Feature — **Science and Technology**

The Magic of Mushrooms

by P. Atthasampunna and S.T. Chang

THE mushroom has always been a thing of mystery. In ancient times the seemingly miraculous manner of its growth without seed, its sudden appearance after rain, its equally rapid disappearance and its curious umbrella-like shape gave rise to a wealth of allusions and mythologies. Today, it is continuing to perform feats of magic and versatility, not only as a source of food, but by helping to convert agricultural and industrial wastes into useful matter.

Edible mushrooms provide high quality protein that can be produced with greater biological efficiency than animal protein. They are rich in fibre, minerals and vitamins, and have a low crude fat content. These properties are major contributing factors to the traditional recognition of mushrooms as "healthy" food.

However, although a large number of mushroom species are not only edible but also possess tonic and medicinal qualities, some are lethally poisonous. There is no simple way of distinguishing between edible and poisonous mushrooms, and one should eat mushrooms only if one knows their names and their properties with considerable precision.

Mushroom cultivation, moreover, requires relatively little in terms of large-scale equipment, capital, and and processing. In the rural areas of less-developed countries, where largescale capital-intensive operations are inappropriate, well-managed mushroom farms can make important contributions to the nutrition and economic welfare of the local people.This is especially true in regions where the indigenous population suffers from protein deficiency.

Nature's garbage man

However, the mushroom would not be worthy of its versatile reputation if it were only a source of food. It can also help to solve one of humankind's most urgent and growing problems — its propensity to create waste.

The agricultural, forestry and food processing industries generate huge quantities of wastes, much of which is either burnt, discharged into watercourses or used for landfill. And, yet it constitutes a potentially valuable resource.

Most agricultural, industrial and household solid wastes are rich in organic matter, mainly cellulose, hemicellulose and lignin, substances that are highly resistant to biological degradation and have little or no food value in their original form. Furthermore, their disposal can be a major source of environmental pollution. However, when properly treated with bioconversion technology — the process whereby micro-organisms are used to transform organic residues into utility products — they can be modified and upgraded into high-quality protein for human and animal consumption, and used for the production of microbial metabolites and the generation of new feedstocks for the polymer industry, which creates materials such as plastics, resins and synthetic rubbers.

Edible mushroom production is a particularly effective form of bioconversion technology. Mushrooms differ from green plants in that they cannot use sunlight to manufacture their food. What they do is produce enzymes that degrade the complex substrates on which they grow and then feed themselves on the soluble substances thus produced. They can be cultivated on a wide variety of woody and cellulose wastes, and the spent residue left after harvesting can be used as an animal feedstock and/or a soil conditioner.

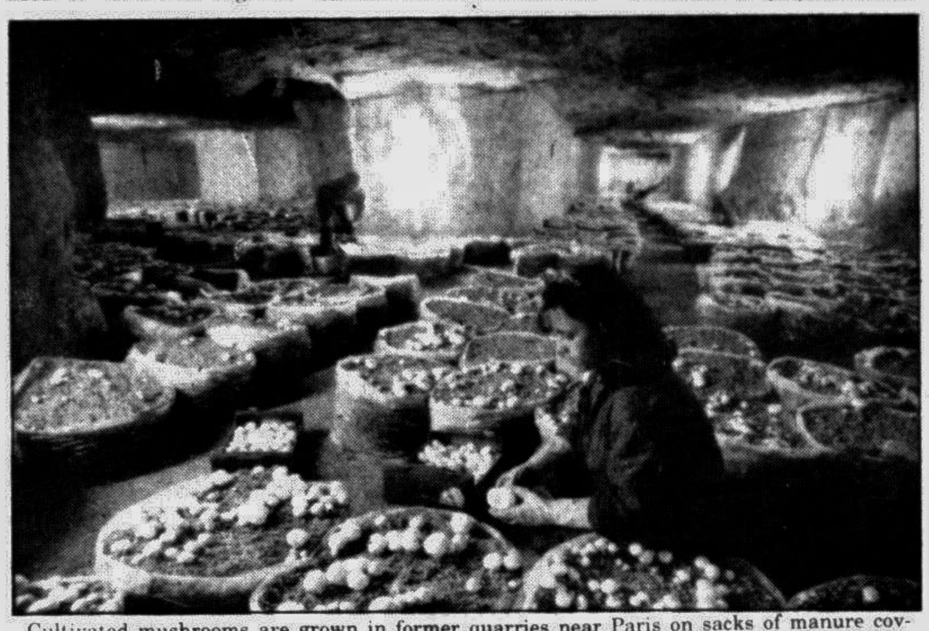
There is also rapidly growing interest in mushrooms as a source of high-value metabolites, substances which can be used to treat tumours, strengthen the immune system and reduce blood pressure and cholesterol levels. One such substance, PSK, also known as Krestin, is made from the mushroom Coriolus versicolor and has become the best-selling anti-cancer drug in Japan, where it has 25 per cent of market share and in 1987 had an annual sale of $357 million. One Japanese company has annual sales of lentinan, a polysaccharide derived from another mushroom, Lentinus edodes, amounting to $90 million. These natural products are active against certain types of tumours and have the advantage of not being toxic to non-target cells.

Mushrooms also represent a relatively untapped source of novel products for use in the food and drink industries as illustrated by the growing number of products reaching the retail market. Important examples include natural food additives such as colorants and flavour compounds that can be used to replace chemical additives that are often considered less acceptable. Furthermore, the food industry is already subject to consumer pressure to produce "healthy" foods and, as the emphasis on prevention rather than cure of diet-related diseases grows, this trend will become even stronger.

It should be noted that world production of cultivated edible mushrooms is, well: mushrooming. Nearly 4,000 tons of mushrooms were cultivated worldwide in 1989-1990, a dramatic increase from just over 2,000 tons cultivated in 1986. There has been a particularly sharp increase in growth over the last five years. This trend is expected to continue in the future.

While it is likely that more low-tech processes such as mushroom bioconversion technology will be of interest to developing countries, it is certain that the application of microbial biotechnology to solid organic wastes will be an important tool for their food industries and environmental management in the years to come.

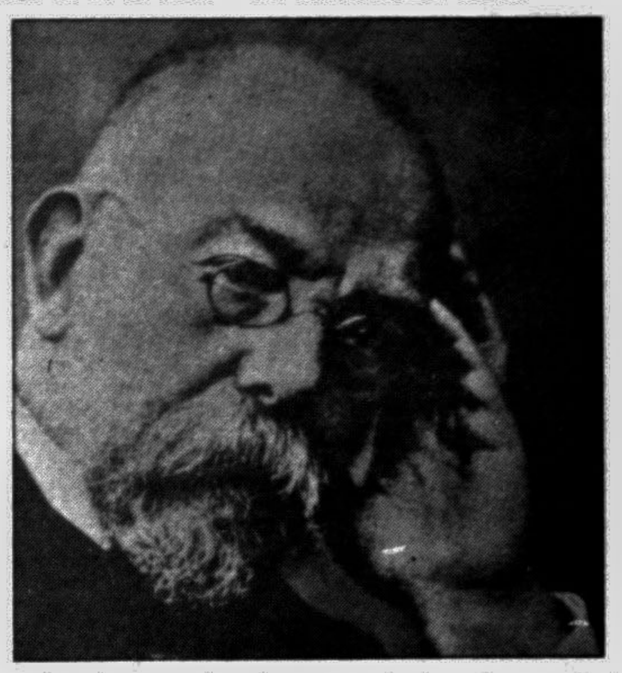
Courtesy — The Unesco Courier



Cultivated mushrooms are grown in former quarries near Paris on sacks of manure covered with crushed chalky soil. The harvest lasts from 3 to 6 months.

Robert Koch:

The man who discovered the tubercle bacillus



NO. Robert Koch was not a friendly, jovial country doctor, one of his colleagues told the Tagesspiegel in 1946.

The 1939 UFA feature film (with Emil Jannings as Robert Koch —Bekampfer des Todes/ Robert Koch — Adversary of Death) had made the researcher's character too folksy. In reality, Koch, who was fired by a "restless, supreme urge to research", was a person who, despite his "kind-heartedness", preferred "to keep people at a distance of ten paces". His temperament was like "frozen champagne". "He never indulged in uninhibited emotional outburst", but could be occasionally "angry and irritated" just as much as he could be "a lively and stimulating companion". The founder of the science of bacteriology was born 150 years ago, on 11 December 1843, in Clausthal, a small town in the Harz Mountains.

Up to the middle of our century, there was an almost cultic veneration throughout the world for the discoverer of the tubercle baillus and cholera pathogen. A mausoleum was erected in Berlin, and in Tokyo, a memorial shrine recalls the man whose message, revolutionary in his day, was: infectious diseases are conveyed and caused by tiny creatures.

After World War II, infectious diseases, once the scourge of mankind, seemed to have lost their terror. Commemorating Robert Koch developed into a wooden ritual. People failed to appreciate the ever existent danger. At a ceremony in honour of Robert Koch in 1982, the minister of health pointed out that the former epidemics had been replaced by civilization diseases.

In 1983, one year after the speeches at the ceremony, an estimated 8000 persons in the Federal Republic were infected by HIV, the AIDS bacillus. The hope that infectious diseases had been overcome once or for all proved false, even in industrial countries. It was not even on the agenda on the poor continents.

In the meantime, there is much to suggest that also tuberculosis is returning to the rich countries. Robert Koch's work and message have lost none of their topicality.

Koch concluded his medical studies in Gottingen in 1866, at the age of 23. In the same year he experienced a cholera epidemic in Hamburg, and as an army surgeon during the Franco-German War (1870/71), he gained experience of dysentery and typhus. Koch, who became a general practitioner in 1872 and district doctor in Wolstein, near Posen, had his great moment in 1876. He succeeded in discovering the anthrax pathogen and portraying the infection's course.

The highlight of Koch's career, however, was the discovery of the tubercle bacteria. He made this known on 24 March 1882 before the Physiological Society in Berlin where he had been working at the Imperial Heath Office (the forerunner of the Federal Health Office) since 1880. Within hours, the news of the discovery was telegraphed around the whole world.

In 1884, Koch discovered the cholera bacillus. A year later, he was appointed professor of hygiene at the University of Berlin. His research expeditions to Africa and Asia broke new ground in science. Koch proved that the rat flea transmitted the plague and the tsetse fly sleeping sickness.

Kock was not only successful as a discoverer. He also provided his colleagues with the technical and intellectual wherewithal. He worked with modern microscopes, developed staining and breeding methods for bacteria and drew up guidelines to help diagnose infectious illnesses. These Koch postulates, which have still lost none of their validity, state that if a suspicious pathogen is discovered in a sick animal, it must be cultured and transferred to a healthy animal, to obtain proof of the cause.

In 1891, a research centre — the Royal Prussian Institute of Infectious Diseases — was set up for Koch. It bears Koch's name today. The man who taught a whole generation of bacteriologists was awarded the Nobel Prize in 1905. To some extent, Koch was also aware of the fact that, in the case of illnesses such as tuberculosis, bacteria are not the only culprits but that poverty, hunger and lack of hygiene pave the way.

Courtesy-Bildung und Wissenschaft

FALLOUT OF THE WORLD'S WORST NUCLEAR ACCIDENT

by Zhores Medvedev

SCIENTISTS are preparing for the dawning of truth about the long-term effects of the 1986 Chernobyl nuclear disaster.

New statistics indicate that the so called "delayed effects" will occur sooner, and be more severe, than anyone predicted, the focus is the incidence of iodine-induced thyroid cancers.

In 1992 a re-evaluation of radio nuclides in the damaged reactor (a study made in 1989-90 but hitherto kept secret), showed that before the explosion the reactor contained 86 million curies (Ci) of iodine 13 and 14 million Ci of iodine-132, iodine-133 and iodine-135 — compounds which have powerful radiation effects.

The disclosure coincided with a revised estimate of the amount of radioactive iodine released during the 10-day "acute phase" of the disaster.

According to early official documents, only 20 per cent of the radioactive iodine was released. But it was subsequently established, on the basis of global fall out, that at least 60 per cent escaped. Radio-iodine is very volatile. Analysis of the isotope composition of the remaining reactor fuel has since caused the figure to be raised again, to 85 per cent.

Radio-iodine accumulates selectively in the thyroid gland. Five to ten times faster in children than in adults, with serious effects on growth and development. In the first weeks after the accident the emission of radio-iodine was the greatest hazard.

In 1986-87 the first prognosis was that, although people in severely contaminated areas might experience morphological and functional changes in the thyroid, the incidence of thyroid tumours would not rise until ten years after the accident. It was expected that the increase would not exceed the existing level by more than 40 per cent.

For 48 hours after the Chernobyl accident (at 0123 local time, 26 April 1986) iodine isotopes accounted for about 60 per cent of the radioactivity in the air west and north of the reactor.

At first the iodine entered people's bodies mainly through the lungs. On 27 April thyroid glands of children in Pripyat, three kilometres away, were found to contain radioactive iodine.

When, on 30 April, the emission was blown southward over Kiev and southwestwards towards Moldavia, Romania and Bulgaria, about 80 per cent of the airborne radioactivity was found to be iodine.

The Kiev authorities distributed potassium iodide tablets to prevent the absorption of radio-iodine, but this was too late to be effective. In many rural areas there was no distribution.

At the end of April, across the affected areas, radio-iodines began to enter people's bodies through the food chain, primarily via milk. After some delay, uncontaminated food products were supplied to towns, but country people continued to consume contaminated food for weeks.

The most seriously affected area, as confirmed in 1992 by a team of European Community experts, was the Gomel region of Belarus.

Before Chernobyl no more than two to three cases of thyroid cancer had been found in any year among children up to the age of 14 in the entire Byelorussian population of 10 million.

In 1989 the count rose to six, of which two were in the Gomel region with a population of 1.7 million. A year later, a further 14 cases requiring urgent surgery were diagnosed in the region. Six more occurred in the Brest region, over which the radioactive cloud had passed on the evening of 28 April on its way to Poland.

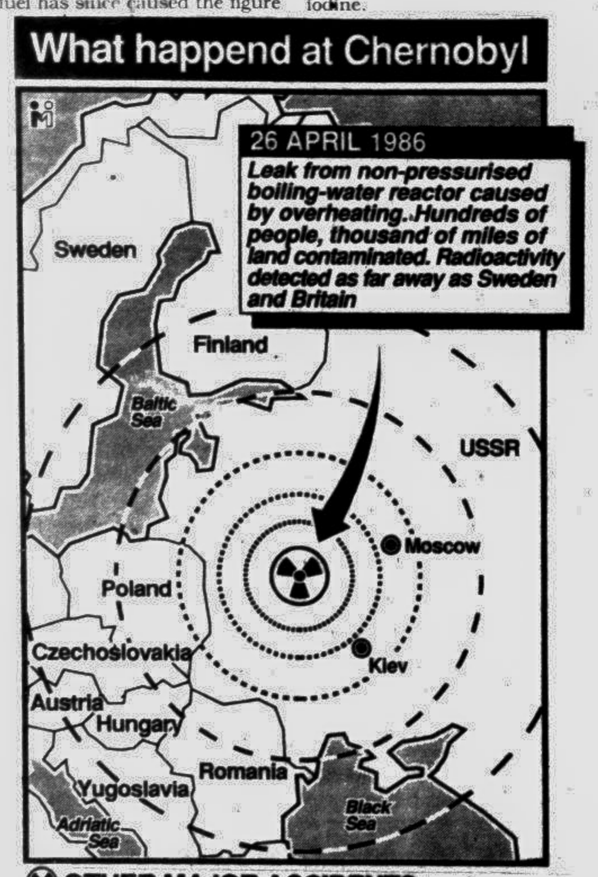
In 1991 the number of children's thyroid cancers in the Gomel region rose to 38, and this level was maintained in 1992 and 1993. The increase also continued in the Brest region, and last year led to a total of 18 cases.

In 1990 it also began to rise in Ukraine, where by 1992 there were 27 thyroid cancers above the pre-1986 level, mostly in three regions.

In addition to child thyroid cancers, there has also been an increase among adults in Belarus. The highest level has been among "liquidators" — workers and technicians mobilised to work in the Chernobyl "exclusion zone" in 1986-87, of whom 284,907 are on a special register to follow the state of their health and that of their children for the next 70 years.

Heavy blame for the final toll will rest with the former Soviet Ministry of Health, which for 10 days (6-16 May, 1986) to avoid destruction of contaminated food products, set a "temporarily permissible" iodine contamination level 100 times above normal.

The action was on the advice of the National Committee for Radiation Protection, which forecast that any rise in thyroid cancers would be in the ten years beginning in 1996. — *GEMINI NEWS*



Gene Therapy Lowers Cholesterol Levels

HER cholesterol was so high that she had a heart attack at age 16. Twelve years later, researchers set out to treat her by implanting genes in her liver, reports AP.

Now, the first published study of this use of gene therapy in humans says the woman's cholesterol levels have fallen dramatically, bolstering hopes for what some researchers see as a coming revolution in medicine.

The woman's cholesterol has remained lower since the treatment in 1992, said Dr. James Wilson, director of the University of Pennsylvania's Institute for Human Gene Therapy.

Though she still has dangerously high cholesterol, a heart specialist said the therapy probably will prolong her life, perhaps by years.

"I feel much better in the sense that I can do more physical activities now, such as skiing and dancing. I was limited before," the 30-year-old seamstress and part-time bank teller from Quebec City said Thursday.

The woman, who insisted on anonymity, has a severe form of a disease called familial hyper cholesterolemia, in which the liver lacks the gene to produce a normally functioning protein that removes cholesterol from the blood. About one in a million people don't have the gene.

Scientists surgically removed about 15 per cent of the woman's liver. In the laboratory, they used viruses to shuttle copies of the missing gene into liver cells. About one-fifth of the cells took up the gene. The corrected cells were then put back into the woman's liver.

"I had nothing to lose," the woman said of the experimental treatment.

Both her parents have the disease, and her 9-year-old daughter appears to have it. Her parents are still alive. But she has lost two siblings to the disease. Another sibling has it. Two other siblings were born without it.

The woman was 28 years old when she underwent the therapy. The average level of "bad" cholesterol, called LDL, for a woman of that age is 108 milligrams per deciliter. Her level was 482 without medication and 448 with it.

After gene therapy, levels fell to 404 without medication and about 360 with it.

The results, reported in the April issue of the journal Nature Genetics, were about as expected based on experiments with rabbits, Wilson said. There have been no side effects, he said.

"She's probably still going to die of her heart disease, but ... she's going to have longer life expectancy because of this," said Dr. Margo Denke, a cholesterol researcher at the University of Texas Southwestern Medical Center in Dallas. The differences might be months to years, Denke said.

Wilson said four other patients have since been treated with the therapy, but that it was too early to say how well it was working.

Dr. Kenneth Culver, executive director of the Human Gene Therapy Research Institute at Iowa, Methodist Medical Center in Des Moines, said the results with the woman "further strengthens the whole premise that gene therapy is going to revolutionize science and medicine."

Dr. Ronald Crystal, a researcher in gene therapy researcher at the New York Hospital-Cornell Medical Center, said the work suggested that correcting even a relatively small number of cells can produce a significant effect.

Gene therapy also is being studied for several diseases, including cystic fibrosis.

Wilson said he hopes to find a way to deliver the genes to the liver without surgery.

Modernisation of UK Lifeboat Fleet Completed

THE provision of fast lifeboats at all 210 Royal National Lifeboat Institution (RNLI) stations that span the coast of Britain will be completed with the imminent arrival of a new 12-metre Mersey class lifeboat at Aldeburgh on the east coast of England.

Aldeburgh currently operates an 11-metre Rother class lifeboat which is the last of the traditional 'double-ended' design of lifeboat in service, the origins of which stretch back over 200 years. The new Mersey is capable of more than twice the speed of the Rother it is replace.

The arrival of the new lifeboat on 30 November will see the realisation of the RNLI's seven year plan "to complete the introduction of fast craft capable of a minimum top speed of 15 knots by 1993," which was announced at the institution's annual meeting in may 1986. The RNLI has spent almost £50 million in achieving this target.

The 12-metre Mersey class lifeboat has been designed and developed by the RNLI specifically for launching by carriage or tractor, although it can also be slipway-launched or kept moored afloat. It is fitted with twin 285 horsepower turbocharged diesel engines and has a top speed of 16.5 knots.

(LPS)

INDIAN ROPE TRICK HELPS HEAR THE SOUNDS FROM HEAVEN

by A J Singh

WHEN the comet Shoemaker-Levy 9 smashes into Jupiter in July — producing the energy equivalent of 250,000 one-megaton atomic bombs — a unique Indian telescope will play an important role in monitoring the shattering event.

But studying the effects of the explosion will be a detour for 65-year-old Dr Govind Swarup's $50 million brainchild, the primary aim of which is to investigate the origins of the universe.

The Giant Meterwave Radio Telescope (GMRT) is a groundbreaker on several fronts.

For a start, spread over 25 kilometres and with 30 huge parabolic antennae each 45 metres in diameter, it is easily the biggest telescope of its size in the world.

The collection area of the antennae is almost twide that of the world's largest single radio telescope at Arecibo, Puerto Rico, and four times that of the biggest Very Large Array (VLA) telescope in New Mexico.

It combines features of the two giants but has cost less than a fifth of either.

Secondly, Swarup has made use of steel wire mesh in the construction of the parabolic dish antennae. This innovation allows the wind to pass through but traps radio waves.

The idea has been taken up by scientists in the industrialised world. GMRT staff recently supervised the export of $100,000 worth of steel mesh wire to Puerto Rico, where Cornell University of the United States is erecting a radio telescope.

"This idea is likely to be adopted by scientists for future radio telescopes," says Swarup, a radio telescope construction specialist who designed and supervised the construction of India's largest radio telescope (530 metres long and 30 metres wide) at Ooty in Karnataka state.

The technology used in suspension bridges and large sports stadiums has been borrowed for the construction of the GMRT antennae, with rope supporting the mesh. Swarup calls it an Indian "rope trick".

Its location on a desolate site in Kadoded, near Narayangoan, about 200 kilometres east of the western city of Bombay, is also special. The unique advantage for radio astronomy is that it can scan both hemispheres. The United States, in contrast, can scan only the Northern Hemisphere.

In addition, there are hardly 150 radio receivers in the Narayangoan area, so it is almost free of the "background noise," or radiowave pollution, produced by radios, televisions and paging devices. That means the telescope will be able to detect, record and analyse even the weakest stellar celestial waves.

It is this advantage which explains why the technologically advanced West has not installed a GMRT.

The instrument has been specifically designed to pick up weak signals from stars, pulsars (dying stars) and meteors.

All the antennae can be rotated to follow the objects they are tracking. Each dish has a reflector which focuses radio waves from a distant celestial object onto a "feed," which in turn amplifies and strengthens the signals. Extremely high resolutions can be obtained.

"The system works like a crossword puzzle," says scientist Ranvir Nayar. "Each antennae scans a particular part of the sky and the pieces are put together by a central processing computer."

Work done here may play a crucial role in proving or disproving the Big Bang theory of the universe, which postulates that large hydrogen clouds were formed after an explosion 15 billion years ago. The clouds condensed and became Cold Dark Matter (CDM), which constitutes more than 90 per cent of the universe. It is CDM which emits wavelength radio signals.

"If we sight these clouds, we can calculate the velocity, nature and other characteristics of CDM", says Swarup. "That will enable us to support the Big Bang theory."

— GEMINI NEWS

Dr Govind Swarup:
'Father of Indian astrophysics'