 cases in 1948, 420 cases in 1949, culminating in more than 1,400 cases by 1956. The audience's vivid memory of those events was demonstrated through gasps from the audience as Robbins showed slides of polio victims in iron lungs and

other examples of those who previously had suffered from the terrible disease.

Although the virtual elimination of polio in this country is considered one of the great success stories of modern medical science, Dr. Robbins pointed out that the polio virus still flourished in much of the world, even in 1980. He said those who have experienced the disease must teach students, families and friends who have never seen evidence of polio why a vigilant program of vaccination must be continued.

When asked if receiving the Nobel Prize was the greatest day in his life, Dr. Robbins showed his personal side and replied that the day he got married was indeed the greatest day of his life.

Lecture Five 1981

Dr. D. Carleton Gajdusek, Director of the Study of Child Growth and Development and Disease Patterns in Primitive Cultures at the National Institutes of Health, was the fifth Roy E. Moon Distinguished Lecturer in Science. He shared the 1976 Nobel Prize for Physiology or Medicine for discoveries concerning the origin and dissemination of infectious diseases. The award was the culmination of two decades of research in New Guinea on the cause of the disease kuru.

He described how he traced the cause of the disease to a slow virus that was transmitted among the natives of New Guinea by their practice of ritual cannibalism. By custom the surviving members of a family ate the brains of their dead relatives. He showed photographs that he stated were the first pictorial evidence of human cannibalism ever recorded. Dr. Gajdusek explained that in addition to giving a solution to the cause of kuru he hoped that his work on this specific slow virus might provide insights that would help research on multiple sclerosis and Parkinson disease. Today Dr. Gajdusek's contributions to the study of kuru have been especially useful in understanding the outbreak of "mad cow disease" in Europe.

At the annual barbecue for students to meet the speaker before the lecture, Dr. Gajdusek spoke in a very personal way about his experiences as a student and addressed the life circumstances and choices that influenced his career and helped him arrive at where he was. His remarks so captivated the students that subsequent Moon Lecturers were invited to talk on the critical moments that influenced their careers. This precedent was also followed by other lecture series later established on campus.

Lecture Six 1982

In the sixth lecture Dr. Kip S. Thorne, Professor of Theoretical Physics at the California Institute of Technology, provided a fascinating description of the search for black holes to a crowd of more than 500.

Dr. Thorne described the three ways in which stars "die" after expending the nuclear fuel at their cores. He pointed out that smaller stars collapse into white dwarf stars, and that this will be the fate of Earth's sun in about five billion years. Medium-sized stars collapse inward with such force that they explode as supernovae. Finally, the largest stars - those 10-100 times more massive than Earth's sun - collapse with such gravitational force into a small volume of such high density that not even light can escape the resulting gravitational pull. The fact that light cannot escape and the super-density of these objects leads to the name black hole.

Thorne pointed out that while no actual black holes had been confirmed as of 1982, theoretical evidence for them dates to as early as 1939. He stated that he was 80 percent certain that black holes existed but reserved the 20 percent to "hedge my bets because we (scientists) have been wrong before."

He went on to describe how advanced x-ray and radio telescopes had provided the ability to experimentally investigate the theory of black holes. He added that the discovery in the early 1960s of other strange phenomena such as pulsars and quasars had caused scientists to take a more serious look at the possibility of the existence of black holes. Dr. Thorne said that many now believe that the x-ray star Cygnus X-1 is a black hole, and that there is some evidence that there may exist a black hole at the center of our own galaxy, the Milky Way.

In 2001 we find that Thorne's ideas about black holes have proven to be correct. In addition to a massive black hole in the center of our own galaxy, the Hubble Space Telescope has provided irrefutable evidence of super massive black holes in numerous other galaxies. These monstrous objects appear to be the rule rather than the exception. And now, X-ray telescopes orbiting above Earth's atmosphere have detected the telltale signs of a hot accretion disk at the site of Cygnus X-1. Such an object is predicted by black hole theory. Although somewhat cautiously given in 1982, Dr. Thorne's predictions have proven to be very accurate.

Lecture Seven **1983**

In April of 1983 Dr. Tanya M. Atwater, Professor of Marine Geophysics at the University of California at Santa Barbara, became the first woman scientist in the lecture series. Her lectures covered complex theories involving shifting continents, plate tectonics, and descriptions of unique life forms that thrive in an environment rife with contrast.

With computer graphics on film, she explained how the Earth's continents were joined in one large land mass nearly 500 million years ago. The Earth's singular land mass then drifted apart to form the continents that are seen today on current maps of the Earth. Dr. Atwater said that earthquakes and volcanoes throughout the world are the results of plate tectonics, large masses of the Earth's crust moving in different directions at rates of 2-5 inches per year. "That's really whizzing along for geologic processes," she added.

One famous example is the San Andreas Fault in California where one plate is sinking into the Earth's mantle beneath another plate. Contrary to the popular belief that the Golden State is going to fall into the Pacific Ocean, Atwater said that a better description might be that Los Angeles is going to become a suburb of San Francisco.

Using slides and a short movie, Dr. Atwater told of her underseas voyages in "Alvin," a modified submarine-bathysphere, to inspect firsthand the large volcanic super-hot, deep-sea hydrothermal vents that dot the ocean floor near the Galapagos Islands and in the Gulf of California. She showed slides of beautiful "tripod" fish, bright orange spiral corals, and clumps of tubeworms that thrive in extremes of temperature that range from ice-cold to 650-degrees Fahrenheit.

Dr. Atwater's discovery of the tubeworms was revolutionary because they represented a different metabolic cycle than had previously been identified. The tubeworms were so unique that National Geographic featured the discovery in an article.

Lecture Eight **1984**

In the eighth science lecture, Dr. Har Gobind Khorana, the 1968 recipient of the Nobel Prize in Physiology or Medicine, focused on the need for society to decide whether genetic engineering would be used as a tool to help mankind or proliferate misery.

Dr. Khorana of the Massachusetts Institute of Technology received the Nobel Prize for discoveries concerning the interpretation of the genetic code and its function in protein synthesis. His work provided independent and convincing proof of genetic code assignments.

Although genetic engineering had received special scrutiny for its possible misuse, he pointed out that almost any science, in fact, had the potential to be used for good or evil. When asked whether or not he foresaw military applications of genetic engineering, he mentioned two possibilities: 1) the creation of specific deadly diseases and 2) the creation by gene manipulation of very aggressive people to serve as soldiers. He cautioned, however, that using gene modification to alter behavior, if possible at all, would be a long way in the future because behavior genes had not yet been identified.

He spoke optimistically about controlling genes for the benefit of mankind. "We are getting basic insight into cancer problems and how to fight against them," he said. "It might be a long time before we can actually use it. The whole field has yet to do a lot of basic research."

Specifically, he spoke of how the knowledge of genetic makeup could enable scientists to eliminate diseases like sickle cell anemia. He stated this is likely to be accomplished after we learn how to take out the bad portion of a gene and replace it with a good one. Khorana said eventually doctors might be able to examine amniotic fluid in the womb to spot and treat potential birth defects and

immune deficiencies. Dr. Khorana said that pharmaceutical firms were already experimenting with applying genetic information in the production of some of their products. He also indicated that genetic engineering has been successfully used to create more hardy and prolific agricultural products.

Today, genetic engineering has borne out many of Dr. Khorana's predictions. For example, diabetics now routinely take insulin produced through genetic engineering. Likewise, the genetic manipulation of plants used as food for humans has recently come under attack.

Lecture Nine 1985

Dr. Arthur Guyton, Chairman of the Department of Physiology and Biophysics at the University of Mississippi School of Medicine, served as the ninth Moon Lecturer and spoke on how research into the circulatory system had furthered progress toward developing an artificial heart.

As an aspiring young surgical resident in 1946, Dr. Guyton was stricken with polio. Following his recovery, he was confined to a wheelchair and he turned his attention from the operating room to the classroom and research laboratory.

Guyton said many early experiments concerning the heart did not work because the heart pumps the blood that flows to it, rather than controlling the output of blood to the body. Body tissues themselves control the flow of blood by expanding or restricting blood vessels as blood is needed.

"The heart acts like a servant to the system," Guyton said. "It is the last to know what it will pump and how much."

Until that concept was understood, progress in fully understanding cardiovascular disease and in attempting to develop an artificial heart was limited.

As far as addressing and preventing heart disease, he said giving up smoking and following a good diet were the two most important factors.

"If we could get rid of smoking and implement dietetics, we would do as much good for mankind as we will do in the next 100 years of research," he said.

During his distinguished career, Guyton published more than 25 medical textbooks and more than 500 articles. He trained some of the nation's foremost physicians, including eight of his ten children, who earned medical degrees.

With his natural interest in mechanics, he developed a special leg brace and a hoist for moving patients from bed or chair to bathtub. He also created a version of the still widely used motorized wheelchair. It was for these accomplishments that he received a Presidential Citation.

Lecture Ten 1986

Dr. Donald C. Johanson spoke to a capacity crowd of some 800 people on his controversial 1974 discovery of "Lucy," the 3.5-million-year-old hominid skeleton at the Hadar site in Africa's Great Rift Valley. That find forced scien-

tists to re-examine their theories on man's ancestry in the Afar Triangle region of Ethiopia.

He said he named the skeleton while working on it one day as he was listening to the Beatle's song "Lucy in the Sky with Diamonds" because he and his associates quickly tired of calling it the Australopithecus afarensis skeleton.

Johanson said that the partially complete skeleton and parts of 13 other fossil skeletons found at the same site are now accepted as a primitive ancestor to both Homo sapiens and the Australopithecines, a parallel line of manlike hominids that became extinct a million years ago.

Lucy and the First Family, as the other skeletons of the species became known, were 3 1/2 feet tall, bipedal, small-brained hominids able to live in varying climates. However, no tools were found in association with them. Dr. Johanson speculated that Lucy might have been gathering crocodile eggs when she was killed. A crocodile could have killed her since there is a tooth puncture mark on one of her bones.

These discoveries stirred debate because they indicated that man became bipedal before developing a large-size brain and tool-making capability. Scientists previously believed the opposite. Johanson discussed how a scientist's biases could play a part in the interpretation of scientific discoveries. In particular, he explained how his findings have placed him in opposition to the famous Leakey family, which discovered Homo habilis, an early ancestor to man that lived about 2.5 million years ago in East Africa. They support the view that Lucy and the Australopithecus genus are not ancestors to the Homo genus but a completely separate development.

Lecture Eleven **1987**

Dr. Hans Mark, Chancellor of the University of Texas System and former Deputy Administrator of the National Aeronautics and Space Administration, was the 11th lecturer. In speaking on "The Search for Extraterrestrial Life," he said the fundamental question is whether life is fairly common in the universe or whether the life process occurred only once and only on Earth.

Dr. Mark described the evolutionary process leading to life on Earth to include three distinct stages: 1) chemical evolution, 2) biological evolution and 3) the evolution of intelligence or communication. A time scale that outlines these three evolutionary periods was the most important result of man's trips to the moon, he said. This time scale was produced by radioactive analysis of moon rocks, which revealed an age of five billion years for Earth and the solar system.

The chemical evolution, which began early in the development of Earth's solar system, is defined as the creation of easily replicated amino acids, the basic building blocks of living organisms. Amino acids have been detected in the oldest rocks found on Earth and in meteorites as well, he explained. As an example, he said the Murchison meteorite which landed in Australia in 1972 was found to

contain 35 different species of amino acids, thus confirming that the beginnings of the life processes can also occur in our solar system.

Chemical evolution melds into biological evolution, the process where amino acids form larger, more complex molecules that can replicate themselves and create living organisms, Dr. Mark said. The oldest analyzed Earth rocks show evidence of biological evolution dating back three billion years, he said, but the start of the biological evolution process could not be pinpointed more precisely than that.

The last step in the evolutionary process is intelligence or communicative evolution, encompassing the ability to communicate to the young what previous generations have done, thus building up a body of knowledge transmitted through learning. It is this development that would allow life that might exist elsewhere in the universe to contact us or to understand our attempts to contact them.

"I truly believe that before the end of the century, we will find a signal that says yes, there is somebody out there," Dr. Mark said.

From the vantage point of the year 2001, it appears that this prediction did not come to pass, at least in the time frame that Dr. Mark suggested.

Lecture Twelve **1988**

Dr. Michael S. Brown, a Nobel recipient and the Paul J. Thomas Professor of Medicine and Genetics and Director of the Center for Genetic Disease, Southwestern Medical School at Dallas, was the 12th distinguished lecturer. Brown shared the 1985 Nobel Prize in Physiology or Medicine with colleague Joseph Goldstein for their discovery of cholesterol receptors, cell structures that pull cholesterol-carrying proteins from the blood.

The pair's work led to important discoveries by other scientists of differing kinds of receptors that carried varied substances into cells. "We had no notion when we started that cells could actually reach out and take chemicals in this way," Brown said. "Once we realized this was possible, other scientists made other discoveries."

Dr. Brown described the interest that he and Goldstein had in the genetic sensitivity to high-cholesterol diets because it appears that some people are extremely sensitive to cholesterol in diet while others are resistant. The Pima Indians in Arizona eat a high-fat and high-cholesterol diet, and suffer from obesity, factors that led physicians to predict a high incidence of heart disease among them, Brown said. The U.S. government opened a coronary care unit in a hospital for the Pima Indians and expected to have hundreds of patients. Instead they had to close the unit for lack of activity, said Dr. Brown. Researchers found the Pimas have low cholesterol levels and low incidence of heart attacks.

"Somehow, the Pimas have very active genes that produce a high level of receptors," Brown said. "There's a chemical switch that turns the genes on. The Pimas have a lot of switches. Although it seems clear that this results from genetic

effects, it is complicated by the fact that even if people share the same parents, they don't share the same exact genes."

"It's like a bowl of jellybeans, where you pick five different kinds out of the bowl and your brother picks another five," Brown said.

Scientists now know genetic defects are responsible for defects in receptors for insulin and cholesterol-carrying, low-density proteins, he said. The AIDS virus gets into cells by attaching itself to receptors. "The whole concept has been very important for genetics," he said. Understanding the concept has led to modern cholesterol-controlling drugs.

Dr. Brown explained that the goal of his research was to understand the genetic structure to see if it might be possible to tell people how to change their specific lifestyles, based on their predispositions toward certain diseases. "There seems to be a gradient for every disease," he said. "Sunburn is genetic. People from Ireland sunburn easily because of a lack of pigmentation. Those from the Mediterranean don't sunburn as easily."

Lecture Thirteen **1989**

Dr. Cyril Ponnamperuma, Director of the Laboratory of Chemical Evolution and Professor of Chemistry at the University of Maryland, delivered the 13th lecture titled "Life in the Universe." Dr. Ponnamperuma explained that with more than 200 billion stars in the universe, life ought to be a common occurrence.

Planets could orbit many of these stars, much like Earth orbits the sun, and some of the planets could harbor life. "Maybe 50 percent of all stars in the universe could support life," Ponnamperuma said. "The discovery of extraterrestrial life would be the most monumental event in human history."

Using an arbitrary formula, some scientists have calculated intelligent life may exist on a million planets in the Milky Way. "The distance between these extraterrestrial civilizations might be as large as 1,000 light years," Ponnamperuma said. Scientists have been trying to prove that theory by sending unmanned spacecraft to other planets and by attempting to make radio contact with other heavenly bodies.

Astronauts have not discovered organic matter, which provides the basis for life, on the moon, because of its lack of an atmosphere, he said. Mars has long been the focus of speculation about extraterrestrial life because its canals seemed to indicate the presence of intelligent beings, Ponnamperuma said. He explained, however, that they had been formed by water from the molten polar ice caps. Although the Viking space probes that visited the planet in the 1970s found no proof of life on Mars, Ponnamperuma emphasized the possibility of life on Mars still exists, and the polar caps are, to him, a likely spot to find it. Infrared analyses of Jupiter and Saturn, two giant gaseous planets, even show the possibility of "a sea of organic matter," Ponnamperuma said, though evidence of life has yet to be found.

Listening to radio signals in the hope of receiving messages from extraterrestrial intelligence is another technique used to seek proof of its existence. Initial attempts at sending messages have been abandoned in favor of "eavesdropping," Ponnamperuma added. He compared the likelihood of finding other life by this method to the probability of meeting a friend in New York City without arranging a meeting place. Since we would look at familiar places like Grand Central Station or Times Square first, Ponnamperuma advised to search for "a Grand Central Station of space."

Therefore, radiation frequencies emitted by hydrogen gas have been searched, as that is the most abundant element in the universe. But the giant ears have been basically silent so far, and the two times they did pick up what were thought to be signals, they turned out to be coming from Earth itself.

Lecture Fourteen 1990

Dr. Leon Richard Kass, Professor in the College and the Committee on Social Thought at the University of Chicago, spoke on medical ethics during the 14th lecture. Physicians should never receive a license to kill, even in the case of patients suffering from a painful terminal illness, he told his audience.

Those who advocate "mercy killings" by physicians argue that each person has the right to control his or her own life, and that right to choose is more important than life itself, Kass said. He believed, though, that the choice could easily be manipulated, and sometimes it is really someone else, rather than the patient, choosing whether he or she should die.

"In this view doctors are seen as highly competent hired syringes who sell their services to the patient," said Kass. Under the "hired-syringe" rationale, "if a patient wants to have their nose fixed, change their sex, select the sex of their baby, or take euphoric drugs for kicks, the physician supplies it," Dr. Kass said.

Others argue that doctors should take the lives of their patients because of the physicians' great compassion for suffering individuals, a viewpoint with which Kass also disagrees. Patients may want to die when they are faced with the fear of little time to live and untreatable pain. However, Kass said much of the pain is treatable, though doctors sometimes simply do not diagnose the correct type or amount of pain medication needed for relief. If professional medicine did its job better, the fear would be lessened, he said.

Kass suggested that physicians needed to re-examine the purpose of medicine - to assist in healing and in the creation of the wholeness of the body and mind of the patient, not the patient's relatives. Kass stated that while he opposes the direct, intentional killing of patients by physicians, he is not opposed to cessation of life support systems. He could support the withholding of intravenous injections comparable to food and water in some cases. In the case of a premature child who would not prosper, Kass said he would support providing water and

nursing and nothing more. "But that's easy for an outsider to say, and hard for a physician and patients to do," he said.

Physicians and other medical professionals face a greater ethical crisis in the daily routine of their jobs than in the headline-making dilemmas posed by advanced technology, Kass said. "Far more important are the ordinary, humdrum, ethical matters of daily practice, of whether someone listens to the patient, of whether someone takes the trouble to find out what's worrying them," he said. Doctor-patient relationships have suffered with increased medical specialization and attention to medical technique, Kass said.

Lecture Fifteen 1991

Dr. Lynn Margulis, Distinguished University Professor of Botany at the University of Massachusetts, delivered the 15th Moon Lecture on "Gaia: The Living Earth from Space."

"Gaia is the sum of all living organisms embedded in the biosphere," she said. The biosphere is a 25-kilometer thick shell of ocean, land and atmosphere on Earth's surface. Gaia is the interaction of living organisms, from the largest tree to the smallest microbe, with carbon dioxide, oxygen, nitrogen, metals and other ions, she said. This interaction modulates Earth's temperature, acidity and atmospheric composition.

Margulis said it was bacteria that two to three million years ago made Earth different from its sister planets, Mars and Venus. Bacteria changed the composition of the atmosphere, using carbon dioxide and releasing oxygen, she said. "The surface of the Earth that just looks like dirt is actually a live surface," she said. "It is a tissue surface where all the life is producing and removing gasses."

Living organisms thus produce an environment favorable for their ability to adapt rather than adapting and evolving within a passive environment already in place. "All organisms change their immediate surroundings and tend to grow and change those surroundings unfit for themselves and unfit for the organism upon which there is selection pressure. Now, we're putting enormous selection pressure on the plastic-eating organisms and we're putting selection pressure on mobile carbon dioxide-using organisms."

In her explanation of the Gaian theory, Margulis said evidence of how Gaia builds and changes the Earth could be found everywhere. She showed the audience photographic slides of an egg-shaped mountain off the coast of Chile. What appeared to be a dark, barren rock islet turned out to be a mountain of nesting birds. "That's not the kind of mountain you will find on either Mars or Venus," she said. "It is produced by these organisms. There is upwelling of phosphorous-rich water, which supports the growth of algae and plankton, which supports the growth of small fish, and then larger fish. And these guano birds eat the larger fish, and they go year after year nesting on that off-shore island until we have a mountain-sized object which people mine for the phosphorous."

The 16th Moon Lecturer, Dr. Chen Ning Yang, shared the 1957 Nobel Prize in Physics with his colleague and classmate Tsugn Dao Lee for the discovery of non-conservation of parity in weak nuclear interactions.

Dr. Yang, Director of the Theoretical Physics Department at State University of New York at Stony Brook, said the ancient Greek's obsession with geometry and symmetry set the development of astronomy back about 1,500 years. During his lecture on "Symmetry and Physics," he said that same emphasis on symmetry and geometrical solids formed the basis of Kepler's laws of planetary motion and Newtonian physics. Theoretical particle physicists, he said, still use the same deductive pattern Kepler used in the 16th and 17th centuries to match the findings of their experiments with predictive mathematics in an attempt to develop rules governing the nature of the universe.

"We generally fail, but once in a while someone comes up with an idea that fits perfectly, and we make a small step forward," he said. "At other times the discovery results in a giant leap in scientific knowledge."

"If poetry is the condensation of thought, then fundamental physics is the poetry of nature," Yang said. "And physicists are trying to write down the rules of how nature is governed in the most condensed form."

The idea of symmetry recalls William Blake's poetry, Yang said: "To see a world in a grain of sand and a heaven in a wildflower, to hold infinity in the palm of your hand and eternity in an hour."

"You can write down these equations on a small sheet of paper, yet they describe the entire universe," he said. He cited Kepler's discovery of tiling, or infinite repetition of patterns, as the seed idea that later led to the understanding of crystal symmetry and the concept of groups in 19th- and 20th-century physics. Kepler's concept of tiling has its practical applications as well, Yang said, noting, "You will find that your bathroom floor has one of the 17 symmetrical groups displayed and discovered by mathematicians."

Those earlier concepts of symmetry in physics in turn led to the discovery of quantum mechanics in 1925. Later physicists have found that symmetry dictates interactions from the physical structure of macromolecules to the paths of electrons and subatomic particles to the arrangement of elements in the periodic table. Francis Crick and James D. Watson, who described the chemical structure of DNA, even found symmetry played a role in their discoveries. Even Albert Einstein's discovery of the theories of relativity involved symmetry, Yang said. However, Einstein reversed James Maxwell's basic order of scientific deduction, examining the symmetry in nature and developing theories and equations first and experiments last, to devise the theory of general relativity.

Dr. Donald C. Johanson as the 17th Moon Lecturer became the only scholar ever invited back to participate in the program. Johanson, President of the Institute of Human Origins, also served as the tenth lecturer in the series in 1986.

In his encore lectures he again concentrated on his 1974 finding of a hominid skeleton called "Lucy" in the Hadar region of Ethiopia. In his earlier talks, Lucy was described as being 3.5 million years old. In the 1993 talk, he identified her as 3.2 million years old, demonstrating the nature of how science refines its estimates of any measured quantity with additional data.

It was Lucy's ability to walk on two feet that "launched an evolutionary journey far different from all other animals," Johanson said before a crowd of some 700 people. Lucy answered a long-standing evolutionary question about whether humans developed large brains or upright posture first. Lucy was significant because she possessed a mixture of advanced and primitive characteristics, Johanson said.

"She was peculiar because she had very long arms compared to her lower limbs. She was only about 3 1/2 feet tall. She was a full adult because her wisdom teeth were erupted. We didn't have much of her skull preserved, but enough to tell us her brain was about one-fourth the size of our brains today," Johanson said.

Johanson's belief that Lucy, scientifically known as Australopithecus afarensis, represented the earliest human ancestor was met by resistance by the famous Leakey family, which discovered Homo habilis, another early ancestor to man who lived about 2.5 million years ago.

"When I was here the last time, Richard and Mary Leakey held very firmly to this view of two parallel lines of evolution - that Australopithecus was never in our ancestry but always a side branch. I'm happy to say that in his new book, Origins Reconsidered, he has abandoned this earlier contentious view which had thrown the two of us into an argument about the shape and geometry of the human family tree and has pretty much accepted the view that I promulgated with my close colleague Tim White in 1979."

After Lucy, Homo habilis marked the first expansion of the brain and the beginning of the manufacture of stone tools, Johanson said. The ever-changing nature of evolutionary theory is sure to produce new conclusions as more fossil evidence is uncovered, Johanson added. "There are many pieces of the puzzle still missing, waiting to be discovered by dedicated researchers that will undoubtedly force us to reinterpret the details of the human family tree," he said. "However, there is one thing that I believe will never be rewritten - and that is the commonality of humanity. Africa is the place of our origins and will continue to teach us new things."

Prior to the lecture, the audience observed a moment of silence in memory of Joy Moon, the widow of Roy E. Moon.

A common aspect of some 5,000 human diseases is that they are linked to genes and that is important in finding a cure for them, said Dr. C. Thomas Caskey, the 18th Moon Lecturer and the Director of the Human Genome Center and Chair of the Department of Human and Molecular Genetics at the Baylor College of Medicine in Houston. Such knowledge provides hope in eventually treating cancer, cystic fibrosis, coronary artery disease, AIDS, manic depression and the almost endless list of hereditary and behavioral abnormalities and diseases.

"If you can identify the gene and isolate it," Caskey said, "then you can generally know the function of the gene and what causes the disease." After gene identification, Caskey said, the next step involves developing therapeutics that would intervene on the particular gene. This developmental process, however, takes time.

Caskey said that the fast-paced growth of genetic technology is a mixed blessing because "with new knowledge come both opportunities and problems." The vast benefits of genetic research include enabling a couple to know whether pregnancy might result in a fetus that is at risk for inheriting a fatal disease. Caskey acknowledged that such benefits are accompanied by challenges. "We have this constant problem in science to assure that things are done in an acceptable social framework," he said.

He addressed the question of whether a person's genetic risk "map" might be used by insurance companies to deny coverage. If genetic testing reveals a likelihood of inheriting, say colon cancer, would that constitute a pre-existing condition? To avoid such use of genetic predictions, Caskey said that insurance firms should base underwriting predictions on total populations and not be allowed to exclude the small percentage of persons known likely to inherit certain diseases.

Concerning fanciful stories of cloning the perfectly beautiful and highly intelligent baby, he said, "There are too many genetic variables and random assortments to clone favorable traits." Genetic research is not about such goals but rather about preventing or postponing diseases and developing other useful technologies such as creating insulin with recombinant DNA, Caskey asserted.

Caskey's comments, like Khorana's, have proven to be especially relevant in the last few years because of scientific breakthroughs in cloning (1997) and human genome sequencing (2000). His suggestions and predictions will undoubtedly be soon put to the test because of these momentous scientific achievements.

Dr. Eugene Shoemaker, Scientist Emeritus of the U.S. Geological Survey and Co-Discoverer of the Shoemaker-Levy 9 Comet, was the 19th lecturer. His lectures "The Crash of Periodic Comet Shoemaker-Levy 9 on Jupiter" and "Comets, Craters and Catastrophes" looked at the potential damage to Earth from a major comet crash.

He stated that if the Earth suffered a comet impact like the one on Jupiter in the spring of 1994, dust clouds would shroud the planet in darkness and millions of lives would be lost if it happened during the northern hemisphere's spring, since dust and darkness would make crops fail.

"I think it is worth considering an international program to detect any comets out there with our name on them, and to develop a means of diverting the course of comets or asteroids aiming for the Earth," Shoemaker said. But the odds are, he said, that such an impact by an asteroid or comet six-tenths of a mile in diameter - large enough to be catastrophic - would happen only once every million years. Nevertheless, "the Earth revolves in an asteroid swarm and there is a one in 1,000 chance of a comet crashing on Earth during the lifetime of young people today," Shoemaker said.

He showed slides of the comet he and his wife, Carolyn, discovered in 1993. The comet fragmented and struck Jupiter in a "string of pearls."

"I'd spent my whole life hoping to see a comet hit, but I didn't think it would ever happen," said Shoemaker. Carolyn Shoemaker, an amateur astronomer who actually first spotted the comet, has discovered more comets than any other astronomer in history. She accompanied her husband to San Angelo from their home in Flagstaff, Ariz.

Dr. Shoemaker was an early proponent of the theory that dinosaurs and some 70,000 other species were rendered extinct when a comet struck the Earth off the coast of the Yucatan Peninsula. He explained that when a comet hits the Earth, the area it lands on is left much richer in noble metals such as iridium, platinum and gold than the normal crust of the Earth. Since iridium is the easiest noble metal to detect, it is used as a tracer to detect craters or areas that have been hit by comets. Although controversial at that time, the idea is generally accepted now.

Speculating that this wasn't the only such event, Shoemaker pointed out that it wasn't totally negative. The catastrophe also "opened up environmental space for new forms of life," including mammals and humans, he said. His "impact geology" has led to a re-examination of the evolutionary theory that has presumed a slow and uniform process in the development of new forms, and to the belief by some scientists in "emergent evolution" - the relatively sudden appearance of new species. In addition, he pointed out that other such catastrophic events in nature produce positive results. "The elements of which this building and the people in it were made came from supernovae explosions of stars," Shoemaker said.

Shoemaker's contributions to geology include proving that the meteor crater in Arizona was formed when a meteor struck the Earth, rather than being a volcanic crater as was widely believed. He also taught astronauts about the geology of the moon, and developed improved methods for mapping the moon's surface.

His descriptions of the catastrophic results that could occur when an asteroid collides with Earth have even captured the fancy of Hollywood filmmakers through several recent movies such as "Armageddon" and "Deep Impact."

Lecture Twenty 1996

Dr. Alfred G. Gilman, co-recipient of the 1994 Nobel Prize in Physiology or Medicine, spoke on "Understanding Cell Communication: The Path to Tomorrow's Treatments," as the 20th Moon Lecturer.

Dr. Gilman, Professor and Chairman of the Department of Pharmacology at the University of Texas Southwestern Medical Center at Dallas, received the Nobel Prize for discovering the nature and function of key "pathway molecules" known as G proteins, which determine cell response to non-sensory information.

His lecture on cell communication encompassed three main themes. First, he stressed the importance of the generality and universality of communication between cells. Second, all cells are capable of sensing and responding to signals in the environment. "Most cells in complex organisms can send out chemical signals," he said. "When they get them, they respond in important and pre-determined ways." Finally, Gilman said that most of what we know in the field of biology has been discovered this century (20th), and especially during the previous two decades. "Biology is an incredibly young science - we are just scratching the surface," he said. "The future is going to be fantastic."

Gilman explained the nature of cells. He showed slides of bacteria, very basic, one-cell organisms, which swim around constantly with the aid of tail-like flagella. However, if there are no chemical signals in the environment, they move around randomly, Gilman said. Multi-cellular organisms, such as humans, also contain mobile, unattached cells, he said. He illustrated this with the example of white blood cells that "swim" to the site of a cut or wound because they were "told" of the presence of infection by chemicals at the site.

Another example in the human body is sperm cells. Gilman explained this with the help of a video clip. "Sperm congregate around the egg because they sense a positive attractant," he said. "This obviously facilitates fertilization." Although there is very strong evidence that human eggs secrete a chemical that attracts sperm, research in this area has been somewhat restricted because of technical and ethical factors. However, he pointed to several areas in which this research could be beneficial to man because it could lead to new forms of contraception or a cure for human infertility.

Gilman compared the specialization of our cells to the way workers at a company have a specific job to do. "But we also need to have supervisors or

managers to see if we have the right sizes of cells, number of cells and if the cells are doing the right job." The supervisors in the body are the chemical communication systems, such as hormones, growth factors and neurotransmitters. Using a combination of video clips, animation and cartoon slides, Gilman showed how the receptor, that part of the cell that receives the message from outside the cell, is the "lock" on the cell's surface. The drug or the message is the "key" that fits exactly into the lock.

Lecture Twenty-one **1997**

Dr. Thomas R. Cech, Distinguished Professor of Chemistry and Biochemistry and of Molecular, Cellular and Developmental Biology, at the University of Colorado at Boulder, received the 1989 Nobel Prize in Chemistry for his discovery that RNA could serve as a catalyst for biological reactions.

Serving as the 21st Moon Lecturer, he offered his own solution to the familiar question: Which came first, the chicken or the egg? "The same thing can be both chicken and egg," suggested Dr. Cech. He and his research group discovered that ribonucleic acid - also called RNA - could function like a protein, something once thought impossible. For the furtherance of life, Cech explained, two ingredients are necessary. "There has to be genetic information" - call that the chicken - "and there also has to be something to copy the chromosomes" - call that the egg. Genetic information is present in deoxyribonucleic acid - called DNA - and in RNA.

Proteins act as enzymes that can copy the chromosomes, and prior to Cech's work it was assumed only proteins could perform this function. But Cech's discovery means that a single molecule - RNA - could both provide genetic information and copy it as well. "Maybe at the beginning there was just RNA that could copy itself," he suggested. "We can't tell historically if that is what happened, but it's chemically plausible."

What's also chemically plausible is that Cech's discovery could lead to better medicines. Currently, drugs aimed at treating cancer, AIDS and other diseases focus on proteins. But, thanks to Cech's research, pharmaceutical companies may someday offer drugs that target RNA. To explain the process, Cech offered a video metaphor. Think of DNA as the master copy, RNA as the copies of the original and proteins as the image on the screen, he suggested. By targeting the RNA, the drugs are moving one step up in the process. Cech called the RNA molecules that act like proteins, ribozymes. He said he also could envision scientists engineering ribozymes to hunt and destroy any RNA that was making inappropriate proteins.

For cancer patients, the results eventually could be no more chemotherapy, as we know it now. In current chemotherapy, the protein treatments are not specific enough to target just the cancerous cells, so they injure healthy cells as well and cause many unpleasant side effects, he explained. By contrast, a

ribozyme-based treatment could go after the cancerous cells only and not make the patient sick in the process. Cech said he knew of four pharmaceutical firms that currently were studying ribozyme treatments exclusively and many others that also are researching the possibilities. He predicted that within five to ten years, such treatments could become available.

Lecture Twenty-two **1998**

The 22nd Moon Lecturer was Dr. Sylvia A. Earle, Founder and Chairman of Deep Ocean Exploration and Research, Inc, and National Geographic's Explorer in Residence. One of the world's foremost oceanographers, Dr. Earle has led more than 50 expeditions and spent approximately 6,000 hours underwater studying the ecology, and above water exploring technological advancements for deep-sea research.

"This planet is blessed with a vast aquatic space, about which we know very little," she said. "The greatest era of exploration is just ahead." Earle described the fact that throughout history humankind has responded to the call of the sea, noting that about half of Earth's population lives within 50 miles of the sea. But only "ever so gradually," she said, have humans "mustered the means to gain access to the great depths." Underwater exploration has made tremendous advances in the latter part of this century, she said, spurred by research conducted by the military and industry, most especially by offshore oil and gas development.

Underwater oceanic exploration is vitally important to the understanding of the Earth's ecosystem, Earle stressed. "If you had to choose a place that is most important for keeping this planet as it is, you'd focus right here, on the cornerstone of our life support system, the sea, where most of the life actually occurs, both in terms of the abundance of life and also in terms of diversity. Every dive into the sea is like diving into the history of life on our planet."

Insight into the ocean's ecosystem affects every person on the planet, she said. No matter whether or not we actually go into the ocean ourselves, the oceans are still profoundly important to us all in shaping the climate, weather, atmosphere - the life support system on Earth, upon which we are all, one way or the other, dependent.

Discovery involves not only hardware such as improved submersible craft, but also synthesizing information from different researchers. For instance, as the result of collaboration among oceanographers, meteorologists and other scientists, "we are just beginning, right now, to get enough information to figure out a profoundly important phenomenon called El Niño," she said. Other such collaborations could include using underwater sensors to predict earthquakes. "As we begin to synthesize information that has been around here and there, we now have the key, through computers, to knit some of these things together, to get people together and share those ideas."

Lecture Twenty-three **1999**

The 23rd Moon Lecturer was Dr. Keith L. Black, the Director of the Division of Neurosurgery at Cedars-Sinai Medical Center, Director of the Cedars-Sinai Comprehensive Brain Tumor Program, and Director of the Cedars-Sinai Neurological Institute. He lectured on "Applying Basic Research to the Treatment of Brain Cancer" and "Brain Cancer and the Art of War."

Black believed that cancer research was not being given the national priority that it deserved. "If we put the same effort toward cancer that we did toward getting a man on the moon, then we can achieve a cure," he said. "Cancer will affect one out of three people in their lifetime," he said, "and it will cause 500,000 deaths this year." He described the fact that the budget of the National Cancer Institute for research is the equivalent of but one B-1 Bomber.

Dr. Black discussed the development over the past 60 years of medicine into what is defined today as Western Medicine. Still the medical revolution seems to have just begun. Although many would consider the current treatments for cancer to be somewhat sophisticated, Black characterized the current options of surgery, radiation therapy and chemotherapy as slash, burn, and poison. In the future he predicted that we would develop much better approaches.

In his specialty area of brain tumors, he has pioneered research on ways to open the blood-brain barrier, allowing chemotherapy to be directly administered to brain tumors. Unlike other organs, the brain has a thick wall of capillaries around it that keeps out all sugars, proteins and even water. By discovering how the brain regulates itself in the biochemical system, Black has been able to break that barrier and treat the tumor directly.

Black's other remarkable research includes the development of a kind of cancer vaccine. This is not a vaccine in the traditional sense, but instead is given to patients after they are diagnosed with cancer. He learned one of cancer cells' main survival tactics is to fight the immune system. One of the ways it does that is to make itself invisible to the immune system. By better understanding cancer's relationship to the immune system, Black has found a way, in essence, to light up the cancer cells to the immune system so it can recognize and destroy them.

Lecture Twenty-four **2000**

When F. Sherwood Rowland, the 24th Moon Lecturer, was named the recipient of the 1995 Nobel Prize in Chemistry, the Royal Swedish Academy of Sciences praised his contribution "to our salvation from a global environmental problem that could have catastrophic consequences."

Dr. Rowland, the Donald Bren Research Professor of Chemistry and Earth System Science at the University of California Irvine, spoke on "Two Global Atmospheric Problems: Stratospheric Ozone Depletion and the Greenhouse Effect" and described how he initiated a study of chlorofluorocarbons (CFCs) in the

atmosphere on a project funded by the U. S. Atomic Energy Commission.

Although CFCs were known to be harmless in the lower atmosphere, Rowland questioned what might happen when they reached the stratosphere. He noted that those artificial compounds had proved useful in a wide range of applications and were used in great volume.

Working with post-doctoral student Mario Molina, Rowland discovered that CFCs were especially harmful when released via aerosol propellants. While the concept that aerosol deodorant and hair spray could deplete the ozone seemed wildly ridiculous at first, as time went on the evidence showed that CFCs were indeed a serious problem in the stratosphere. One million tons of CFCs were produced in the 1970s and the 1980s, Rowland said. Although this amount is impressive enough, the fact that each chlorine atom can remove 100,000 molecules of ozone means that the impact is truly global.

When he realized the implications of his findings, he first thought that he must have made some mistake. But repeated measurements showed that his initial conclusions were correct. One critical question was whether or not the CFCs produced any delayed effects. Even if CFC use was stopped, previous CFC use might continue to destroy ozone for years. Once scientists discovered a hole in the ozone over the Antarctica in the 1980s, the public and the news media began to realize just how serious ozone depletion had become. Rowland's work led to a global agreement to eventually halt all use of CFCs - something that had seemed inconceivable at the onset of his research, he said.

Rowland also discussed his ongoing research taking air samples from remote areas of the world. He and his team test the air's chemical composition in an effort to study global smog and global warming. He indicated that most of these problems come from automobile exhaust, and that it was a lot easier to ban CFCs than it will be to ban the use of automobiles. Our only hope in this area, he says, is to vastly improve the use efficiency of energy derived from the burning of fossil fuels.

His essential message was that global warming is a problem, that more people realize it and that we need to change the efficiency of our energy use to hopefully mitigate the harmful effects.

Lecture Twenty-five **2001**

The 25th Annual Moon Lecture brings to ASU another Nobel Laureate, Dr. Ferid Murad, who received the 1998 Nobel Prize in Physiology or Medicine.

Dr. Murad is professor and chair of the Department of Integrative Biology, Pharmacology and Physiology, and director of the Institute of Molecular Medicine at the University of Texas-Houston Health Science Center. He received the Nobel Prize after he identified the exact chemical mechanism by which nitroglycerin eases heart pain. His discovery has been called one of the most important in the history of cardiovascular medicine.

His research found that nitric oxide, among its many functions, signals blood vessels to relax and widen, thus lowering blood pressure. By releasing nitric oxide into the bloodstream, he was able to demonstrate how nitroglycerin helps ease angina pain in heart patients. Subsequent studies based upon his research showed that nitric oxide helped prevent blood clots and relaxed the smooth muscle cells in the lungs and gastrointestinal systems.

Dr. Murad's research has opened the doors for the future formulation of new medications to stimulate or inhibit the production of nitric oxide in the body. Such drugs will be able to treat a variety of conditions, including heart disease, stroke, shock, cancer, retinal diseases, infertility, bacterial infections and inflammatory diseases such as arthritis and colitis.

The topics of Dr. Murad's Moon Lectures are "Cells Use Nitric Oxide to Talk to Each Other" and "Nitric Oxide, a Unique Molecule for Cell Signaling."

ASU College of Sciences Dean David Loyd said, "Dr. Murad is but the latest in a the long line of world-renowned scientists the Roy E. Moon Distinguished Lectureship in Science has brought to West Texas. The Moon Lectureship has provided the opportunity for the campus and the local community to hear and interact with scientists of international stature. In honoring Dr. Moon with this lecture series, the members of West Texas Medical Associates have enhanced the intellectual experience both for our students and for area residents. We are grateful to West Texas Medical Associates for their ongoing support of ASU and this lecture so we may all learn from scholars like Dr. Murad."

Acknowledgements

This commemorative booklet was produced to reflect the quality of scientists and the variety of topics covered in the 25-year history of the Roy E. Moon Distinguished Lectureship in Science.

The dedication and hard work of the members of the selection committee over the years is gratefully acknowledged. Each year much time and effort is expended in considering possible speakers and then selecting the best choice for that year. We should note the particularly long and faithful service of Dr. Fazlur Rahman, who learned from Dr. Moon, his mentor, the importance of a public informed about science. Dr. Rahman has worked with Dr. Patrick E. Gibson, Dr. John T. Granaghan, Jr., Dr. Jane Rider and other physicians of West Texas Medical Associates over the years to uphold Dr. Moon's philosophy and to honor his late mentor's memory.

The synopses of their talks are based upon news reports in the San Angelo Standard-Times and the ASU Ram Page. The materials were finalized with assistance from the ASU College of Sciences and its various departments. Production was coordinated by the ASU News and Information Office.

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