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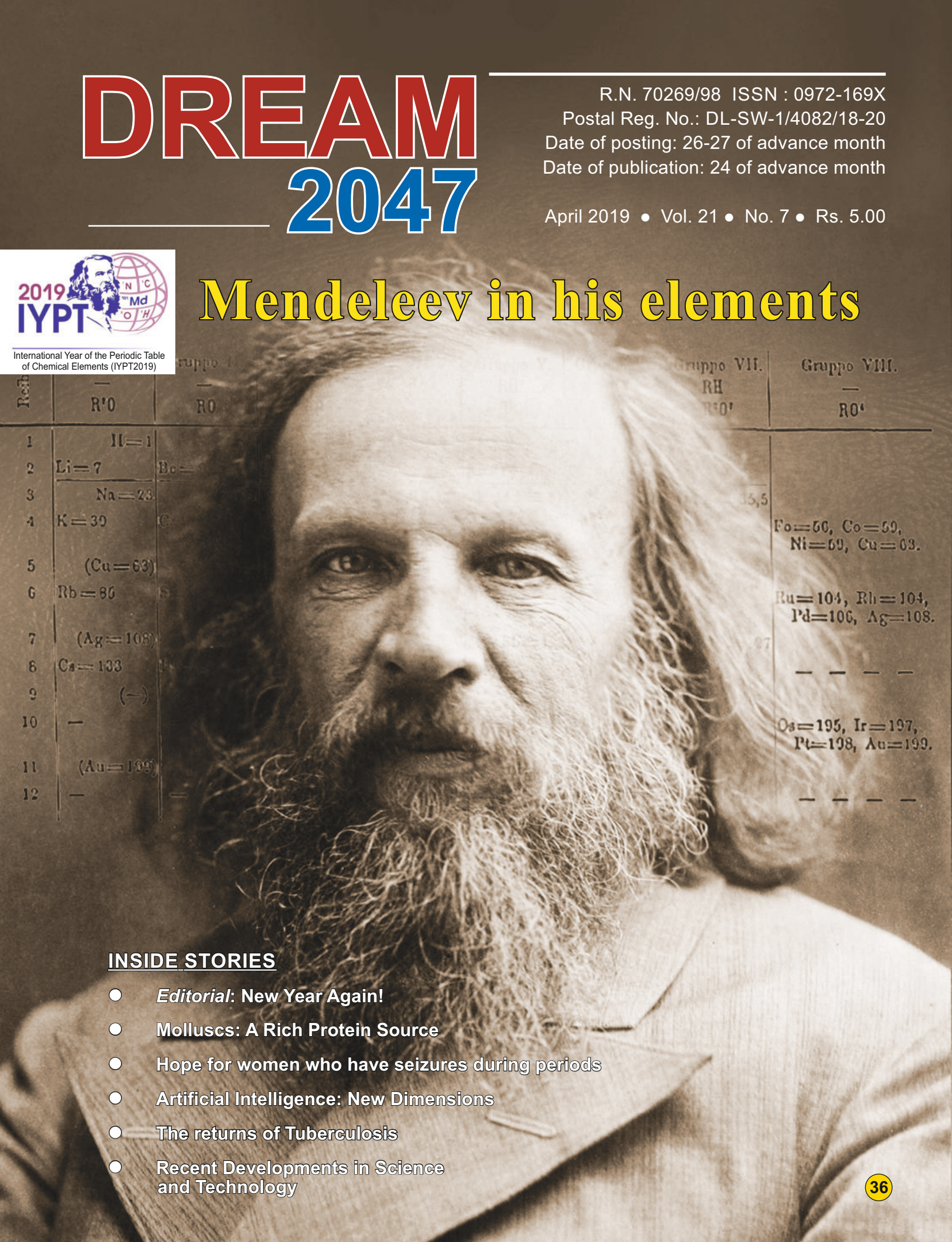
2019 IYPT
International Year of the Periodic Table of Chemical Elements (IYPT2019)

Mendeleev in his elements



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New Year Again!

Nakul Parashar

Come April when the world celebrates our foray into space!

Saare jahan se achcha (the best in the world), was the proud response from the first Indian in space, Wing Commander Rakesh Sharma, when he was asked by then prime minister Late Smt Indira Gandhi about how India looked from space. This event happened on 3 April 1984, when Wing Commander Sharma flew to space station *Salyut* 7. Launched from Baikonur Cosmodrome in the erstwhile Soviet Union (now Russia), Wing Commander Sharma spent eight days in the space station. Coincidentally 12 April every year is celebrated as the International Day of the Human Space Flight. In its resolution of 7 April 2011, the General Assembly of the United Nations said, "to celebrate each year at the international level the beginning of the space era for mankind, reaffirming the important contribution of space science and technology in achieving sustainable development goals and increasing the well-being of States and peoples, as well as ensuring the realisation of their aspiration to maintain outer space for peaceful purposes." On 12 April 1961 the first human to fly into space, Yuri Gagarin, completed one orbit of the Earth on-board *Vostok*-1.

Whether the physical exploration was done by robotic spacecraft or human spaceflight, it has been equally interesting. Topics like targets for exploration, crewed (human) or un-crewed (robotic) spaceflights, application of automated systems and the list is indeed long yet spellbinding. For deep space explorations (the exploration of distant regions of outer space), robotic spacecraft are preferred. This is because farther destinations like Saturn, Uranus, and Neptune are too far to reach with human or crewed spaceflights. Costs and lower risk factors thus play an important advantage for robotic spacecraft over crewed spaceflights.

The human mind has always been curious to explore new horizons. Despite all odds, it is surprising to know that among targets of space exploration is the mighty Sun as well. Yet, from the Apollo Telescope Mount (a solar observatory attached to *Skylab*, the first American space station) to the Parker Solar Probe, which was launched in 2018, many spacecraft have been launched specifically to study the Sun in detail.

From Sun to Moon! We all know that Moon was the first place in the space that was visited by human beings. The story began with 1959 when Soviets got the images of the so-called far side of the Moon, followed by US exploration attempt made in 1962 through *Ranger* 4. It was then followed by a series of robotic explorations up until 1969 when *Apollo* 11 got the first humans to step on the Moon. The saga continues and we expect that in 2023, Exploration Mission 2, the first crewed mission of NASA's *Orion* spacecraft, is due to perform a fly-by of the Moon and return.

Besides its connection with space, April also has many other points of relevance in the lives of our Indian populace. Several states in the country celebrate their new year. *Ugadi*, *Gudi Padwa*, *Baisakhi*, *Poila Boisakh* and many more fall in April. It also marks the beginning of our fiscal year as well. New projects and schemes that have an annual life cycle get started in April. Thus, greetings in advance.

At Vigyan Prasar too, we plan to extend our existing activities to various regional languages. In publishing, we're planning to work closely with some famous popular science magazines in regional languages so that they not only continue to exist but reach to a much bigger readership as well. A number of such publications in our country were started by scientific luminaries like Prof S.N. Bose and others. These exemplary popular science magazines continue to exist. To begin with, through print and other communication channels like radio and films, our endeavour would be to take the popular science content in three regional languages and gradually cover all official Indian languages.

However, to succeed, our endeavour requires you, your continuous feedback and support. So, wouldn't you!

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Molluscs: A Rich Protein Source


Dipanjan Ghosh and Poulomi Das

A large number of different species of molluscs are eaten worldwide. Some species are commercially exploited and shipped as part of international trade in seafood; other species are harvested, sold and consumed locally. Mollusc farming is a viable alternative, although in India it is still far from being widely followed or even accepted. In our country a huge variety of dietary systems is followed. Though the estimated protein consumption in India is mostly plant-based, economic development can be expected to increase the demand for animal-based protein.

Introduction

Molluscs, a group of invertebrate, aquatic or terrestrial animals, belong to a large phylum Mollusca which include ecologically and structurally immense variety of forms such as snails, slugs, mussels, and squids. It is one of the most diverse groups in the animal kingdom, other than arthropods, with nearly 1,00,000 described species. Molluscs have a soft unsegmented body, usually wholly or partly enclosed in a calcareous shell secreted by a soft mantle covering the body (Figure 1).

Molluscs have adapted to all habitats except air. Although basically marine, bivalves (mussels and oysters) and gastropods (snails and slugs) include freshwater species. Gastropods have also adapted to land with thousands of species living on rocky, sandy, and muddy substrata. According to an estimate, tropical rain forests of North-Eastern India and Western Ghats are the home of nearly two-thirds of the total Indian land snails.

Molluscs flourish well and reproduce mainly in the rainy season. After the onset of monsoon, all the wetlands and paddy fields of Indian plains harbour large populations of various freshwater molluscs. In summer, most of the wetlands get dried up. Hence, the molluscs have adapted to survive mainly by aestivation through burrowing under vegetation, mud, bricks or debris. Some species resort to anaerobic respiration during this period. This enables them to carry on their lives under unfavourable conditions as well.

A large number of different species of molluscs are eaten worldwide, either cooked or raw. Some species are commercially exploited and shipped as part of international trade in seafood; other species are harvested, sold and consumed locally. Some mollusc species are collected and eaten locally, but are rarely bought and sold. Some molluscs

Figure 1: Ariophanta interrupta – A terrestrial snail with a left-handed shell [Photo: SayanNeogi].

are also believed to have medicinal properties and have been used for treatment of various ailments.

In Indian cuisine

Molluscs, especially those inhabiting the coastal waters, backwaters and estuaries, are of importance in contributing a good deal to the economic well-being of our country. Snails, mussels, oysters, clams and cephalopods have been used as food for

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thousands of years. Marine molluscs are very popular in coastal regions of Kerala, Karnataka, Maharashtra, Goa, and in the Andaman and Nicobar Islands. They are either prepared with drumsticks, breadfruit or other vegetables or filled with rice and coconut paste with spices and are served hot. A well-known preparation is '*Kadukka*' of Kozhikode and Thalassery coastal area of North Kerala, in which Asian Green mussel (*Perna viridis*) and Brown mussel (*P. perna*) are stuffed with a mixture of ground raw rice paste, shallots and spices and then steamed and fried with the shell on. Another famous spicy dish '*Pachilede Pindi*' available in coastal Karnataka is actually special rice ball stuffed with spicy fried mussels and steamed.

Freshwater bivalves and gastropods are an important diet component in Eastern and North-Eastern India, particularly in West Bengal, Jharkhand, Bihar, Odisha, Assam, Manipur, Meghalaya, Mizoram, Tripura, and Arunachal Pradesh. Snails, slugs, clams and mussels are largely consumed in rural areas, especially by the marginal people to meet the daily need of proteins. Freshwater molluscs play a vital role in the economy and tradition of West Bengal, serving as a food in 81per cent families in certain populations. In the neighbouring state of Assam, molluscs are considered as a gourmet food and are popular among tribal and tea garden workers. People normally employ traditional techniques for preparation of various ethnic dishes from molluscs.

Mollusc species as food

About a dozen freshwater gastropods and bivalves are used as non-conventional animal protein source in Eastern and North East Indian cuisine. The list includes few land snail species also. The largely available edible species is localy known as 'gneri' or 'googly' (*Bellamya bengalensis*). This small freshwater snail (Figure 2) inhabits mainly in stagnant water bodies such as ponds, tanks, lakes and ditches; sometimes also found in rice fields. Gneri feeds on mainly freshwater algae like *Chara*, *Spirogyra*, and few aquatic plants like *Ceratophyllum*, *Hydrilla*, etc. 'Jolshamuk' or 'ghonga' (*Pila globosa*) is the most widely used freshwater snail species which is found mainly in waterlogged agricultural fields, ponds, or in lakes (Figure 3). These snails feed on aquatic herbs such as *Pistia*, *Vallisnaria*, *Sagittaria* and so on. Ghonga provides a good amount of flesh in comparison to that of its total body weight. 'Hamukh' or 'shamuk' (*Brotia costula*) is a freshwater edible snail occurring in habitats ranging from clear, narrowly tangled jungle creeks, comprising of sandy bottoms to large muddy rivers. This species feeds mostly on algae and detritus. 'Jhinuk' (*Lamellidens marginalis* and *L. corrianus*) and 'seepee' or 'seetui' (*Parreysia caerulea*) are mainly present in deep freshwater bodies like ponds and lakes as bottom dwellers. These freshwater bivalves (Figure 4) are harvested for food usually in the spring or summer (before rain), when the water level of their habitat remain low. Freshwater mussels mostly feed on phytoplankton, protozoans, dinoflagellates, and organic debris.

Figure 2: Googly (*Bellamya bengalensis*) is the common edible freshwater snail widely used in Indian cuisine *[Photo: Poulomi Das]*.

Figure 3: The protein content of ghonga (Pila globosa) is highest among all other freshwater gastropods found in Eastern and North-Eastern parts of India [Photo: SayanNeogi].

Some land snail species are also edible, if cooked properly. The giant land snail or 'Sthol shamuk' (*Lissachatina fulica*) is the only known species which is consumed in the North-East by aboriginal people. The species can be found in agricultural fields, natural or planted forests, shrub and scrublands and even urban areas. It eats a wide range of fruits, vegetables and agricultural wastes. Sometimes eat sand, very small stones and bones from corpses as calcium sources for its shell. Giant land snails are usually fried and served. In Manipur, a special recipe of land snail is prepared in combination with dry fish, known as '*Tharoi Thongba*'. In Tripura, people cook land snails just like other meat and sometimes the delicacy is cooked mixed with dry fish.

Occasionally, a few other species of freshwater gastropods and bivalves such as *Bellamya dissimilis*, *Gyraulus labiatus*, *Paludomus conica*, etc., are also eaten locally, though all such practices are yet to be considered as promising non-conventional food source.

Nutritional benefits

All the species of molluscs described above contain high amounts of proteins, moderate amounts of carbohydrates and little fat (Table 1). The quality of protein depends on its amino acid composition and the protein of snails and mussels contain all the essential amino acids required by humans.

Figure 4: A*part from diet component,Lamellidensmarginalis– a common freshwater mussel of India, is known to produce pearls [Photo: Sayan Neogi].*

The fat content of mollusc meat is comparatively lower than that reported for any other conventional meat. A review of the available literature has revealed that mollusc meat contains higher amounts of good fat PUFA (polyunsaturated fatty acids) than bad fat SFA (saturated fatty acids), related with atherosclerotic disorders. It is also helpful to keep off lupus, diabetes, psoriasis, obesity, rheumatoid arthritis, cystic fibrosis, etc.

Freshwater molluscs are also an excellent source of minerals, both macro- and micro-elements. Calcium and phosphorus contents are higher than all other elements. Therefore, mollusc meat could be ideal supplement for calcium and phosphorus, which help in blood clotting, bone and teeth calcification and energy generation in body cells, respectively. Higher potassium

level indicates that its daily consumption can help in normal functioning of nerves, muscles and heart tissues, sugar metabolism, ion-balance, and oxygen metabolism in the brain. A substantial quantity of magnesium and manganese suggests that molluscs could be an alternative to conventional meat which is required for bone formation, reproduction and normal functioning of the nervous and enzyme systems. Freshwater snails and mussels are rich in iron, copper and zinc contents. Iron needs to be mentioned, because in India its deficiency in diet causes widespread anaemia in infants, children, adolescents and pregnant women. Copper is an active component of some enzymes which helps in cellular respiration. Finally, zinc plays an active role in immunity and helps in cell division, growth, wound healing and the breakdown of carbohydrates.

In addition, mollusc meat contains considerable amounts of vitamin A, vitamin B_{12}, vitamin C, and vitamin D. Due to the presence of almost all the necessary nutrients, freshwater molluscs can be used as substitutes for fish and red meat. Again, as it is easier to digest than other meat, molluscs might be an important diet for children and elderly people.

Table 1.Approximate composition of edible gastropods and bivalves on the basis of dryweight (data are in per cent)*

Name of species	Moisture	Protein	Carbohydrate	Fat	Ash	Fibre
Freshwater and land snails						
Bellamya bengalensis	82.1	50.089	11.97	5.497	20.335	0.198
Pila globosa	85.5	57.048	5.62	5.0	17.924	0.177
Brotia costula	69.86	15.08	9.12	0.96	9.43	0
Lissachatina fulica	79.28	48.649	12.05	7.77	8.591	0
Freshwater Mussels						
Lamellidens marginalis	85.9	45.844	10.57	3.596	15.489	0.018
L. corrianus	84.2	45.121	9.267	3.019	14.77	0

***References:**

1] R.L. Baby, I Hasan, K A Kabir and M N Naser, Nutrient Analysis of Some Commercially Important Molluscs of Bangladesh, *Journal of Scientific Research*, Vol 2, No 2, pp 390-396, 2010.

2] O.O.Babalola and A O Akinsoyinu, Proximate Composition and Mineral Profile of Snail Meat from Different Breeds of Land Snail in Nigeria, *Pakistan Journal of Nutrition*, Vol 8, No 12, pp 1842-1844, 2009.

Medicinal uses

For a long time, molluscs have been used as medicine by aboriginal people for curing asthma, circulatory disorders, constipation, giddiness, haemorrhoids, high body temperature, nervousness, rickets, rheumatism, urticaria, etc. Snail meat is used in stroke treatment, and in treatment of whooping cough, poor eyesight and night blindness. It is said to help in restoring virility and vitality, cure hypertension and small pox. In traditional medicine, snail meat is used in the preparation of concoctions for various cases like reduction of labour pain and blood loss in pregnant women during child birth. Molluscs are also recommended for treatment of ulcer and as a curative meal for patients with diabetes. However, all these medicinal properties of molluscs are not clinically proven.

Negative impacts

In India, a large number of wetlands that are found near villages and small towns have become highly polluted, leading to problems such as eutrophication, oxygen depletion and pestilence. Some portions of most rivers, particularly when sited near urban and industrial areas, are highly polluted, due to untreated industrial effluents and the continuous dumping of raw sewage. Riverine ecosystems are threatened by pollution, encroachment, tannery discharge, and chemical run-off containing cadmium (Cd), chromium (Cr), lead (Pb) and mercury (Hg). Molluscs can accumulate metals higher than any other group of invertebrates. Heavy metal contamination in molluscs is therefore a serious concern as they occur at the lower trophic levels in the food chains for food and space. Research has also shown riverine species of gastropods and bivalves to have accumulations of arsenic (As), mercury (Hg), lead (Pb), and selenium (Se) in their tissues.

Several dinoflagellates, desmids (freshwater green algae) and cyanobacteria containing toxins are responsible for bloom in freshwater bodies. These organisms and their toxins are usually harmless to molluscs, but if these molluscs are consumed by humans, the concentrated toxins may cause poisoning which may lead to serious illness. Moreover, freshwater snails and mussels are the repository of a large number of parasitic diseases. For instance, schistosomiasis or snail fever caused by parasitic flatworms called *Schistosoma* is a very common disease. The parasite can affect liver, urinary bladder and other organs. *Echinostoma*, an intestinal fluke (trematodes) parasite, use freshwater molluscs as intermediate host. This parasite can cause a disease collectively called echinostomiasis. Paragonimiasis is also a food-borne parasitic infection caused by the lung fluke known as *Paragonimus*. All these ailments may spread through molluscs if cooked improperly.

End notes

To solve the problem of accumulation of toxins from natural habitats, mollusc farming is a viable alternative, although in India it is still far from being widely followed or even accepted. In our country a huge variety of dietary system is followed. Though the estimated protein consumption in India is mostly plant-based, economic development can be expected to increase the demand for animal-based protein. By 2050, with a population projected to reach 1.6 billion, India should explore unconventional sources to increase the protein intake level. And in this context, introduction of mollusc farming, at least at government level, for sustainable food source is worth considering. Mollusc farming may also provide healthy alternative foods, which are reasonably priced and affordable to general public.

Hope for women who have seizures during periods

Dr Chaganty Krishnakumari

The electrical activity is caused by complex chemical changes that occur in nerve cells. Brain cells either excite or inhibit (stop) other brain cells from sending messages. Usually there is a balance of cells that excite and those that can stop these messages. However, when a seizure occurs, there may be too much or too little activity, causing an imbalance between exciting and stopping activity.

Brain cells use electrical signals to communicate with each other. These electrical signals are normally very carefully regulated. When nerve cells in the brain fire electrical impulses at a rate of up to four times higher than normal, leading to a sort of electrical storm in the brain, it is known as a *seizure*. It can be described as a sudden surge of electrical activity in the brain. Seizure usually affects how a person appears or acts for a short time.

The electrical activity is caused by complex chemical changes that occur in nerve cells. Brain cells either excite or inhibit (stop) other brain cells from sending messages. Usually there is a balance of cells that excite and those that can stop these messages. However, when a seizure occurs, there may be too much or too little activity, causing an imbalance between exciting and stopping activity. The chemical changes can lead to surges of electrical activity that cause seizures. A condition of repeated seizures in a person is called epilepsy. Epilepsy and seizure disorders affect about 60 million people worldwide.

Women with epilepsy face an additional problem during menstrual period. Catamenial epilepsy is a subset of chronic epilepsy that causes a dramatic increase in seizures during a woman's menstrual periods. Catamenial seizures affect 10–70% of women with epilepsy, many of them of reproductive age. Most of these patients suffer from uncontrollable seizures, which could damage the brain and adversely impact their quality of life. Although this condition has been documented for millennia, currently there is no effective drug therapy, leaving many women and their families desperate for a cure because the mechanism of these seizures was not clearly understood until 2016.

Cracking the basic neuronal code underlying catamenial epilepsy

For the past two decades, Dr. Samba Reddy, professor of neuroscience and experimental therapeutics at the Texas A&M University College of Medicine in USA, has been searching for answers to catamenial epilepsy. His research has been pivotal in cracking the basic neuronal code underlying catamenial epilepsy and mobilising resources for researching this women-specific brain condition. His lab is mainly focussed on drug development for epilepsy and brain disorders. Dr. Reddy's research has been continuously funded by the US National Institutes of Health for over 14 years.

Dr. Reddy has carefully and thoroughly examined together the hormone mechanisms, specific models, and therapeutic strategies to treat catamenial epilepsy and published a paper in the October 2017 issue of the *Journal of Neuroscience Research*, co-authored by his doctoral student Bryan Clossen. This is the first of its kind of research to use modern transgenic tools to investigate the age-old problem of hormonal seizures in women with epilepsy.

"Normal anti-epileptic drugs don't

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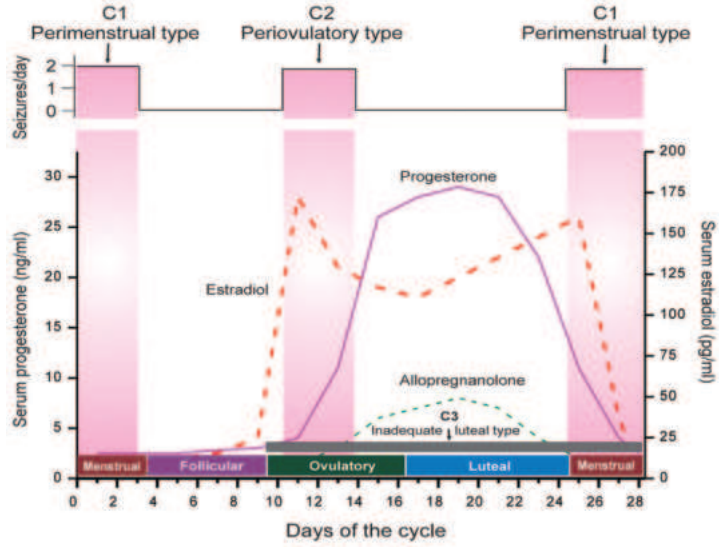
work for these patients," Dr. Reddy said. "For a long time, doctors have been treating women with catamenial epilepsy the same way that they would treat men with epilepsy. This is ineffective because the hormonal changes that occur during the menstrual cycle in women make the brain insensitive to typical epilepsy medications like diazepam and valproate."



Human menstrual cycle

The menstrual cycle

The menstrual cycle is the monthly series of changes a woman's body goes through in preparation for the possibility of pregnancy. During a woman's menstrual cycle, there are four separate phases that occur sequentially: (a) menstrual phase; (b) follicular phase; (c) ovulatory phase; and (d) luteal phase.

(a) Menstrual phase

About once a month, the uterus grows a new, thickened lining (endometrium) that can hold a fertilised egg. When there is no fertilised egg to start a pregnancy, the uterus sheds its lining. This is the monthly menstrual bleeding, also called menstruation or menstrual period that a girl will have from her early teen years until her menstrual periods end around age 50, known as menopause.

(b)The follicular phase

An ovarian follicle is a cellular aggregation set found in the ovary. It secretes hormones that influence stages of the menstrual cycle. Women begin puberty with about 400,000 follicles, each with the potential to release an egg cell (ovum) at ovulation for fertilisation. During this phase, follicles in the ovary mature during a woman's menstrual cycle. It ends with ovulation. The chief hormones controlling this stage include FSH/LH and estrogens.

(c) Ovulatory phase

In this phase, an ovarian follicle gets matured and releases its ovum.

(d) Luteal phase

The luteal phase is the latter phase of the menstrual cycle. It begins with the formation of the corpus luteum and ends in either pregnancy or luteolysis that occurs in the absence of pregnancy at the end of the luteal phase. Corpus luteum is a mass of yellow tissue that secretes progesterone, a principal hormone necessary for pregnancy.

Cyclical regression of the corpus luteum is known as "luteolysis". During this phase, body sheds the lining of the uterus (womb), completing the menstrual cycle.

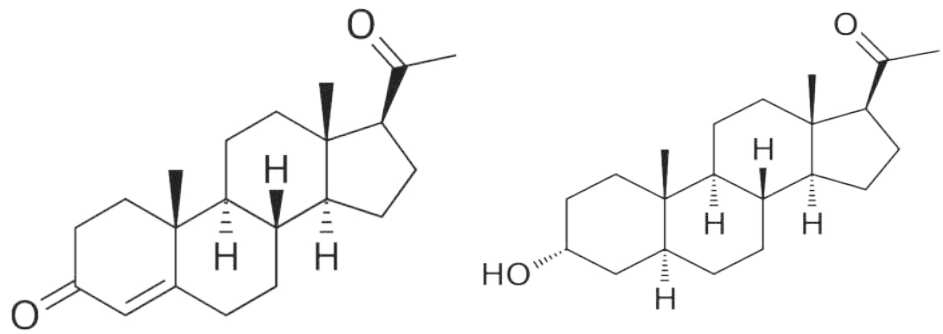
"If a brain with epilepsy is too excited, then its electrical circuits will misfire excessively and cause the person to have a seizure," Dr. Reddy said. "However, if someone with epilepsy keeps a high level of tonic inhibition (A constant, long-lasting inhibition, in contrast with phasic inhibition that describes short intermittent bursts of inhibition) in the brain, the electrical circuits do not get overexcited and a seizure will not occur."

Neurosteroids, also known as neuroactive steroids, play an important role in balancing neuronal excitability by making brain receptors either more or less responsive to the neurotransmitters that mediate tonic inhibition. When the hormone progesterone is released in the body, it travels to the brain and is converted into a neurosteroid known as allopregnanolone.

"Allopregnanolone preferentially binds to a type of receptor in the brain and makes these receptors more responsive to the neurotransmitter gamma-aminobutyric acid, also known as GABA," Dr.Reddy said.

GABA functions as an inhibitory neurotransmitter in the brain; so it is critical for individuals with chronic epilepsy. When a lot of GABA binds to GABA receptors in the brain, the electrical circuit in the brain is able to remain inhibited so that a seizure does not occur. This means that the presence of progesterone in the blood is critical to keeping seizure levels low in women with catamenial epilepsy.

Progesterone levels decrease during menstrual periods, causing allopregnanolone levels to fall, which results in extrasynaptic receptors being less sensitive to GABA and results in increased excitation in the brain. This leads to an increase in the number of seizures for women with catamenial epilepsy.



Progesterone (left), Allopregnanolone (right)

"When it comes to the menstrual phase in the cycle, the tonic inhibition in

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Artificial Intelligence: New Dimensions

Dr. Deepak Kohli

In today's world, Artificial Intelligence (AI) is being used in medical research, manufacturing, banking, sports, space stations, and in many other applications. Machines having AI can work relentlessly and with ease. AI-based health assistants are in use for the treatment of common man. Machine learning algorithms are now being associated with analytics and customer relationship management (CRM) platforms to know how companies can help the customers in a better way.

Intelligence or brain power is a significant characteristic of human being. All the achievements gained by our civilisation are the result of human intelligence, be it the invention of fire, cultivation of crops, invention of the wheel or the invention of in internal combustion engine. It is with the help of his intelligence that man can use different machines for his benefit. Now, by using the power of his brain, man has succeeded in providing artificial intelligence to machines. This artificially created brain power is called artificial intelligence or AI in abbreviated form. The 'friend suggestion' option on Facebook is a part of AI.

The founder of AI was John McCarthy. He, along with his collaborators, Herbert Simon and Allen Newell started research on Artificial Intelligence and developed facility for its execution in 1955. Their initial work was very primitive. However, things are in very advanced stage now due to the improvement in algorithms, computing ability and storage capacity (Memory) and the technology is gaining popularity.

Through AI, computer systems or machines are being designed in a way that they may they may take decisions, discriminate between right or wrong, remember scenes, identify people, or do other such things that humans can do, easily. In simple language, machines are being given a brain similar to the brain of human beings so that they may take decisions like humans. If a machine can recognise a person, play chess with him/her, the machine is said to have AI. This is the technology which has made possible to run unmanned vehicles and planes.

In today's world, AI is being used in medical research, manufacturing, banking, sports, space stations, and much more. Machines having AI can work relentlessly and with ease. Let us now see how AI is being used in different fields.

In the field of medical research things like X-ray imaging, performing surgeries, diagnosis of diseases, etc., are being carried out with the help of AI. These days, a powerful AI system known as IBM Watson Health is quite popular for medical diagnosis and is being used in many leading hospitals. Moreover, AI-based health assistants are also in use for the treatment of common man.

AI is used in the field of sports equally effectively to capture the images of crucial stages of the event so that appropriate strategies may be adopted as per the situation of the field. AI not only helps reporting better play methods but also suggests play strategies to the coach. It may be mentioned here that the Deep Blue computer of IBM having AI has defeated famous chess player Garry Kasparov.

Similarly, AI is being used in manufacturing where it not only improves manufacturing but also provides support to the manufacturing process. AI is being used in robots that can show emotions through facial expressions. The robot *Sophia*, which was brought out in 2016, is an excellent

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example of AI. This robot can converse with people and has appeared in many interviews.

In the field education, automatic grading can be done with the help of AI which provides ample time for the teachers to teach the classes. With the help of AI, a child can be evaluated in a better way. His/her needs, the subjects he/she is weak in, can be understood better and can be helped accordingly. Currently students are getting their problems solved comfortably from their home with the help of AI tutors. Due to this their interest in studies is also increased.

With the help of robotic process automation, frequently repeated actions are being done using machines. Machine learning algorithms are now being associated with analytics and customer relationship management (CRM) platforms to know how companies can help the customers in a better way. Chatbots, which are computer programs designed to simulate conversation with human users, especially over the internet are being attached to websites to provided fast services to the consumers. Thus, AI is also helping in business.

With the help of AI financial institutions are getting a lot of advantages. Earlier, companies had to spend a lot of money and time on data analysis, but now AI helps do all this in a very short time and at much less cost.

In our day-to-day life we are using many techniques of AI. Operating systems like iOS, Android and Windows used in mobile phones are common examples. Using these operating systems in our mobiles we can search for anything on the net by voice command without typing it. Moreover, recommendation for music and films on YouTube, smart home appliances, safety surveillance, smart car, etc., are the gifts of AI. Google assistant, Amazon Alexa, Apple CT, Microsoft Cortina, etc., are operated by AI.

Studies on AI are being speeded up and heavy investment is being done in this field. Be it manufacturing of automatic cars or that of a computer capable of defeating human players, many companies are working in the field. Fortified by AI, Google's AlphaGo can defeat human player in a computer board game called Go. This clearly shows that AI has the potential to surpass humans.

AI may have many advantages and positive influences; for example, we can introduce brain power equivalent to a human's in machines. However, introducing emotions in machines is not possible at present. Machines devoid of emotions will work as per programme and hence will perform their job without any fault. Such machines will perform without any rest and hence the job can be done at a faster pace. Not only this. Instead of a working period of 8 hours for humans, a machine worker may remain on job 24×7 continuously.

There are many jobs which we want to do but avoid due to the risks involved; machines equipped with AI can do all such jobs without fear. There may be places where we cannot go, but these machines can be easily sent there.

On the one hand we have advantages of AI, but AI also has disadvantages and negative effects. The greatest negative effect on our lives will be regarding employment. Machines capable of thinking and working like humans will be more efficient and cost-effective and will be preferred, thus reducing human employment.

Undoubtedly, the new technologies have made us lethargic. We have developed a tendency of depending on machines. When thinking and rationalising machines will be in vogue, we will stop using our brain and may get fully dependent on machines. This will affect our thinking and decision-making ability.

The coming generation will be very badly affected by this technology. We used to read books to find answers to the problems in our school home work, but our children today depend on computer to solve every basic problem. They get everything without much struggle. In the times to come the future generations having facilities of newer technologies of AI will stop using their brains which will have a negative effect on their mutual growth.

AI may also help develop powerful automatic weapons or devices with the help of which a few people may be able to exploit a vast population. This may also give a big blow to the economy. Moreover, AI may make machines free from the control of humans in future, resulting in a clash between machines and men.

In a nutshell, artificial intelligence may be boon or a bane; it will depend only on us and the way we use it.

(Translated by Shri R.S. Dass) ■

Hope for women who have seizures during periods

(Continue from page 30)

the brain vanishes because there is very little neurosteroid being produced," Dr.Reddy said. "As a result, the inhibition levels are reduced and the circuits become hyper-excitable."

In this study, Dr. Reddy and his student Clossen used mice lacking extra synaptic δ GABA-A receptors to investigate whether reduction of tonic inhibition affects catamenial seizure susceptibility or intensity. They examined the impact of decreased levels of neurosteroids in the hippocampus, an area in the brain that regulates seizure circuits.

They removed the extra synaptic δ GABA-A receptors that mediate tonic, or sustained, inhibition in the brain to check the hippocampal vulnerability to seizures. Then the menstrual cycle was simulated by varying circulating levels of neurosteroids like allopregnanolone. Their results showed a significant increase in the severity and duration of seizures when neurosteroid levels were low.

"We cracked the neuronal code of tonic inhibition, the electrical circuit shunting force mediated by extrasynaptic δ GABA-A receptors in the hippocampus, as the major regulator of the catamenial seizures," Dr.Reddy said. "This opens up the possibility to start clinical trials that focus on treating catamenial epilepsy with synthetic neurosteroid agents that enhance tonic inhibition."

The paper's findings provide a possible latform for clinical trials that take the research from laboratory to therapy of catamenial epilepsy. A pulse therapy with low doses of neurosteroid agents may help control catamenial seizures without side effects. ■

Mendeleev in his elements

Dr. Jayanthi Chandrasekaran

To mark the 150th anniversary of the publication of Mendeleev's periodic table of chemical elements, the year 2019 has been declared as the "International Year of the Periodic Table of Chemical Elements," or "IYPT 2019" by UNESCO. The periodic table is an invaluable reference tool for chemists and by its design enables discovery of chemical elements and their characterisation. To this day, scientists continue to modify the periodic table as new elements are discovered or synthesised.

The periodic table is an invaluable reference tool for chemists and by its design enables discovery of chemical elements and their characterisation. To this day, scientists continue to modify the periodic table as new elements are discovered or synthesised. Dmitri Ivanovich Mendeleev, a Russian chemist and professor of chemistry in St. Petersburg University is considered the father of the periodic table. His method of organisation and arrangement of chemical elements in 1869, known as the periodic table, is being feted globally in the year 2019, which has been declared as the "International Year of the Periodic Table of Chemical Elements," or "IYPT 2019" by UNESCO to mark the 150th anniversary of the publication of Mendeleev's periodic table of chemical elements

The chemical elements

The periodic table is an arrangement of all the known and yet to be discovered chemical elements, which make up everything around us and the entire universe. The element carbon is found in all living things.We breath oxygen in and out constantly to live. Nitrogen is an essential part of the food we grow and eat. Hydrogen is part of theSun that keeps our planet warm and gives us light. Fluorine is essential for healthy teeth.Sodium and chlorinemake up the common salt that makes our food tasty. Calcium is essential for healthy bones. Less familiar elements like neodymium and rare-earth elementsare used in cell phones, and the list is endless. The world would be a duller place without the gleam of gold or sparkle of chromium. Seven elements, namely iron, carbon, gold, silver, uranium, titanium, and siliconhave changed modern life, for good and ill.

Periodicity

The first chemical element to be discovered in 1669 was phosphorous by Hennig Brand, a German merchant, pharmacist and alchemist. In the century that followed, chemistry was a patchwork of observations and discoveries.By the beginning of 19th century,some47 elements had been discovered providing enough data for chemists to see the patterns.The first attempt to group together the chemical elements according to atomic weights was made by Johann Wolfgang Dobereiner (1829).

In 1862, Alexandre-EmileBeguyer de Chancourtois, a French geologist, was the first to notice a sort ofperiodicity among the elements known at that time. He found that when the elements were arranged in order of increasing atomic weights, the chemical properties were repeated. Because the properties repeated themselves regularly, or periodically, the chart came to be known as the periodic table.

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Two otherchemists Lothar Meyer and John Newlands published their versions of periodic table in 1864 and 1865, respectively. Their periodic tables were also based on chemical properties wherein elements with similar properties were grouped together.

Mendeleev's periodic table

In 1869, Mendeleev also came up with a comprehensive list of all the 63 elements known then, arranging them in the increasing order of atomic weights such that groups of elements with similar properties fell into the same positions in vertical columns in his table. While both the periodicity and serial arrangement of elements according to atomic weights were known by then, two facts stood out in Mendeleev's table thatdeclared his genius to the world. He laid more stress on similarity in properties rather than on increasein atomic weight of the elements. So, whenever a particular element did not fit in the arrangement, he left a gap in the periodic table. Besides leaving a gap, he went a step ahead and predicted the properties of the undiscovered elements by considering the properties of adjacent elements.

For example, the space below aluminium in the table was left empty and referred as *eka*-aluminium (*eka* means one in Sanskrit; *eka*-aluminium is one step down from aluminium in his table) with the prediction that its atomic weight would be 68, it would be a solid at room temperature, lustrous, conductor of heat, can be flattened into sheets, drawn out as wires, and would have a low melting point and the density of 6g/cm^3.

These were no magic predictions but were deduced by Mendeleev'sunderstanding of the properties of the other elements surrounding the *eka*-aluminium in his table. Six years later, in 1875, a French chemist by name Paul-Émile Lecoq de Boisbaudran discovered a new element from an ore sample and named it gallium after Gaul, the historical name of France. Gallium, with an atomic weight of 69.72 and density of 5.9 g/cm^{3}anda melting point of30°C, is a solid at room temperature and turned out to be the *eka*-aluminium of Mendeleev.

The other "missing" elements *eka*-boron (scandium) and*eka*-silicon (germanium) were also discovered subsequently, conforming to the basic characteristics Mendeleev had recorded. The accuracy of those predictions led to the periodic table's acceptance. The element *eka*-manganese in his table is now known as technetium. Technetium is very rare in Earth's crust and was synthesised in a cyclotron in 1937, thirtyyears after Mendeleev's death.

Using his periodic table, Mendeleev boldly proposed that some of the elements, whose behaviour did not agree with his predictions, must have had their atomic weights measured incorrectly. Indeed, Mendeleev's periodic table helped in correcting the atomic masses of some of the elements, based on their positions in the periodic table. For example, the atomic mass of beryllium was corrected from 13.5 to 9. Atomic masses of indium, gold, and platinum were also corrected.

There was, however, a basic flaw in Mendeleev's table: the position predicted by an element's atomic weight did not always match the position predicted by its chemical properties. In these cases, elements were positioned in the periodic table according to their properties, rather than their atomic weights.

One of Mendeleev's insights is illustrated by the elements tellurium and iodine.Iodine has a lower relative atomic mass than tellurium. So, iodine should be placed before tellurium in Mendeleev's table. However, iodine has chemical properties similar tothose of chlorine and bromine. To make iodine line up with chlorine and bromine in his table, Mendeleev reversedtheir positions. He simply assumed that there was an error in the determination of one or both of the atomic masses and went on to incorporate this "correction" in his 1871 table listing the atomic weight of tellurium as 125. But the "correction" was erroneous. Mendeleev was right to put tellurium in the same group with sulphur and oxygen; however, strict order of atomic weights according to the best information he had available would have required iodine (127) to come before tellurium (128). While his suggestion to change the atomic weight of tellurium was wrong, his classification was proved to be correct in later years. The error occurred because his periodic table was produced without any knowledge of the atomic structure.

In 1913, when English physicist Henry Moseley arranged the elements in the periodic table by the increasingnumber of protons (atomic number) rather than their atomic weights (mass numbers), the flaws in the periodic table that had been making scientists uncomfortable for decades simply disappeared. This was possible because 'atomic number' of an element is a more fundamental property than atomic weight. Thus, the modern periodic law states that the properties of the elements are periodic functions of their atomic numbers.

Though Mendeleev was denied the Nobel prize, he received an exclusive honour. In 1955, scientists at the University of California, Berkeley created 17 atoms of an element previously undiscovered. This element filled the empty spot,101 of the modern periodic table and was officially named Mendelevium in his honour. The Russian Chemical Society and a Moon crater are also named after Mendeleev. So next time you look at the periodic table, you know that you are in the presence of 'Mendeleev in his elements'.

The returns of Tuberculosis

Alok Kumar Mishra

Tuberculosis is an ancient disease and continues to be a serious infectious killer. From the pre-antibiotic era, when TB infected persons were kept in sanatoriums due to unavailability of any effective medication, we have come a long way. The first effective vaccine against TB was developed in 1921. After that, a sharp decrease in the incidences of TB was observed worldwide. When the world started believing that TB is almost eradicated, the resurgence of the deadly disease happened in the form of drug-resistant TB. Now there is multi-drug resistant TB, causing a threat to all of us. It has now become imperative to ensure that people know how the disease is spread, why proper medication is essential. Public awareness of the disease is now the need of the hour.

Tuberculosis (TB) is caused by an airborne infectious agent, *Mycobacterium tuberculosis*. It is an ancient disease and continues to be the second largest infectious killer worldwide after HIV. Tuberculosis is believed to have been introduced into the human population with the domestication of cattle around 5,000 BCE. The causative agent of human tuberculosis is very similar to the bacterium *Mycobacterium bovis*, which causes TB in cattle. The signs of TB have also been seen in the fragments of a spinal column of Egyptian mummies of 2400 BCE. Since it first appeared in human population, TB has plagued large populations of the world. According to the World Health Organisation (WHO), every third individual of the human population is latently infected with the TB bacterium.

The infection of TB without disease symptoms or progression of pathological conditions is called latent TB infection. However, latent infections may turn active in 10% cases and develop into active disease. Although TB has been a malady of mainly the poor and majorly victimised the underprivileged societies since antiquity, some examples from the best and the brightest through the course of human history made it to be called as an indiscriminate killer. The most notable examples of the great personalities who suffered from TB have been the Royals, philosophers, politicians and writers. Aurangzeb, the Mughal emperor; John Keats, the great poet; Emily Jane Brontë, the English novelist and poet; Eleanor Roosevelt, the American politician, diplomat and activist; Henry VII, the King of England; Louis XVII; son of the King of France; Muhammed Ali Jinnah, the politician and the founder of Pakistan; Srinivasa Ramanujan, an all-time great mathematician; Kamala Nehru, wife of Jawaharlal Nehru; and many other famous people in the world have been afflicted with the dreaded disease.

Battle with tuberculosis

In 1720, the English physician Benjamin Marten surmised for the first time, that TB could be caused by "wonderfully minute living creatures". In the battle against tuberculosis, the first and foremost step had been the introduction of sanatorium cure in the late nineteenth and early twentieth century in the pre-antibiotic era. Sanatoria were the health resorts where the tuberculosis patients were used to be kept so that they could get fresh air and sunlight. In 1882, German physician and microbiologist Robert Koch discovered the microbial cause of TB, which revolutionised the development of vaccine and effective drugs to combat the disease. The first effective vaccine was developed in 1921 by French bacteriologists Albert Camille Guérin. In his honour, the vaccine was named as Bacille Calmette-Guerin or BCG vaccine. Antibacterial drugs such as sulfonamide and penicillin had been discovered in the early 1990s and chemotherapy for infectious diseases had been started, but these antibacterial agents were ineffective against *M. tuberculosis.*

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Further, by systematic screening of soil bacteria and fungi, Ukrainian-born, American biochemist and microbiologist Selman Waksman discovered actinomycin in 1914. Although actinomycin was an effective drug against *M. tuberculosis*, it could not be introduced into TB chemotherapy due to its high toxicity in human and animals. In 1943, Streptomycin was successfully purified from the soil bacterium *Streptomyces griseus.* Streptomycin had excellent inhibitory activity against *M. tuberculosis* with comparatively low toxicity to humans and animals. The first administration of the antibiotic in critically ill TB patients was done in 1944. The drug showed impressive effects on the disease and the patients made quick recovery. The drug did have some side effects, but TB was no longer unbeatable. Now it was possible to cure the people afflicted with the deadly disease.

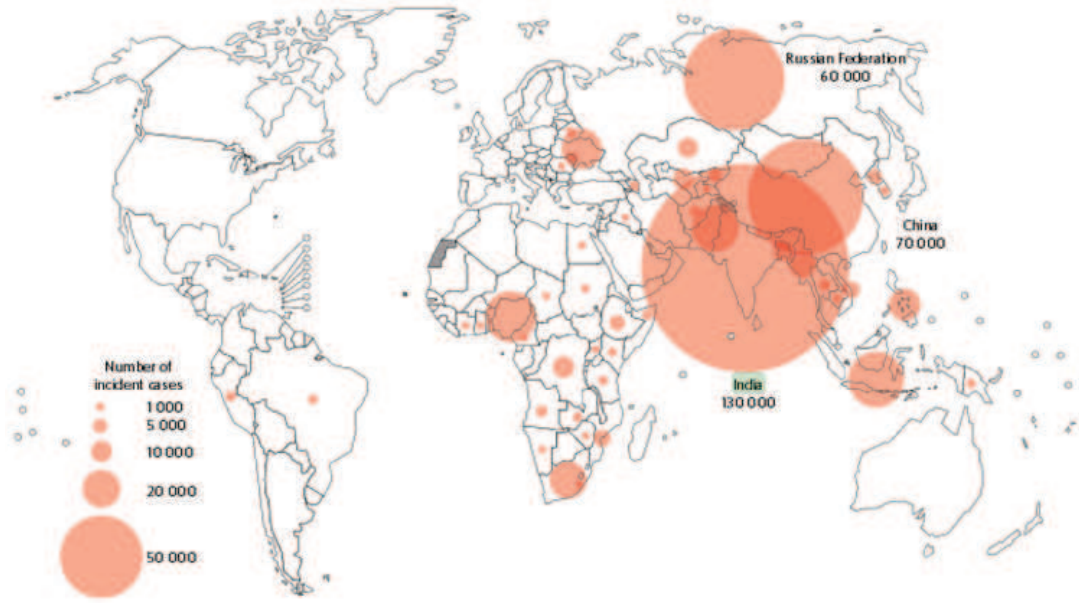

Figure 1. WHO, Global TB report 2016. India has the highest Burden of MDR/RR TB

However, the success of streptomycin monotherapy (single-drug treatment) did not last long, resistant mycobacterial strains began to appear, which endangered the success of antibiotic therapy in near future. Therefore, rapid introduction of new antibiotics was important to outpace the problem of emerging drug resistance. In the subsequent years, a large number of antibiotics had been introduced in clinical practice for management of TB. To overcome the problem of drug resistance, streptomycin monotherapy was replaced by a multi-drug therapy in which a combination of more than one drug is given. Multi-drug therapy drastically reduced the probability of the bacterium getting resistant to drugs.

Drug-resistant TB

Drug-resistant TB means that certain drugs are ineffective against the infection. Drug-resistant TB has been categorised on the basis of its resistance against multiple drugs. The current regimen of the anti-TB chemotherapy is comprised of a two-step treatment. In the first line of treatment, four antibiotics, namely Isoniazid, Rifampicin, Pyrazinamide, and Ethambutol are given orally, whereas in the second line, three injectable drugs, Kanamycin, Amikacin, and Capreomycin are used. If a TB patient is found insensitive to rifampicin is termed as Rifampicin Resistant or RR-TB, whereas if the resistance is for at least two first-line anti-TB drugs(Rifampicin and Isoniazid) they are kept under the category of multidrug-resistant or MDR-TB. Moreover, if the resistance is against more than one first-line anti-TB drug and at least one-second line injectable drug then it is labelled as a case of extensive drug resistance or XDR-TB.

Resurgence of tuberculosis

Since the advent of the golden age of antibiotics (1940s-1960s) a sharp decrease in the incidences of TB was observed worldwide. Several developed countries even proclaimed that TB is no longer a public health concern for them. The rapid global decline of the disease burden made the people envisage the complete eradication of tuberculosis in near future. The discoveries by Koch, the introduction of effective vaccine and antibiotics during the 1940s to 1960s led to the belief that TB was almost defeated. Indeed, at one point, it was, predicted that TB would be totally eliminated worldwide by 2025. However, the belief was broken by the worldwide reports of cases of MDR-TB.

After a phase of rapid decline, TB has turned back with its ugliest face. The resurgence of TB in its new resistant form was so dreadful that the WHO had to declare it as a global emergency in 1993. TB is the first disease which had been perceived and declared as global healthcare emergency by WHO. The TB bacterium poses a severe strain on the poor economies of the world and creates a vicious downfall of the socioeconomically underprivileged communities. The communities living in poverty with limited access to the healthcare facilities and often suffering from malnutrition have been the major targets of TB. Along with several socioeconomic factors responsible for the return of TB, the emergence of drug resistance, the association of TB with the immunosuppressive syndromes such as HIV AIDS, and lifestyle disorders such as diabetes have been identified as the major reasons.`

The outbreak of MDR-TB

The emergence of multi-drug resistance in 1982 alarmed the world for a worse situation than ever before. Unfortunately, our powerful antibiotics, so-called magic bullets, acted as a double-edged sword. The antibiotics not only killed the susceptible bacteria but also selected the resistant strains. The unnoticed side-effect of the use of antibiotics against tuberculosis came into the picture with the outbreak of multidrug-resistant strains in the 1980s. The emergence of drug resistance in *M. tuberculosis* created a severe healthcare

challenge for both rich and poor economies of the world. In its second innings, the pathogen came back with an evolved form against which our miracle antibiotics are ineffective. There are two main reasons for developing resistance: either the patients don't take their drugs properly or they get the infection from someone who has already got drug-resistant TB. Moreover, the association of mycobacterium in spreading epidemics of HIV-AIDS and diabetes has exacerbated the problem several folds.

Association of TB with HIV

Other than the emergence of drug resistance, the onset of the HIV epidemic in 1980's has had an unprecedented impact on the epidemiology of TB and majorly contributed in its resurgence. The human immunodeficiency virus (HIV), the causative agent of acquired immunodeficiency syndrome (AIDS) compromises the immunity of the infected person. Since TB targets persons with weak immune system, patients suffering from AIDS become more vulnerable to TB. A patient co-infected with HIV and TB is four times more unlikely to recover from the disease, as compared to one who has only TB infection. Thus, the emergence of HIV has not only increased the global TB burden and TB-associated mortality but it also has made the diagnostics of TB much more difficult. According to WHO estimates, about one-third of the HIV-infected population in the world is also latently infected with TB. While the risk of developing active TB among the latently infected population is only about 10% in their lifetimes, among AIDS patients the chance of the activation of the disease is much higher. TB accounts for the major cause of mortality in HIV patients; hence, the spread of HIV has significantly contributed to the surge in TB cases. In fact, the HIV-TB association is posing a significant social and economic threat by infecting young adults in their most productive years of life.

Association of TB with diabetes

The association between diabetes mellitus and TB has been recognised for centuries. In recent decades, incidence of TB has declined in high-income countries, but incidence remains high in countries that have high rates of infection with HIV, a high prevalence of malnutrition, lack of awareness or poor implementation of TB control strategies. At the same time, rising prevalence of diabetes mellitus globally has created a new challenge for TB management. There is growing evidence that diabetes is a vital risk factor for TB affecting disease presentation and treatment response. Recent studies suggest that among total TB cases, 15% cases are associated with diabetic population. Diabetes leads to immune suppression, which in turn makes the patient more vulnerable to acquiring active TB disease either by reactivation of latent TB infection or new infection from outside. TB and diabetes together set hurdles for the treatment of each condition. The lengthy treatment of TB complicates the management of a patient's glucose levels, whilst TB patients who are diabetic are less likely to recover from TB treatments. Although, the introduction of insulin in the 1920s and the discoveries of several antibiotics have substantially lowered the diabetic TB mortality rate, the worldwide emergence of non-insulin-dependent diabetes mellitus remains the next global challenge.

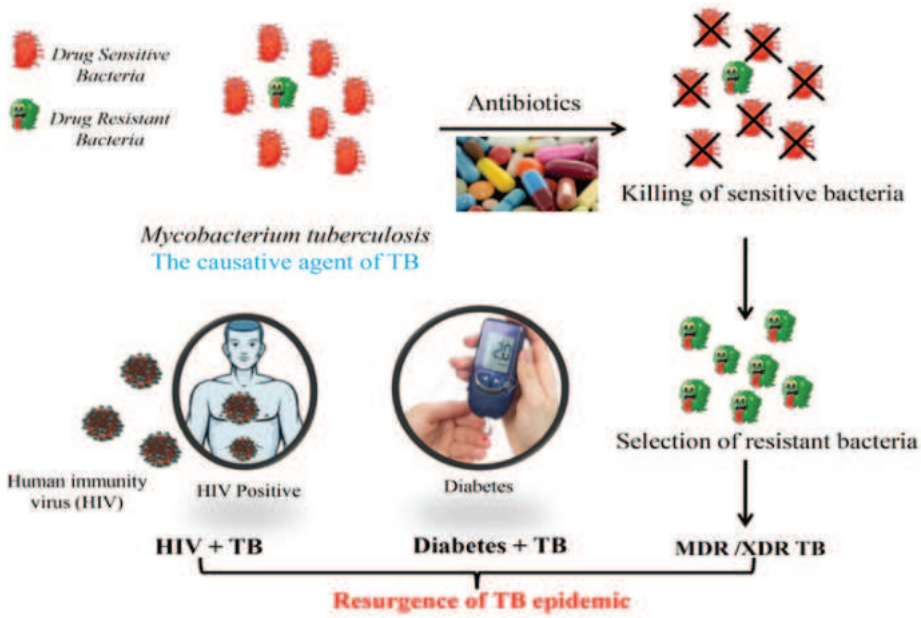

Figure 2. The emergence of drug resistance and association with diabetes and HIV AIDS

Collapse of treatment

It is often suggested that TB treatment fails because a patient doesn't take their TB drugs properly. However, there may be a number of different grounds for TB treatment failure. It is unquestionably true that improper medication of TB patients can lead to the development of drug-resistant TB. However, sometimes when patients are not diagnosed as infected with drug-resistant TB then the treatment that they are provided may result in treatment failure even if the treatment is taken correctly. WHO has recommended two TB control strategies, namely Directly Observed Treatment Short course (DOTS) and DOTS Plus to ensure effective treatment. In recent decades, DOTS has been perceived as a profoundly viable methodology for TB control. DOTS consists of five fundamental components: 1. Maintained political and fiscal commitment; 2. Examination by sputum smears microscopy; 3. Standardised short-course treatment directly observed by trained healthcare workers; 4. An uninterrupted supply of anti-TB drugs; and 5. Standardised recording and reporting of the results of treatment. Under DOTS, the patient has to take the TB medication in front of a DOTS agent. The DOTS agent is usually a volunteer from the patient's community and maybe a family member.

Other socioeconomic factors

It is unfortunate that despite sustained political intervention, financial obligation,

research, and community efforts, TB remains a significant well-being issue around the world. The social issues such as poverty, overcrowding, use of biomass fuel, smoking, poor ventilation and malnutrition majorly contribute to the prevalence of TB. Low-income countries and underprivileged societies, within urban cities in developed countries, present elevated incidences of TB and associated death rate. Other social issues including immigration, social inequalities, and drug or alcohol abuse are also strongly associated with TB. However, among these factors, the root cause is poverty. To overcome the TB-associated health care burden in countries like India, poverty alleviation efforts need to be accelerated. It will not only reduce the risk of TB transmission but also the progression from infection to disease. The pursuance of overarching poverty reduction strategies, reduction of food insecurities, improving the social, financial and health condition of migrants and other congregate settings, promoting healthy diet and lifestyle, reduction of smoking, alcohol and drugs abuse, and public awareness for the disease will immensely benefit TB care and prevention

Conclusion

Public awareness is vital to forestall the spread of TB and to successfully treat existing cases. TB ranks close to HIV as the main cause of death around the world. Noticeably, around 95% of TB mortality is reported in low-and-middle-wage nations and it is among the top five causes of death of women aged 14 to 45. TB-HIV association is quite strong as about one in every three deaths among HIV-positive cases is due to TB. However, about 6 million lives have been saved through the coordinated efforts of HIV and TB control programmes over last ten years. Besides this, MDR-TB has become a widely spread form of TB and found to be present virtually in all the nations surveyed by WHO. The major cause for the spread of multi-drug resistance is the improper or erroneous use of anti-TB drugs. Other than MDR-TB, a significantly more serious type of multi-drug resistance TB, XDR-TB and totally drug-resistant (TDR-TB) may develop with improper medication. XDR-TB and TDR-TB are very severe forms of DR-TB that hardly responds to a few of the available anti-TB drugs. The most important step of TB prevention strategy is to stop the spread the bacteria from infected person to healthy individuals. This is achieved by spotting the infected individuals at the earliest and then providing them with the effective medication so that they remain no longer infectious and also could recover from sickness. A general perception about TB awareness is that it is needed only for the individuals who are already afflicted with the disease. However, public awareness of the disease is now the need of the hour. It has now become imperative to ensure that people know how the disease is spread, why proper medication is essential. It is also necessary to ensure that efforts to trim down the stigma associated with the disease are encouraged. With these efforts eventually, people would come forward for early testing and treatment.

Recent Developments in Science and Technology

Biman Basu

If detected early, some cancers may be cured completely. But detecting cancer early has been difficult till recently and most cancers were detected when it was too late. Researchers at the University of Kansas Cancer Centre in USA have now come up with an ultrasensitive diagnostic device that could allow doctors to detect cancer quickly from a droplet of blood or plasma, leading to timelier interventions and better outcomes for patients

DNA with four-base pairs created

Deoxyribonucleic acid or DNA is the master molecule that defines every organism on Earth – from the tiny bacteria to the giant blue whale. The molecule is composed of two chains that coil around each other to form a double-helix carrying the genetic instructions used in the growth, development, functioning, and reproduction of all known living organisms and many viruses. DNA is a complex molecule that stores and transmits genetic information and is passed from parent to offspring in all living organisms on Earth. The structure of DNA was revealed for the first time in 1953 by James Watson and Francis Crick and the molecule was found to be made up of four nucleotides, each containing a base, plus a molecule of sugar and one of phosphoric acid. All this is contained in a double-helix structure. The four bases, or "letters," of DNA form pairs: adenine, A, pairs with thymine, T, and cytosine, C, bonds with guanine, G. These pairs are essentially the building blocks of life on Earth; the way in which the pairs are arranged in the DNA creates the genetic instructions for how proteins are made, which in turn decides who we are and every critical process that keeps us alive.

Crystal structure of a hachimoji double helix built from four naturally-occurring bases, G (green), A (red), C (blue), T (yellow), and four synthetic bases, B (cyan), S (pink), P (purple), and Z (orange). (Credit: Millie Georgiadis, Indiana University School of Medicine)

Till recently, DNA was known to be made up of only four bases designated by the letters A, T, C, and G. Recently, an interdisciplinary team of researchers led by Steven Benner at the Foundation for Applied Molecular Evolution in Alachua, Florida, USA, has developed a new type of DNA in the lab that is made up of eight letters, rather than the natural four and can store and transmit genetic information like natural DNA. The two new added pairs are: P-Z and B-S, making a DNA with a total of four pairs bases, namely A-T, C-G, P-Z, and B-S.

Benner's team, which collaborated with laboratories at the University of Texas in Austin, Indiana University Medical School in Indianapolis,

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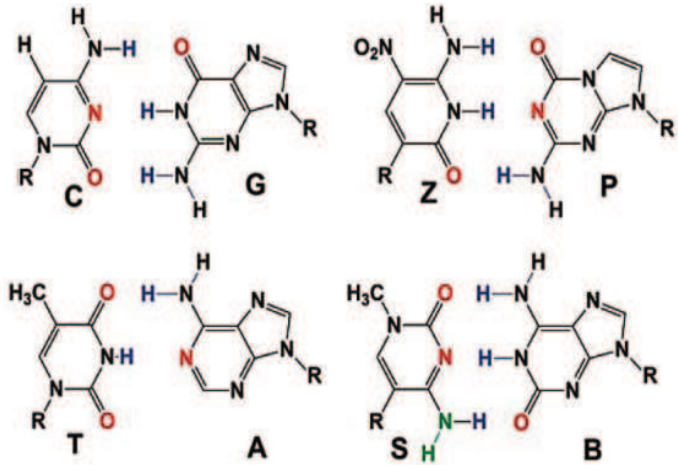


The eight bases of hachimoji DNA (Credit: Wikipedia)

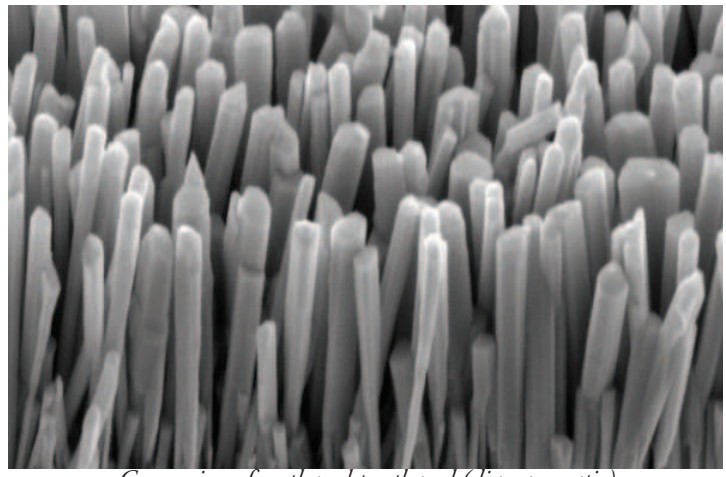
and DNA Software in Ann Arbor, Michigan, dubbed their creation "hachimoji" DNA (from the Japanese *hachi*, meaning "eight", and *moji*, meaning "letter"). Hachimoji DNA meets all the structural requirements that allow the natural DNA to store, transmit and evolve information in living systems. This unprecedented feat suggests there could be an alternative to DNA-based life, as we know it on Earth – a genetic system for life that may be possible on other worlds.

Synthetic DNA is made from scratch in a laboratory and offers custom-programming that can provide instructions that might not occur in nature. Right now, synthetic DNA–using the typical four bases – has been engineered for novel purposes, like creating new scents for perfumes, but there are also potential medical applications, like manufacturing an enzyme that can break down gluten and treat celiac disease. By carefully analysing the roles of shape, size and structure in hachimoji DNA, the new research expands our understanding of the types of molecules that might store information in extra-terrestrial life on alien worlds. NASA, one of the agencies that funded the study, announced in a press release that the hachimoji DNA research will alter its search for life on other planets, since the discovery suggests that extra-terrestrial life might not use the same building blocks as life on Earth.

This study opens the door to further research on ways life could structure itself in environments that we consider inhospitable, but which might be teeming with forms of life we have not yet imagined.

Methanol converted to ethanol using sunlight

Methanol is a colourless liquid that can be made from agricultural waste. It has long been considered as a green alternative to fossil fuels. But its main drawback is that it is toxic and can generate only half as much energy as the same volume of petrol. Researchers of McGill University in Montreal, Canada have found a potentially cheap way of converting methanol to ethanol using sunlight and gallium nitride nanowires "spiked" with magnesium as a catalyst. Ethanol is a more popular alternative fuel that is less harmful and packs more energy.



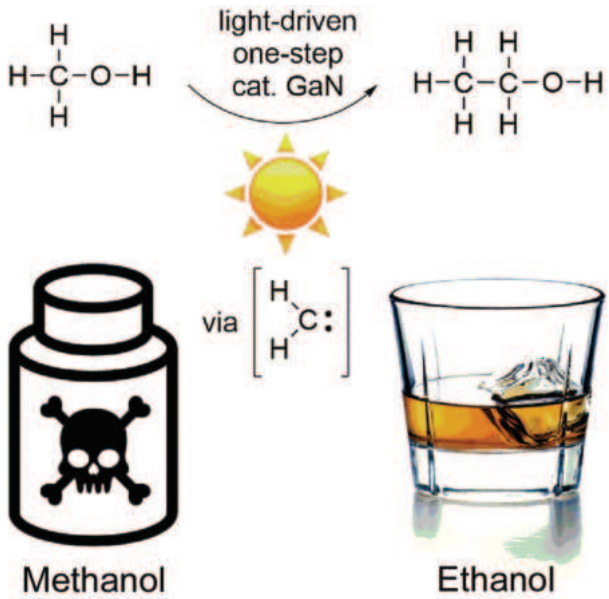
Conversion of methanol to ethanol (diagrammatic)

The notion of converting methanol to ethanol is not new and there are several methods of doing so. But these methods require adding heat, pressure, and toxic chemicals, such as carbon monoxide. Ethanol can also be produced directly by fermenting corn kernels or sugarcane. But growing those crops requires precious farmland that could otherwise grow food crops. So, conversion of methanol produced from agricultural waste directly to ethanol using sunlight offers a much better alternative.

The basic idea of the new research took birth in 2014 when Chao-Jun Li, a chemist at McGill University and his colleagues showed that "a tiny forest of nanowires" made from the semiconductor gallium nitride (GaN) could be used as a catalyst to convert methane gas into benzene, a chemical used to make dozens of other industrial compounds such as plastics, solvents, and adhesives. According to Li, in this case, the nanowires rearranged the chemical bonds between carbon atoms, which is also what is needed to convert methanol to ethanol. Naturally, the McGill researchers decided to see whether GaN nanowires could be used to restructure methanol and turn it into ethanol. The researchers grew and tested several different nanowire compositions and found a forest of long, thin GaN nanowires spiked with magnesium worked best to absorb ultraviolet (UV) light from sunlight and use that energy to convert methanol to ethanol. The absorbed UV light caused the nanowires' surfaces to become more negatively charged than their cores, the team found. The charge rips a water molecule from an individual methanol molecule sitting on a nanowire surface, leaving behind a reactive intermediate compound called methyl carbene. While the water molecule floats away, the methyl carbene reacts with a neighbouring methanol molecule to make ethanol (*Chem*, 14 February 2019|DOI:https://doi.org/10.1016/j.chempr.2019.01.005).

The researchers, however, note that the process is just a proof of concept. Converting methanol to ethanol requires UV light, which is just a small fraction of the sunlight that reaches Earth. For the process to be commercially economical, they say, it may require tweaking the nanowires to get them to work with visible light, which has less energy than UV light, but is far more abundant in the Sun's rays.

In addition to producing ethanol, the nanowire catalyst can also generate other valuable hydrocarbons like 1-propanol, an alcohol used in pharmaceutical manufacturing, from methanol. According to the researchers, this ability raises hopes for tailoring nanowires to convert low-value commodity chemicals into a range of higher



Scanning electron microscopy (SEM) image of p-type gallium nitride (p-GaN) nanowire arrays grown on a silicon substrate (Credit: ACS Nano)

value ones, using only light.

The direct conversion of the more readily available methanol to the more user-friendly, less toxic, and broadly applicable ethanol is an important landmark towards securing the sustainable "fossil alternative". At the same time, successfully turning it into a viable commercial process poses a tremendous scientific challenge.

Breakthrough 'lab-on-a-chip' detects cancer faster

Cancer is one of the most dreaded diseases known to mankind. If detected early, some cancers may be cured completely. But detecting cancer early has been difficult till recently and most cancers were detected when it was too late. Researchers at the University of Kansas Cancer Centre in USA have now come up with an ultrasensitive diagnostic device that could allow doctors to detect cancer quickly from a droplet of blood or plasma, leading to timelier interventions and better outcomes for patients (*Nature Biomedical Engineering*, 25 February 2019 | DOI: 10.1038/s41551-019-0356-9).The "lab-on-a-chip" for "liquid biopsy" analysis detects exosomes–tiny parcels of biological information produced by tumour cells to stimulate tumour growth or metastasise.

Historically, scientists had considered exosomes as'trash bags' that cells could use to dump unwanted cellular contents.But in the past decade, theyhave realised that exosomes were quite useful for sending messages to recipient cells and communicating molecular information important in many biological functions. "Basically, tumours send out exosomes packaging active molecules that mirror the biological features of the parental cells. While all cells produce exosomes, tumour cells are really active compared to normal cells."

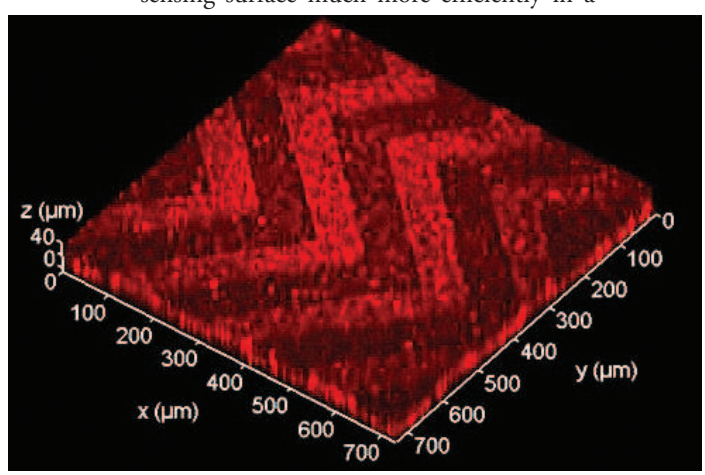
According to Yong Zeng, associate professor of chemistry at Kansas University, who led the research, "the new lab-on-a-chip's key innovation is a 3-D nanoengineering method that mixes and senses biological elements based on a 'herringbone' pattern commonly found in nature, pushing exosomes into contact with the chip's sensing surface much more efficiently in a process called mass transfer". He said, "we developed a 3-D nanoporous herringbone structure that can drain the liquid in that gap to bring the particles in close contact with the surface where probes can recognise and capture them". This overcame the main problem encountered by scientists formass transfer in microscale channels, because when particles were moving closer to the sensor surface, they were separated by a small gap of liquid that created increasing hydrodynamic resistance.

Zeng compared the chip's nanopores to a million little kitchen sinks: "If you have a sink filled with water and many balls floating on the surface, how do you get all the balls in contact with the bottom of the sink where sensors could analyse them? The easiest way is to drain the water", he said.

To develop and test the pioneering microfluidic device, Zeng teamed up with other scientists of Kansas University Cancer Centreand a graduate student from Godwin's Biomarker Discovery Lab in the same university. The collaborators tested the chip's design using clinical samples from ovarian cancer patients andfound that the chip could detect the presence of cancer quite early in a minuscule amount of blood plasma.

According to Andrew K. Godwin,professor and director of molecular oncology, pathology and laboratory medicine at Kansas University Medical Centre,"This area of study is especially important for cancers such as ovarian, given the vast majority of women are diagnosed at an advanced stage when, sadly, the disease is for the most part incurable".

What is more, the new microfluidic chips developed at Kansas University would be cheaper and easier to make than comparable designs, allowing for wider and less-costly testing for patients.According to Zeng, with the microfluidic chip's design now proven using ovarian cancer as a model, the chip could be useful in detecting a host of other diseases. He said. "Almost all mammalian cells release exosomes, so the application is not just limited to ovarian cancer or any one type of cancer. We're working with people to look at neurodegenerative diseases, breast and colorectal cancers, for example". ■



The new lab-on-a-chip's key innovation is a 3D nanoengineering method that mixes and senses biological elements based on a herringbone pattern commonly found in nature, pushing exosomes into contact with the chip's sensing surface much more efficiently. (Credit: University of Kansas)