

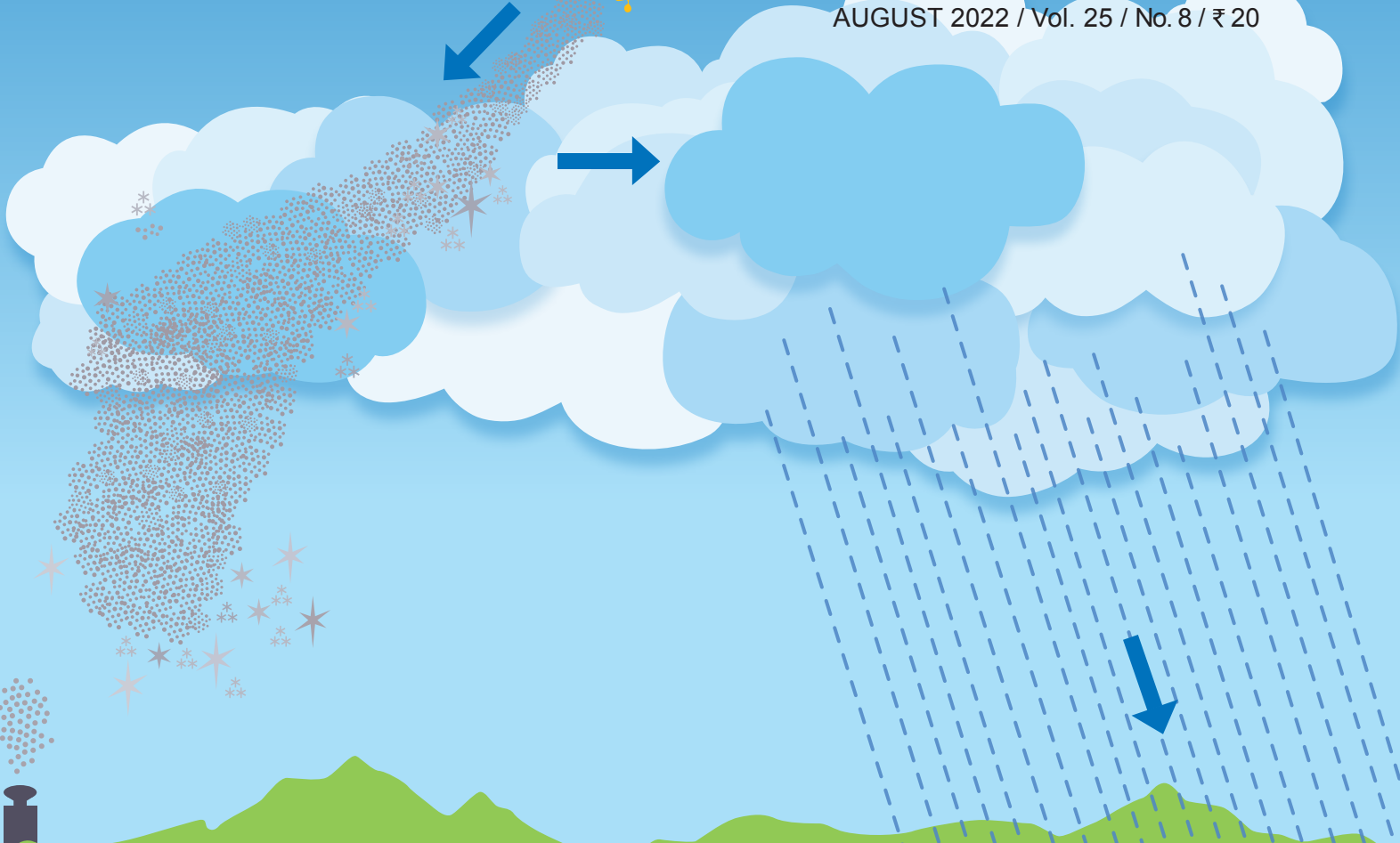
VIGYAN PRASAR

DREAM

2047



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CLOUD-SEEDING

TURING
PATTERNS

HEALTHY TEETH FOR A
SPARKLING SMILE

THE PUZZLE
CALLED PCOSE



VIGYAN
PRASAR



विज्ञान का अमृत महोत्सव

Editor-in-Chief

Nakul Parashar

Editor

Rintu Nath

Production

Pradeep Kumar

Bipro Kumar Sen

Ganesh D. Kalghuge

**Address for
correspondence**

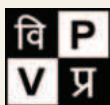
Vigyan Prasar, A-50,
Institutional Area, Sector-62,
Noida-201 309, U.P., India

Tel: +91-120-2404430, 35**e-mail**

dream@vigyanprasar.gov.in

website

http://www.vigyanprasar.gov.in



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MY WORD

NAKUL PARASHAR

Happy Independence Day Greetings**INDIAN**

science & technology has acquired due momentum in research, development and innovation. The outcome of this pace is duly visible through the number & variety of S&T-based start-ups that have hogged the current limelight. Many more on the anvil make one feel good and proud, especially as we enter the period of the next 25 years towards celebrating the centenary celebrations of our Indian Independence.

Indeed, we've come a long way through our glorious past 75 years, and hence, time to bow to the spirit of those who built where we are today. Dr Shanti Swaroop Bhatnagar, popularly known as the father of research laboratories in India, was an Indian colloid chemist who helped resolve many problems. He was the first Chairman of the University Grants Commission and founder director-general of the famous CSIR in the country. Dr Homi Jehangir Bhabha, the father of the Indian Nuclear Programme, was the founder-director of the well-known Tata Institute of Fundamental Research (TIFR) and the renowned institute called the Bhabha Atomic Research Centre (BARC). Dr Vikram Ambalal Sarabhai started the space research programme in the country and founded the Indian Space Research Organisation. Dr Subramanyam Chandrasekhar and Dr Hagobind Khoran were two notable Indian-origin scientists who received the Noble Prize for their research.

Prof Prasant Chandra Mahalanobis, who gave us the famous Indian Statistical Institute, is known as the father of modern statistics in the country. Dr GN Ramachandran, the renowned Indian physicist who decoded the triple helical structure of collagen, is known for the Ramachandran Plot to study the structure of the peptide. Indian women scientists have not been behind in

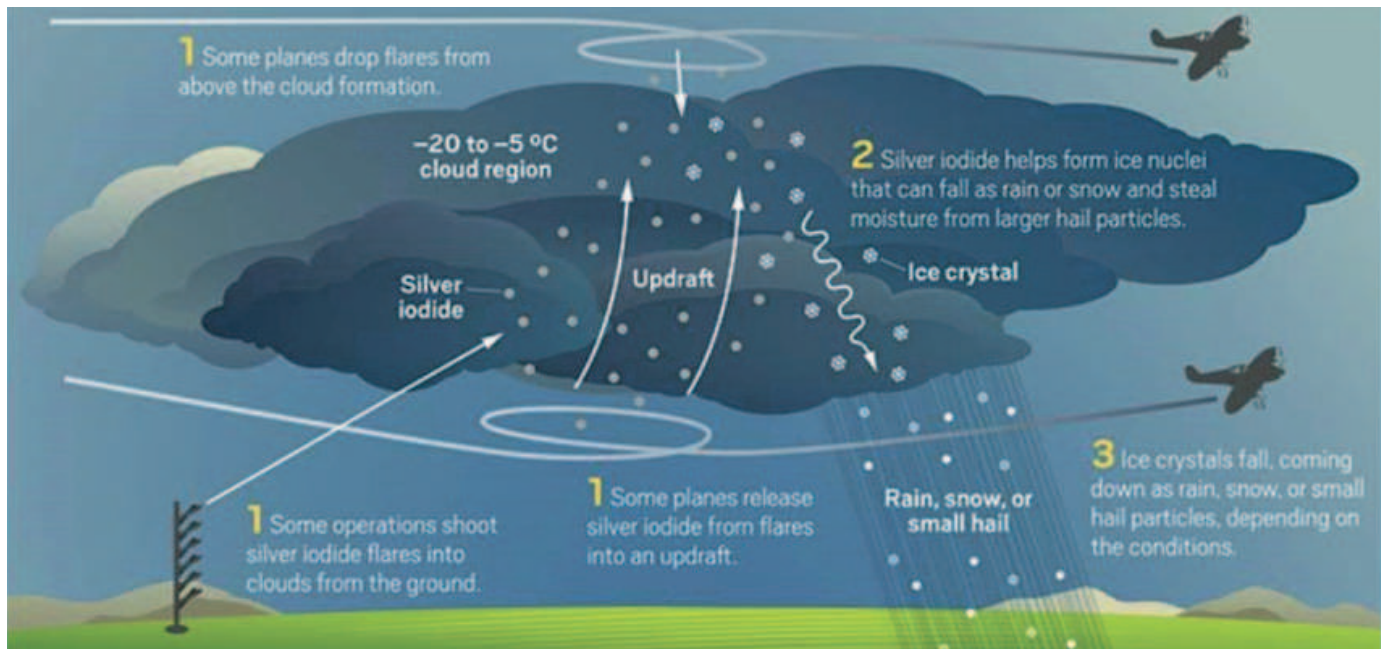
contributing their bit to the development of science & technology during the past 75 years. Dr Asima Chatterjee was a famous Indian organic chemist who developed anti-epileptic and anti-malarial medicine. Prof Janaki Ammal did pioneering research in plant breeding and cytogenetics. Dr Kamala Sohoni is known to be the first Indian woman to have received PhD in a scientific stream in the country and paved the way for many other women to take up science. She is acclaimed for her work on the nutritive value of pulses and paddy. Dr Venkataraman Radhakrishnan, son of the famous Nobel Laureate Acharya CV Raman, was a notable space scientist and the vice-president of the International Astronomical Union. Dr Benjamin Peary Pal was the first director general of the Indian Council of Agricultural Research. He did pioneering work in plant breeding, esp. on wheat, which helped tremendously in producing high-yielding wheat varieties. In the rice research area, Dr MS Swaminathan contributed significantly and was the Director of the famous International Rice Research Institute in Manila for a long time. Dr APJ Kalam, popularly known as the missile man of the country, took the Defence Research & Development Organization to a new height. The list is indeed very long, and acknowledging all of them would convert this into something less than volumes of an encyclopedia. We thus, bow to their spirit and recognise their contribution to the Indian science & technology ecosystem, esp. now as we celebrate the 75th year of Indian Independence and step into our next 25 years –the Amrit Kaal (period of much faster and more significant development of the country). Jai Bharat.

Email: nakul.parashar@vigyanprasar.gov.in

An illustration featuring a yellow and orange airplane flying through a blue sky, releasing a stream of black dots that form a map of India. Below the map, several white and light blue clouds are shown, with blue dashed lines representing rain falling from them onto a brown, hilly landscape. In the bottom left corner, a small brown structure resembling a seed disperser is shown emitting a cloud of black dots.

CLOUD-SEEDING

Cloud-seeding is a type of weather modification procedure intended to increase rainfall in a particular region. To tackle deficit in rainfall, some states have opted for cloud-seeding. Maharashtra had conducted cloud-seeding in 2015 and Karnataka in 2017. In 2018 cloud-seeding was carried out in Mysuru and Hubli regions in Karnataka. Cloud-seeding is generally done by either from the ground or by aircraft.



Steps in cloud-seeding with AgI. In hygroscopic seeding NaCl will be sprayed from the base of the cloud (Source: <https://www.climasouth.eu>)

Every year, during monsoon, several parts of India report deficit in rainfall, leading to drought conditions. To tackle this deficiency, some states have opted for cloud-seeding. Maharashtra had conducted cloud-seeding in 2015 and Karnataka in 2017. In 2018, according to the India Meteorological Department, cloud-seeding was carried out in Mysuru and Hubli regions in Karnataka in July. Similarly, in Maharashtra, it was carried out in Aurangabad, Sholapur and Ahmadnagar districts.

WHAT IS CLOUD-SEEDING AND HOW DOES IT WORK?

Cloud-seeding is a type of weather modification procedure intended to increase rainfall in a particular region. Before answering how it works, let us first see how natural rain occurs.

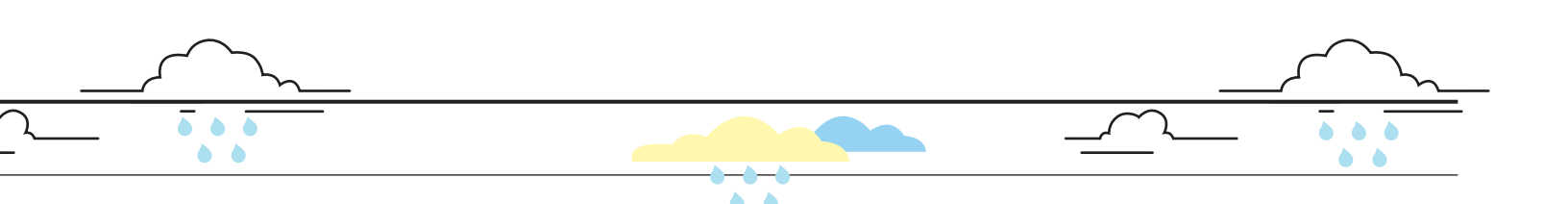
Rain is just one link in nature's water cycle. First, water in rivers, lakes, seas, oceans, etc., evaporates and rises into the atmosphere. Similarly, transpiration from trees and plants and perspiration from animals also transport moisture into atmosphere. As water vapour moves up in the atmosphere, it expands and cools. The higher the water vapour moves, the cooler it becomes. Under these conditions pure water does not freeze at 0°C. Ice crystals start forming only around minus 40°C. However, super-cooled water vapour by itself cannot produce rain, because the particles will be extremely small and diffused. It has to condense and coalesce to form large water droplets or freeze to form ice crystals, to fall as rain drops.

At mid-altitudes, where the temperature may range between minus 25 to minus 5°C, vapour condensation is the dominant process of rain formation. However, condensation

requires a surface on which water molecules can adhere to. This is provided by aerosol particles like dust, soot, black carbon from grassland and forest fires, sulphates from volcanic eruptions, etc., present in the atmosphere. Water molecules adhere to these particles by a process known as nucleation to form microscopic water droplets. This is generally what we call cloud. However, nucleation by itself is not enough for rain formation. These droplets are too tiny (about 0.02 mm) and distributed in the cloud. They have to coalesce, that is, merge with each other to form larger droplets (about 2 to 5 mm), which the cloud can no longer hold, and gravity pulls them down as rain. As the cloud extends to higher altitudes where the temperature is much lower (around minus 40°C), the "ice phase" is initiated. Water forms ice crystals and these in time grow in size and come down as rain or snow depending on the temperature of the of the lower atmosphere.

Hence, one of the basic requirements of cloud formation, in addition to sufficient moisture, is sufficient density of aerosol particles in the atmosphere. If the rainfall is limited by the scarcity of nucleating particles, cloud-seeding helps by providing additional aerosol particles around which water molecules can either freeze to form ice crystals or condense. Chemical compounds such as silver iodide (AgI) and dry ice (solid carbon dioxide) are ice phase initiators at higher altitudes and sodium chloride (NaCl), calcium chloride (CaCl₂) are known to be suitable for condensation of water molecules.

Target areas for receiving rain by cloud-seeding are selected on the basis of Moisture Adequacy Index, which gives information on the spatial and temporal availability of moisture based on satellite pictures. However, such areas should have moisture-bearing cloud cover. Doppler radars are used to identify moisture-bearing clouds over such areas.



The next step is to seed such clouds with aerosol particles to provide additional targets for moisture to condense on and form water droplets. Cloud-seeding is generally done by either from the ground or by aircraft. In the former case, canisters containing the aerosol are fired from anti-aircraft guns or rockets in which the fine particles are carried to the clouds by air currents. For release by aircraft, flares containing the chemicals are attached to the wings of the aircraft. As the aircraft flies through the designated cloud, the flares are ignited dispersing the material. “Hygroscopic” seeding is associated with warm cloud (mid-altitude) seeding. Hygroscopic salts like sodium chloride of particle size between 0.5 and 10 micron are sprayed to the base of warm clouds. As the water molecules collide with the salt particles, the salt spontaneously dissolves forming droplets of different sizes. These merge with each to form bigger droplets, which fall as rain (2 to 5 mm). At higher altitudes, silver iodide is sprayed to provide additional nucleating centres for ice crystal formation.

Cloud-seeding is also used for other forms of weather modifications such as hail storm suppression (in which large-size ice crystals fall to the ground damaging crop and property) and for dissipating fog around airports. In fact,

China claimed to have used cloud seeding technique even to suppress rain during the 2017 Olympic Games in Beijing. The principle behind these applications is “over seeding” the cloud. For example, in hailstorm suppression, the super-cooled cloud is seeded with far more silver iodide particles than required for stimulating rain. Presence of too much of nucleating material will create too many ice crystals, which compete with the available water molecules and few will grow large enough to form hail.

HOW EFFECTIVE IS CLOUD-SEEDING?

Cloud-seeding has a history of more than 70 years, and according to the World Meteorological Society, currently there are more than 80 cloud-seeding projects around the world. The USA, Russia, France, UAE, China and many other draught-prone countries practice cloud-seeding. A report published in 2016 by the *Chemistry & Engineering News* (C&EN) mentioned that more than 50 countries participated in cloud-seeding programmes. In spite of this, the big question



A technician fits canisters containing silver iodide, sodium chloride and potassium chloride onto a small aircraft for cloud-Seeding (Source: <https://www.aljazeera.com>)

about the effectiveness of cloud-seeding remains. Early practitioners claimed a 10 per cent boost in precipitation, but their studies lacked statistical rigour. The science of rainmaking has evolved since then and substantial progress has been made in understanding the natural processes that account for our daily weather. Yet, scientifically acceptable proof for significant effects of cloud-seeding has not been achieved.

A study conducted by the US National Research Council failed to find any statistically significant support for the effectiveness of cloud-seeding and it concluded, “...science is unable to say with assurance which, if any, seeding techniques produce positive effects”. In another study in 2010, Israeli scientists, by comparing rainfall statistics during periods of seeding and non-seeding over a period of 50 years, reported that they were able to explain increases in rainfall “through changing weather patterns” instead of the use of cloud-seeding. However, in 2016, the director of weather modification at the Desert Research Institute in Reno, USA claimed that cloud seeding can produce dependable and affordable water supply in many regions. Similarly, the American Meteorological Society is of the opinion that “Precipitation of super-cooled orographic clouds (clouds that develop over mountains) has been seasonably increased by 10%”. Likewise, a number of studies have been reported where some show positive results (though lacking in statistical rigour) others question its effectiveness.

Nearer home, the Karnataka government called its 2017 *Varshadare* cloud-seeding project a success. In a paper published in the journal *Atmospheric Research* (Vol.219, May 1, 2019) scientists at the Indian Institute of Tropical Meteorology, Pune, reported on “a unique study to estimate the effect of operational cloud-seeding in (i) enhancement of precipitation and (ii) availability of additional water”. They adopted two approaches to estimate the increase in rainfall: (i) Rainfalls within 4-h after seeding was compared at station levels with the rainfalls prior to seeding. (ii) The floating control-target area rainfall analysis was used to estimate the natural rainfall that would have occurred without seeding. Using a very high- resolution rain-gauge network (spatial resolution: 5 km, temporal resolution: 15 min) to measure the surface rainfall, “an analysis of 618 cases showed an average enhancement of 27.9% above the natural rainfall”. The authors concluded,

Cloud-seeding has a history of more than 70 years, and according to the World Meteorological Society, currently there are more than 80 cloud-seeding projects around the world. In spite of several claims of increase in precipitation, the big question about the effectiveness of cloud-seeding remains.

“The study showed that seeding became effective in increasing rainfall under the particular dynamic and thermodynamic conditions.”

The report expressed the hope, “The results of the study may find basis for the operational programs in the world.” Even as the 2019 cloud seeding program was in progress, as of 19 September 2019 the Karnataka State National Disaster Monitoring Centre reported increased rainfall on the days of cloud-seeding.

One of the challenges in obtaining statistically reliable results in cloud-seeding projects is in conducting control experiments.

Once a cloud is seeded, there is no way of knowing how much it would have rained if left unseeded. Also, the effectiveness depends on various environmental parameters like the temperature and composition of the cloud, the wind direction and speed, etc. Furthermore, according to the *C&EN* report, “scientists have yet to understand a critical step in natural rainmaking: ice nucleation. This process involves water vapour freezing onto particles, which leads to precipitation”.

In the early years of cloud-seeding, when AgI was found to be most effective, it was attributed to the similarities in the hexagonal crystalline lattice between AgI and ice crystals. However, experiments reported in the *Journal of American Chemical Society* in 2015 showed that there is no simple correlation between a particle’s structural similarity to ice crystals and its ability to nucleate. Similarly, bacteria are known to be very effective as nucleating agents, because the protein on its surface freeze water around the melting point of ice. Yet, the molecular mechanism of this process is unknown. Hence, the effectiveness of cloud-seeding projects has remained a point of debate. More research is needed to understand the basic mechanisms in cloud-seeding to unambiguously assess if the practice works out or not.

Another interesting question is, when is the best time to perform cloud-seeding? Since cloud seeding does not create cloud, Arlen Huggins of Desert Research Institute in Reno says, “The best time for cloud-seeding is when you have normal levels, or higher levels of precipitation. Then you could save the extra water in a reservoir for when you are in drought”.

Dr. M.S.S. Murthy retired as a senior scientist from the Bhabha Atomic Research Center. He is a popular science writer and authored several books both in English and Kannada.

E-mail: mssmurthy104@gmail.com



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Healthy Teeth for a Sparkling Smile

‘Properly aligned clean teeth add to your personality and confidence’

Healthy teeth portray healthy lifestyle. According to the folklore: Take care of your teeth on a daily basis and they will take care of you. However, despite increasing awareness about dental/oral healthcare, most of us are not accustomed to visiting a dentist for routine checkup. We show up only when a serious problem, not cured by folklore treatments or self or suggested medication(s), gets out of enduring limits. This article provides basic information on some common dental problems and dental/oral healthcare.

What are the most common dental/oral problems?

Common dental/oral problems, some of which may be preventable by practising good oral hygiene, include:

★ **Calculus or tartar**—Yellowish/brownish hard crusty deposit build-up on teeth near/below the gum line due to inadequate regular removal of

dental plaque—a sticky colourless biofilm of bacteria. Acids produced by these bacteria destroy tooth enamel resulting in bad breath, tooth decay (caries), and gum disease. Calculus is quite hard and so firmly attached that it cannot be removed with a brushing or flossing and can be removed only with ultrasonic tools or dental hand instruments such as periodontal scaler.

★ **Caries**—Commonly referred to as dental cavities or tooth decay, it is caused mainly by plaque buildup on teeth, which produces acid that destroys the tooth enamel requiring root canal treatment (RCT) and proper filling of the cavity.

★ **Tooth erosion**—Loss of tooth structure caused by acid attacking the enamel. It is irreversible loss of tooth structure due to chemical dissolution by acids not of bacterial origin; most common cause being excessive consumption of acidic foods and drinks.

★ **Tooth sensitivity, toothache**—

Discomfort or pain felt in the teeth from sweets, hot drinks, cold air/drinks or ice cream, and even while brushing and flossing is usually the result of worn tooth enamel or exposed tooth roots. However, it may be caused by other factors, such as a cavity, a cracked or chipped tooth, a worn filling, or gum disease.

★ **Tooth abscess**—A pocket of pus caused by bacterial infection. It occurs when bacteria invade the dental pulp or the innermost part of the tooth that contains blood vessels, nerves and connective tissue. It may occur at the tip of the root (periapical) or in the gums at the side of a tooth root (periodontal). It may cause severe, persistent, throbbing toothache radiating to jawbone, neck or ear, sensitivity to hot and cold beverages/foods, sensitivity to chewing or biting, fever, swelling in the face or cheek, swollen lymph nodes, and sudden rush of foul-smelling/tasting, salty fluid in the mouth. If untreated, infection may spread deeper into the jaw and

surrounding areas of head and neck or even other parts of the body.

★ Wrongly spaced, crooked, misplaced or prominent teeth - Irregularities of teeth, bite and jaws (e.g., malalignment, crowding, spacing, diastema, overjet, underbite, crossbite, overbite) requiring corrections using bands, wires, braces and other fixed or removable corrective and supportive appliances or retainers.

★ Supernumerary teeth or hyperdontia - Occurrence of teeth that appear in addition to the regular number of teeth requiring extraction.

★ Halitosis - Bad breath caused primarily by gum disease, cavities, oral cancer, dry mouth and bacteria on the tongue.

★ Gingivitis, Periodontitis - Gum disease varying from mildly swollen to bleeding gums to painful chewing and complete tooth loss.

★ Canker sores - Small, shallow lesions with red inflamed soft tissue that develop on the tongue, inside of cheeks, lips, gum line and throat, and may be caused by injury from vigorous tooth brushing, dental work, braces or dentures, or a sports accident. They can be painful and can make eating and talking difficult. Acidic foods, including citrus fruits, may trigger a canker sore or make it worse. These sores are non-contagious and usually disappear on their own but could be sign of something more serious (including HIV) if they do not go away within two weeks.

★ Fever blisters or cold sores - Caused by Herpes simplex virus (HSV-1), these appear as clusters of red, raised blisters outside the mouth, typically around lips, under the nose or chin causing itching, burning or tingling sensation. They are considered highly contagious and will come and go in 2-4 weeks without leaving a scar but are not completely curable.

★ Oral submucous fibrosis (OSMF) - A premalignant condition and crippling disease characterised by inflammation and progressive fibrosis and stiffening of oral mucosa, restriction in opening of the mouth and tongue movement, and dryness of mouth. Believed to be caused by sustained areca nut or betel quid chewing, besides other factors. OSMF

has a significant mortality rate because it can transform into oral cancer, particularly squamous cell carcinoma at a rate of 7.5%-9.5%.

★ Dental fluorosis - Common disorder characterised by hypomineralisation - a softening and discoloration - of tooth enamel due to ingestion of excessive fluoride during enamel formation of permanent teeth in childhood (up to 8 years of age).

Early use of fluoride toothpastes in young children too can lead to fluorosis in permanent teeth. It is primarily a cosmetic condition characterised by white spots/patches/lines/streaks, cloudy spotsches, brown stains or pitting on the teeth, but the damage to the enamel is permanent.

What is dental plaque and how is it formed?

Dental plaque or biofilm is a sticky, colourless film of bacteria that forms on our teeth. Often undetected, it develops when traces of food containing carbohydrates are frequently left on the teeth. Bacteria in our mouth thrive on these foods, producing acids, which if not removed by daily brushing and flossing, destroy tooth enamel resulting in dental caries and gum diseases. Brushing within 30 minutes of eating slows down bacterial colonisation of teeth. Brushing dilutes inflammatory acid and helps rid the mouth of bacteria that produce it. Gum disease begins with gingivitis caused by plaque irritating soft tissues along the gum line that gradually gets worse as the population of bacteria increase. Plaque can also develop on tooth roots under the gums and cause breakdown of bone supporting the tooth. This causes gums to recede from the teeth and may result in tooth loss or further gum infection. Inadequate removal of plaque causes built up of calculus or tartar (yellow or brownish hard crusty deposit) on the teeth near the gums, which cannot be removed by brushing or flossing.



Which toothbrush should be use?

Most dentists recommend use of a 'Soft' or 'Super-soft' toothbrush, since firmer bristled (Medium, Hard) toothbrushes can damage tooth enamel and irritate the gums. Use of brushes with flexible ribbed neck designed to prevent excessive force to teeth, enamel and gums is advisable. Electric or power

brushes have been designed to provide adequate force while brushing and to get to tough areas better than manual brushes. Toothbrush bristles wear out over time, lose their shape, flexibility and effectiveness, and may even become sharp due to friction and can cause gums to

bleed, when it is the time to change your brush. Proper care is also needed to keep the toothbrush clean and hygienic. To keep it free of airborne or hand-held contamination, store it upright so that it can dry before next use, but do not leave it open on washroom counter as flushing toilets and spraying showers can spread millions of germs over all surfaces including your toothbrush.

How to brush teeth?

It is recommended to rinse mouth with clean fresh water first thing in the morning to get rid of any leftover taste. Apply pea-sized amount of toothpaste to the toothbrush and gently rub it in circular fashion over each tooth (front, back and chewing surfaces) and along the gum line. According to the American Dental Association, for proper brushing, place your toothbrush at 45° angle to outer gum line and gently move the brush back and forth in short tooth-wide strokes. Similarly, brush inner surface of each tooth. Then brush chewing surfaces of teeth using backward and forward motion. Do not brush across your teeth. Spend two to three minutes brushing.

At the end of the day, repeat the entire brushing procedure. Ideally, brushing teeth while standing in front of a mirror helps to observe movements of the brush/floss and the teeth that

require attention. Overbrushing (brushing harshly, too much or for too long) or using medium- or hard-bristled toothbrush to achieve shiny teeth may overdo a good thing and cause 'toothbrush abrasion' leading to sensitive teeth and receding gums.

Does fluoride-containing toothpaste provide additional safety?

Toothpaste is a paste or gel dentifrice used with a toothbrush to clean and maintain health and aesthetics of the teeth. Basically, toothpastes are complex formulations with often more than 20 ingredients aimed to combat dental caries, gum disease, malodour, calculus, erosion and dentin hypersensitivity. Toothpastes also contain abrasives to clean and whiten teeth, flavours for breath freshening and dyes for better visual appeal. Recently, a few herbal/Ayurveda-based toothpastes have also been marketed. Use of fluoride-containing toothpaste and flossing between teeth at least once a day to remove food particles and bacteria can prevent plaque buildup. In fact, widespread use of fluoride has been the major factor in the decline in prevalence and severity of dental caries. However, since high fluoride concentration may increase risk of enamel fluorosis (discoloration or mottling) and tooth damage, especially in children and those living in areas with high fluoride levels in drinking water, it is important to regulate exposure to fluoride to avoid its adverse effects. It is also advisable not to stick to any brand of toothpaste over prolonged periods.

How is use of dental floss helpful?

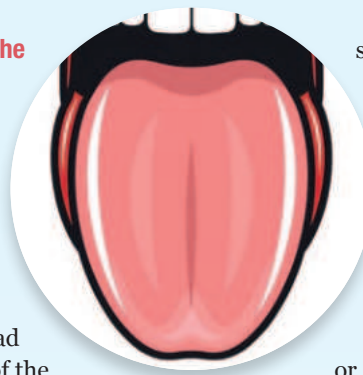
A variety of devices such as wooden and plastic toothpicks, interdental brushes and dental floss of variable thickness made from biodegradable materials is now available. Flossing is recommended to remove hidden crumbs, debris or dento-bacterial plaque from spots in between the teeth where toothbrush cannot easily reach. Flossing in combination with brushing daily prevents gum disease, bad breath and dental cavities.

Why is it useful to clean the tongue after brushing?

A tongue cleaner/scraper is an oral hygiene device designed to remove some of the millions of microorganisms (up to 500 different types of bacteria and fungi), decaying food debris and dead cells from the rear surface of the tongue. Microorganisms colonise and multiply on protein-rich areas of tongue and eventually, through saliva, reach all areas of mouth. These microorganisms contribute to periodontal problems, plaque on teeth, tooth decay, gum infections, gum recession and tooth loss. These bacteria produce malodorous compounds that account for most cases of bad breath. Toothbrushes meant for brushing teeth are not effective to clean spongy tongue tissue. Ergonomic tongue cleaners are designed in accordance with tongue anatomy and are optimised to lift and trap plaque coating, clean and massage tongue surface, prevent bad breath, improve sense of taste and stimulate secretion of digestive enzymes. It is best to scrape the tongue before using mouthwash to get most germs out of the mouth.

Is regular use of mouthwash helpful?

Nothing is more offensive and embarrassing than bad breath. Bad breath may be because of certain reasons other than bad dental health such as sinus, nose/throat infection, tonsils, allergies, smoking, constipation, indigestion, liver-malfunction, acid reflux disease, ulcers, breathing disorders, etc. It is crucial to understand exact cause of bad breath for effective treatment. Use of mouthwashes and sprays to freshen breath is recommended between meals and brushings. A variety of mouthwash preparations such as all-natural, alcohol-free, tartar/plaque control, whitening rinses, etc., are available over the counter. It is advisable to talk to a dentist who is familiar with the condition of your teeth and gums to recommend product(s) best suited to your oral hygiene needs and lifestyle. Preferably, one should use



separate mouthwash in place of the two-in-one toothpaste with built-in mouthwash.

Besides, certain homemade/folklore remedies to help treat bad breath include taking clove tea or herbal teas containing peppermint oil, sucking lemon sprinkled with a little salt, myrrh or cinnamon bark, chewing sugarless gum that also stimulates salivary glands keeping mouth moist and drinking enough water as dry mouth is the most common reason for bad breath.

Is tooth bleaching and whitening essential?

Teeth darken over time for a variety of reasons such as consumption of coffee, tea, red wine, dark colas or tobacco, antibiotic use, excessive fluoride intake, etc. Tooth bleaching and whitening is a fast-growing cosmetic trend. However, since careless use of bleaching products may damage gums, tooth enamel, dentin, pulp and other areas of the mouth, their use only under a dentist's supervision is advised. For details of Dental Specialisations, please see: Singh MM. Know Your Dentist. Science Reporter, Vol. 56(4), pp. 38-41, April 2019.

Note: This article is representative of certain (not all) dental/oral disease forms. The location, appearance and extent of each diseased condition may vary from person to person. Information embodied in this article is intended for educational purposes only and is not intended to provide medical advice, diagnosis, treatment or directions of any kind on personal health matters, which should be obtained directly from a specialist. The author thanks websites and authors of publications consulted in the preparation of this article.

Dr. Man Mohan Singh is former ICMR Emeritus Medical Scientist, Chief Scientist, Head, Endocrinology Division & Coordinator, Reproductive Health Research Program, CSIR-Central Drug Research Institute, Lucknow, and Director, Research & Development, Saraswati Dental College, Faizabad Road, Lucknow.

E-mail: singhmm46@gmail.com



The Puzzle Called PCOS

Polycystic ovarian syndrome, commonly known as PCOS, is arguably one of the most common endocrine disorders in women of reproductive age, affecting 5% to 10% of women worldwide. PCOS receives considerable attention because of its high prevalence and possible reproductive, metabolic and cardiovascular consequences. It was first described by Irving Freiler Stein and Michael Leventhal in 1935. This familial disorder appears to be inherited as a complex genetic trait. It is characterised by a combination of hyperandrogenism (either clinical or biochemical), chronic anovulation and polycystic ovaries. In simple terms, these are high levels of male hormones, irregular or skipped periods and cysts in the ovaries respectively. It is frequently associated with insulin resistance and obesity.

PCOS is a condition that alters a woman's hormone levels. It affects a woman's ovaries, the reproductive organs that produce oestrogen and progesterone—hormones that regulate the menstrual cycle. The ovaries also produce small amounts of male hormones called androgens. The release of an egg by the ovary each month is called ovulation. Two hormones called follicle-stimulating hormone (FSH) and luteinizing hormone (LH) control ovulation. FSH stimulates the ovary to produce a follicle—a sac that contains an egg—and then LH triggers the ovary to release a mature egg (ovulation).

Up to 70 percent of women with PCOS have insulin resistance, meaning that their cells cannot use insulin properly. Insulin is a hormone produced by the pancreas to help the body use sugar from foods for energy. When cells cannot use insulin properly, the body's demand for insulin increases. The pancreas makes more insulin to compensate. Extra insulin triggers the ovaries to produce

more male hormones. In PCOS, many small, fluid-filled sacs grow inside the ovaries. The word “polycystic” means “many cysts”. These sacs are follicles, each one containing an immature egg. The eggs never mature enough to ovulate. The lack of ovulation alters levels of oestrogen, progesterone, FSH, and LH. Oestrogen and progesterone levels are lower than usual, while androgen levels are higher than usual. Extra male hormones disrupt the menstrual cycle, so women with PCOS get fewer periods than usual.

Consequences of PCOS

Short-term

- ✿ Irregular menses—Women with PCOS produce higher-than-normal amounts of male hormones. This hormone imbalance causes them to skip menstrual

periods and makes it harder for them to get pregnant. The uterine lining builds up for a longer time, so the periods that they produce get can be heavier than normal. Menstrual dysfunction arises from anovulation (absence of ovulation) or oligo-ovulation (irregular ovulation) and ranges from infrequent menses to amenorrhoea, i.e., absences of menses.

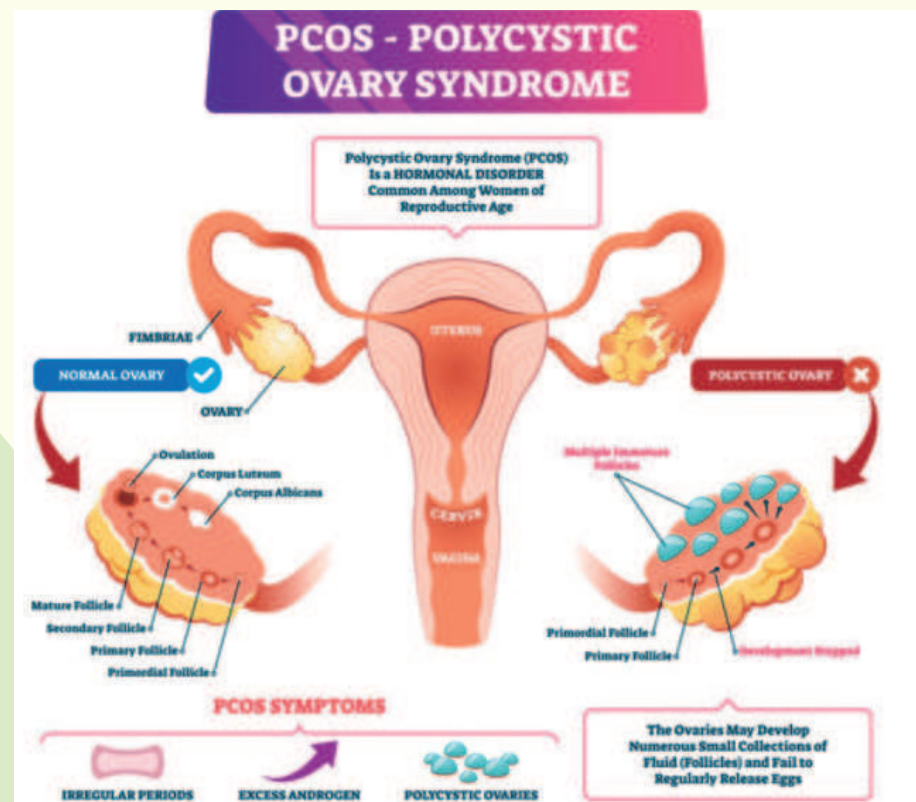
- ✿ Obesity—Up to 80 per cent of women with PCOS are overweight or obese. The body fat is usually deposited centrally in the abdominal wall (android obesity) and a higher waist-to-hip ratio is associated with insulin resistance, indicating increased risk of diabetes mellitus and cardiovascular disease.

- ✿ Acne—It usually arises in the teenage years and affects the psychological well-being of young girls.

- ✿ Excess hair—It is called hirsutism and is irreversible. The excess hair is often on face, back, chest and abdomen. It is also a result of increase in male hormones.

- ✿ Infertility—It is caused due to absence of ovulation, unlike normal women who ovulate every month.

- ✿ Depression—The combination of all



How PCOS affects ovaries. (Source: Cool Springs OBGYN)



MEDICAL SCIENCE

the above symptoms and consequences of PCOS leads to depression in women.

✿ Sleep apnoea—This condition causes repeated pauses in breathing during the night, which interrupt sleep.

✿ Abnormal lipid level—There is rise in LDL (bad cholesterol) and reduction in HDL (good cholesterol).

✿ Acanthosis nigricans—It is darkening of the area behind the neck which is caused due to insulin resistance.

Long-term

✿ Diabetes mellitus—Insulin resistance leads to diabetes mellitus.

✿ Endometrial cancer—Skipped periods lead to increased thickness of uterine lining which can lead to cancer of the uterine lining.

✿ Cardiovascular disease—There can be heart diseases due to abnormal lipid levels.

✿ Metabolic syndrome—It is not a disease in itself. It is a group of risk factors—high blood pressure, high blood sugar, unhealthy cholesterol levels and abdominal fat. These risk factors increase the risk of diabetes and heart disease.

Diagnosis

Using the Rotterdam PCOS Diagnostic criteria, the presence of at least two of the following three criteria are enough to diagnose PCOS:

1. Menstrual cycle anomalies like amenorrhoea (absence of menses) or oligomenorrhoea (prolonged interval between menses),
2. Clinical and/or biochemical hyperandrogenism (excess of androgens) and/or,
3. Ultrasound appearance of polycystic ovaries; after all other diagnoses are ruled out.

A pelvic examination, blood tests, and ultrasound can confirm the diagnosis.

Management

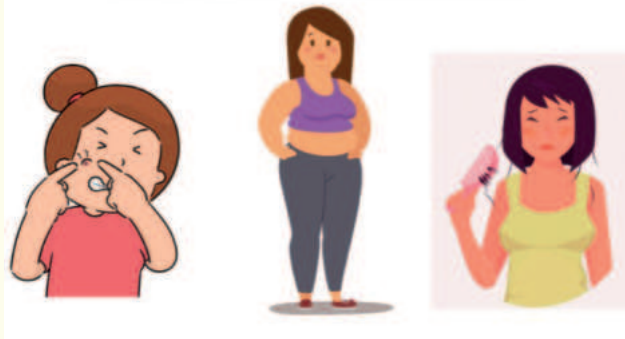
The treatment of choice for each symptom of PCOS depends on a woman's goals and the severity of endocrine

dysfunction. Thus, women who do not ovulate, but desire pregnancy will undergo significantly different treatment than adolescents with menstrual irregularity and acne. Taking oestrogen and progestin pill daily can restore a normal hormone balance, regulate

(a number from 0 to 100 assigned to a food, with pure glucose arbitrarily given the value of 100, which represents the relative rise in the blood glucose level two hours after consuming that food), which cause a spike of insulin release and must be avoided.

Common Symptoms of PCOS

- Irregular Periods
- Acne
- Excess Body Hair growth
- Skin Darkening
- Unhealthy Weight Gain
- Baldness
- Headache



Symptoms of PCOS. (Source: Onsurety Blog)

menstruation, relieve symptoms like excess hair growth, and protect against endometrial cancer.

Though medicines are available, lifestyle modification and weight reduction remain the initial recommendation for everyone. Most important is diet and exercise.

Diet

Protein and carbohydrate balance are important. Diets high in carbohydrates increase insulin secretion, whereas diets high in protein and fat lower these rates. Wholegrain, oats, sprouted grain products and food containing fibre such as fruits, green leafy vegetables must be taken. Processed carbohydrates such as white flour must be avoided. Foods like refined sugar (think of cakes, biscuits, soft drinks, and confectionery), white bread, simple starches and processed foods have a high glycemic index

Exercise

Exercise is important as it regulates menstrual cycles, restores ovulation and improves fertility. It reduces testosterone and improves acne. Exercise improves emotional health (self-esteem, anxiety, depression). It improves insulin sensitivity, enhances metabolism and helps to shed excess weight. A variety of different exercises is recommended, ranging from aerobic workouts, brisk walking, skipping, yoga and pilates (a set of specialised exercises). The optimal amount of exercise to aim is 30 minutes per day for 5 days a week. Using the stairs instead of the lift, walking in a park instead of going to a coffee shop, joining a dance class or swimming

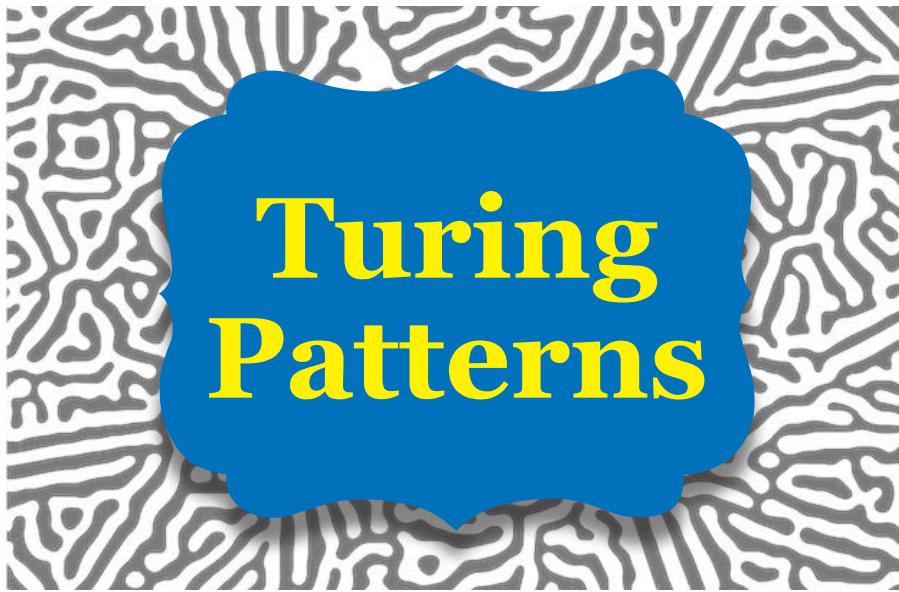
lessons, are other small steps that can be taken. Outcomes of weight management programs in women with PCOS are likely to improve with the inclusion of behavioural and psychological strategies, including goal setting, self-monitoring and relapse prevention.

Summary

PCOS can be a difficult and discouraging condition. Starting from acne to dangerous disease like diabetes, it encompasses a wide range of complications. The consequences of this disease affect both physical and mental wellbeing. However, it can be tackled with a wholesome diet, active lifestyle and a positive attitude.

Dr Tina Nath is Registrar, Dept. of Obstetrics and Gynaecology, Gauhati Medical College and Hospital, Guwahati, Assam.

Email: tinanath1@gmail.com



Turing Patterns

What is common between the zebra stripes, leopard spots and sea-snail shells? Besides being a natural phenomenon, they all may be due to a special type of chemical reaction producing the distinct pattern, first explained by Alan Turing in his seminal paper entitled “The chemical



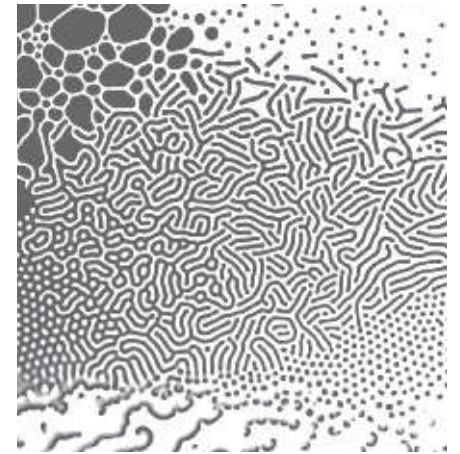
Turing Pattern at the top and a real jaguar at the bottom

basis for morphogenesis” in 1952. Turing, an original thinker of 20th century was born in London in 1912. He was primarily an English mathematician, cryptanalyst and computer scientist. His ‘Turing Machine’, invented in 1936 was a simplest implementation of computing and it helped in cracking the Enigma code used by the German navy during World War II. During his tenure at Newman’s Computing Machine Laboratory in Manchester, UK, he became interested in mathematical biology and his lone paper on this subject is considered visionary. (Fig.1)

Turing Theory

Morphogenesis is the biological process that causes an organism to develop its shape. Turing was fascinated by the fact that identical cells begin to differentiate into specialised cells and grow into complex structures like organs and limbs. The mathematical model he proposed for the interaction of morphogens (substances whose non-uniform distribution governs the pattern of tissue development) to form the

shapes is based on reaction-diffusion mechanism involving an activator and an inhibitor. When these two agents diffuse through the tissue and react with one another, the activator initiates the process of forming pockets of activation (local activation) and tries to increase its production. The inhibitor tries to halt the action of activator (long-range inhibition). Since inhibitor diffuses through the tissue faster than activator, the pockets of activation do not overrun.



Reaction-diffusion model

Depending on the chemical composition of the morphogens and the nature of interaction with each other, the pockets of activation would result in self-regulated patterns of dots, spirals and stripes. (Fig.2)

Turing’s model stood dormant for two decades as it was found that the symmetry of the cells is not disrupted by Turing mechanism but by maternal proteins diffusing from one side of the embryo. In 1972, the developmental biologists, Hans Meinhardt and Alfred Gierer at Max Planck Institute for Viral Research, (unaware of Turing’s model until a referee pointed out), devised a theory of biological pattern formation based on short-range activator and long-range inhibitor. Their computer calculations of the activator–inhibitor scheme revealed formation of spots and stripes pattern as predicted by Turing.

Experimental verification

Several theories have been put forward about how patterns in nature are

formed, but in order to validate them experimental verification is needed. If Turing Patterns were to be verified, it is imperative to identify the morphogens responsible for the pattern. One of the first experimental identifications of an activator-inhibitor system was reported by developmental biologist Jeremy Green and co-workers of King's College, London, in the ridges of the mouth palate of mouse. They were able to identify the morphogens involved as a protein called fibroblast growth factor (FGF) as the activator, and a gene variant dubbed sonic hedgehog (SHH) as the inhibitor. They also found that with the increased or decreased activity of these chemicals, the pattern of ridges was affected just as Turing's equations had predicted.

In 2006, Thomas Schlake, a biologist along with his co-workers at Max Planck Institute of Immunobiology, reported that the process of activation-inhibition plays a role in the formation of hair follicles of mice. The signalling molecule (activator) is a protein called WNT and its inhibitor is DKK protein. When the inhibitor protein concentration is high, they observed that in the genetically mutant mice, the follicle patterns matched with Turing pattern. Philip K. Maini of Oxford University and his collaborators have shown that Turing model of coupled activator-inhibitor processes can generate pigment patterns of the leopards and jaguars.

Turing Patterns have invaded the nano world, of late. In 2018, the challenging task of making materials in nanoscale have been explored by Chinese researchers, Yan Zhang of Zhejiang University and his colleagues through self-assembly method invoking Turing Patterns, in membranes for desalination of water. The polymer membrane consists of trimesoyl chloride (inhibitor) dissolved in the upper organic phase and piperazine, an amine (activator) in the lower aqueous phase.

In order to create Turing membrane,



Scientists have shown, using modern computers, that Turing's equations can be used to mimic countless two-dimensional patterns seen across the natural world, like fingerprints, semi-arid landscapes and coats of animals.



Turing patterns can also be created in nonlinear optics using LLE (the Lugiato-Lefever equation) for spontaneous pattern formation in nonlinear optical systems.



Turing pattern in sand ripple



Turing pattern is a major theory in developmental biology in providing answers to the fundamental question in morphogenesis as to how the spatial information is generated in organisms



the compounds must diffuse at the interface at different rates. When the amine is introduced through nano pores of polysulfone supporting film, it slows down the rate of diffusion of the activator amine. Further retardation of diffusion rates was achieved by increasing the viscosity of the solution with a polymer additive. Then highly ordered Turing structures started to appear on the interface creating the Turing membrane, with the characteristic features of spots and stripes. The researchers have also observed that by controlling the interfacial reaction conditions, the transition between spots and stripes can be controlled.

Applications

Although Turing's model is significant for developmental biologists, its simple core of activator-inhibitor mechanism can be applied to several other patterns. For instance, Turing mechanism is probably in play in the predator-prey model of ecosystems, where the prey functions as the activator engaged in reproducing and increasing their numbers and predators are the inhibitors balancing the natural population. They also find applications in weather systems, distribution of vegetation across landscape, sand ripples and constellations of galaxies. The simplicity of Turing mechanism perhaps is the favourite of Nature for forming diverse patterns.

Turing Patterns are gaining increased attention in the realm of research in every field of science. The complete understanding of the patterns that a system generates may require years of analysis, calculations and simulations along with extensive experimental studies.

Dr. Jayanthi Chandrasekaran is involved in teaching chemistry for undergraduates for more than two decades.

Email: jayanthc1@gmail.com

CONOTOXINS: The cone snail venoms

Cone snails (*Conus* sp.) are highly venomous, predatory gastropods that feed on worms, snails or fishes. Of all the known species of *Conus*, *Conus geographus* is the largest fish-hunting species.

Cone snail habitats include mainly tropical waters such as Indian ocean, Red sea, and Pacific Ocean. They tend to live in the deep sea near reefs and hunt primarily at night. During the day they bury in the sand and confront humans only when provoked. Their toxins have a variety of neuromuscular effects through glutamate, adrenergic, cholinergic and serotonin pathways. Some conotoxins exert their effects on sodium, potassium and calcium ion channels. Some other toxins act on hormonal receptors, stimulating effects of oxytocin and vasopressin.

Cone snails use hypodermic needle-like modified radular tooth and a venom gland to attack and paralyse their prey before engulfing it. The tooth appears like a dart or a barbed harpoon at the end of the proboscis and can be extended some distance out from the head of the snail.

The synthesis of conotoxin takes place in the epithelial cells of the venom duct and then secreted into the lumen of the venom duct. Attached to this duct is the venom bulb, which when contracted, pushes the venom into the harpoon.

Once the fish-eating cone snail detects a fish it becomes more active and moves towards the fish. It extends its snout and a long distensible proboscis is extended out of it. When the proboscis tip is close to the prey, a harpoon-like radular tooth shoots out to pierce the skin of the fish. Within a few seconds the fish is paralysed and is engulfed by the snail.



CONUS

The venom is thought to act on the victim's nervous and muscular systems.

The special interest in *C. geographus* is a result of several human deaths from its sting. Conotoxin was the first cone snail venom investigated at a biochemical and molecular genetics level. This venom is named as 'nirvana cabal' and is known to contain insulin. It is first reported example of insulin in animal venom.

One set of toxins in the venom causes depolarisation of axons at the injection site and inhibits sensory system. A second group of toxins inhibit neuromuscular transmission, resulting in irreversible paralysis.

The initial symptoms of envenomation (the process by which venom is injected by the bite or sting) vary depending on the species of cone snail and the victim. At the envenomation site, local numbness, ischaemia, cyanosis and necrosis may occur and sometime

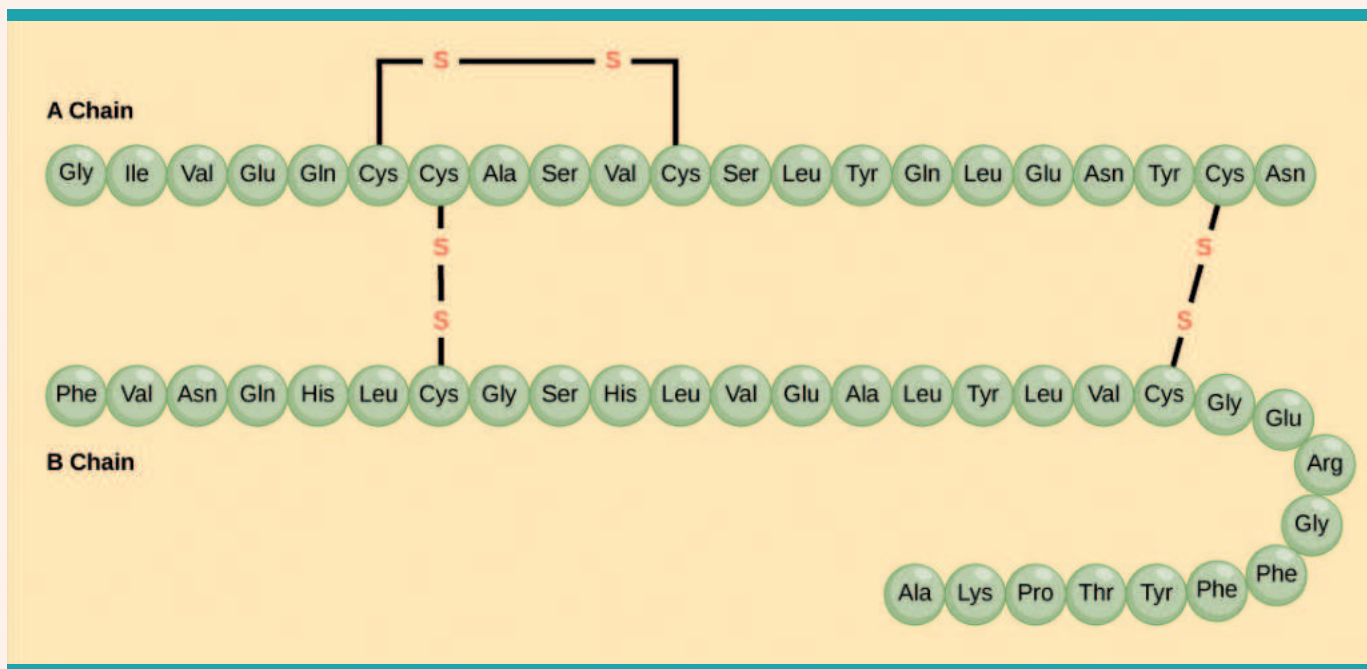
involve entire regions of the body. These progress from initial weakness, sweating and visual changes to generalised muscle paralysis, respiratory failure, cardio-muscular collapse and coma. If the patient is untreated, death is rapid and often occurs within one to five hours.

Different species of *Conus* produce venom containing 50-200 different biologically active peptides. Many conotoxins are endowed with superior

pharmacological properties. Conotoxins from *Conus magus* provided clinically and statistically significant analgesia (insensitivity to pain). This toxin has significant side effects that include abnormal gait, dizziness, fever, urinary retention, nausea, and vomiting.

Human insulin is a protein hormone secreted by the beta cells of islets of Langerhans in the pancreas. This hormone is critical for glucose homeostasis. Reduction or absence of insulin secretion results in diabetes mellitus. Human insulin consists of A and B chains connected by disulphide bonds. This hormone polymerises into a stable hexamer, comprising three insulin dimers held together by two central zinc ions.

If insulin is injected subcutaneously, the hexamer has to dissociate into the dimers and monomers in order to activate the insulin receptor. This is because, the



Insulin Structure

region involved in dimerisation of the insulin molecule, the C-terminus of the insulin B-chain is of critical importance for receptor activation. Hexamer-to-monomer conversion is a slow process that can lead to a significant delay in glucose control. Removing this region of B-chain to generate fast-acting analogue could not be achieved.

This problem is likely to be solved from the discovery of an insulin peptide found in the venom of the fish-hunting cone snail *Conus geographus*. This insulin was shown to rapidly induce insulin shock, leading to dangerously

two additional cysteines (one in each chain) that are assumed to form an additional disulphide between A and B chain. Moreover, the mature molluscan insulin chains are generally longer than vertebrate insulin.

The snail insulin con-InsG1 shows high similarity with vertebrate insulin. The con-InsG1 is more similar to fish insulin than to any other vertebrate insulin.

The cone snail insulin lacks a segment of the B chain. In human insulin this region functions to help the hormone assemble in a cluster for storage and to

that help the cone snail insulin bind to the insulin receptor. They created a truncated version of a human insulin molecule without the region responsible for clumping. They created a hybrid molecule that does not clump but binds to the human insulin receptor with high potency. This hybrid insulin is named 'mini-insulin', which interacts with insulin receptors in ways that Cone snail insulin does not. The mini-insulin had the same potency as human insulin but acted faster. Mini-insulin is very small and monomeric. Despite lack of the B chain C terminal octapeptide, this insulin has similar receptor-binding affinity to human insulin.

Because this mini-insulin is so small, it should be easy to synthesise, making it a prime candidate for the development of a new generation of insulin therapeutics.

Conotoxins have potential as biological weapons to be used in terrorism. Pathogens do not produce an infection. Humans who engage in biological warfare do so by taking advantage of these toxins producing organisms.

Conotoxins from *Conus magus* provided clinically and statistically significant analgesia. This toxin has significant side effects that include abnormal gait, dizziness, fever, urinary retention, nausea, and vomiting.

low blood sugar in its fish prey. But this insulin lacks B-chain, which is important for dimerisation and receptor binding in human insulin. Despite this, cone snail insulin (Con-InsG1) is potent against human insulin receptor.

Molluscan and most other invertebrate insulins differ from the vertebrate hormone in containing

interact with insulin receptor. The cone snail insulin, despite its smaller structure could bind to the human insulin receptor and turn on the receptor to activate signally. The cone snail insulin works faster than human insulin by avoiding the structural changes that human insulin undergoes in order to function.

Researchers isolated four amino acids

Dr.K.Venkataraman is a retired professor of Zoology, Madua College, Madurai 625011

Email: Venkat1941@gmail.com

India Science, Technology & Innovation (ISTI) Portal

The Centralised Repository of Content Generated In and By The Indian STI Ecosystem

With the vision of providing a single-window source of information about science in India by aggregating information on scientific inputs and outputs and disseminating related contents, India Science, Technology & Innovation (ISTI) Web Portal is an attempt to address the gaps in identified issues and compute the impact of funding to enhance effectiveness. The Portal leverages the Government of India's fundamental intent of funding the STI efforts across thousands of organisations, extracting the information and making it available to the scientific community and the general public. The Portal attempts to cater to all Ministries and Departments of the Government of India working in the STI space.

ISTI Portal is a centralised repository of the content generated in and by the Indian STI ecosystem with a significant thrust to reach out to students, researchers, scholars, and scientists from India and abroad to help them choose fellowships, scholarships, funding, and startup opportunities in India. It also caters to STI organisations, science ministries, departments, policymakers, decision-makers, science administrators, funding organisations, industries, associations, STI incubators, incubatees, startups, and so on.

ISTI Portal has been developed as an open access portal, with the primary objective of knowledge dissemination. The Portal presents the respective repositories of ongoing research projects, technologies, innovations, funding opportunities, programmes & schemes, scholarships & fellowships, organisations, and so on. Moreover, the Portal provides a platform where scientists and researchers can pool knowledge and skills from thousands of experts from its database. Currently, the Portal hoards 17000 research projects,

4000 technologies & innovations, 8000 organisations working in the science ecosystem, 1500 available funding opportunities, and 400 programmes and schemes, along with other similar elements. It continuously uploads all the announced calls for proposal, internship opportunities, and other funding opportunities to its diverse group of users.



A glimpse of ISTI Portal Home Page

The Portal owns a rich repository containing around one lakh unique utilitarian records with a specific dedicated web page. The advanced search facility of Portal enables users to quickly fetch the desired information with a click of a mouse within seconds. This facility directs users to explore and utilise tailor-made knowledge and information fully. The Portal is evolving with customised content for specific user groups and continuously updating the content from various science ministries, departments, funding agencies, institutions across the country, etc.

The Portal communicates, popularises and extends scientific knowledge and information by publishing numerous stories highlighting specific science events, news, cutting-edge technologies, sustainable livelihood generation, awareness of contemporary issues, and so on. The stories feature signature articles on any high-end technology, publicly relevant scientific issues and trending stories on topics

like high value research, policies, and so on. The COVID-19 pandemic unleashed a human development crisis from April 2020. On some dimensions of human development, conditions were equivalent to levels of deprivation. In those critical times, access to authentic information was of paramount importance. Understanding the need for better information dissemination and taking science to a broader audience, a dedicated section at ISTI Portal was developed to disseminate pandemic-related information by the publishing of the most relevant initiatives, efforts, and wartime protocols, engaged by the Government agencies. Considering the need to disseminate pandemic-related information, the Portal digitally published 4000 science stories, 700 research projects and 300 technologies to its repository.

As the nation celebrates "Azadi Ka Amrit Mahotsav", marking the 75 years of Independence, ISTI Portal is hosting a year-long programme "Techनीव@75", to highlight the impact of science, technology and innovation in creating social equity, inclusion and aspirations to display the STI capacity at the societal foundation level.

Around 2 lakh visitors visit the Portal every month, amongst which 80% are the most captive audiences (18-44 year age group) who utilise the available resources to generate the quality output of their research. Portal also widens its reach by disseminating the information through the popular UMANG app, managed by MeitY.

In the process, among the series of repositories, the Portal also showcases individuals' contributions to science. If you are a researcher, scientist, S&T awardee, or have contributions to science, please reach out to us at istiportal@vigyanprasar.gov.in. Also, you can visit the Portal at <https://www.indiascienceandtechnology.gov.in/> and provide your feedback.



Workshop on Science of Flight



Interactive session with the participants

Participants of the workshop, with their assembled aerodynamic model

A two-day workshop on Science of Flight: Aerodynamic Model Making was organized by Vigyan Prasar in collaboration with West Bengal State University during July 22 -23, 2022. The workshop venue was Ramakrishna Mission Vivekananda Centenary College, Rahara, West Bengal. One hundred middle school students from four schools attended the Workshop. Shri Madhav Khare was the main resource person.

The Inaugural session was attended by Shri Madhav Khare ; Swami Kamalasthananda, Principal of Ramakrishna Mission Vivekananda Centenary College; and Dr. S Mukherjee, Professor of West Bengal State University. Dr. Tuhin Pal conducted the session proceedings. Swami Kamalasthananda, in his inaugural address, explained the objective of the Workshop. Bodhisattva Maharaj, in charge of the Examination wing of the college, delivered the welcome speech. Dr. Mukherjee, in his address,

explained the rationale of organizing the Workshop and thanked Vigyan Prasar for continuous support. Shri Khare, in his address, briefed the participants about his plans for conducting the Workshop in successive sessions.

The first technical session started after the inaugural session. Beginning with a history of aircraft development, Shri Khare explained the science, engineering of aircraft, and its functioning. It was followed by a video show. Train the trainer session was organized in the post-lunch session. Selected student volunteers, teachers from the college, and a few research scholars from the university were selected for the session.

On the second day, the participants were divided into two groups, and two parallel sessions were organized. Shri Khare explained the functioning of the aircraft with the models he brought. All the participants were given hands-on training. Dr. Nakul Parashar, Director,

Vigyan Prasar, addressed the participants in both sessions separately. Dr. Parashar mentioned that Vigyan Prasar organizes activity-based Workshops for students to promote the joy of learning by doing. After attending the Workshop on the science of flight, some students may select aeronautical engineering as a career option in the future. In the post-lunch session, the participants went to an adjoining ground to demonstrate the skills they acquired in aeromodelling.

In the Valedictory Session, the participants shared their experiences. Shri Khare emphasized practicing the skills acquired in the Workshop. Dr. Parashar shared inspiring thoughts with the participants. Feedback from the participants was obtained by Dr. N. Banerjee and Dr. S. Chatterjee of the West Bengal State University. Participation certificates were given to all the participants. Word of thanks was delivered by Dr Mukherjee.