CMYK Job No.

Registered with the Registrar of Newspapers of India: R.N. 70269/98

ISSN : 0972-169X
Postal Registration No. : DL-11360/2002

Monthly Newsletter of Vigyan Prasar

DREAM 2047

December 2002 Vol. 5 No. 3

VP News

Meeting on EDUSAT

Development and Educational Communication Unit (DECU) and Vigyan Prasar (VP) jointly organized a meeting on 24th Nov. 2002 at India International Centre, New Delhi to discuss the various aspects connected with the development and production of software for the science channel, to be beamed by EDUSAT, the satellite for education, science and technology, to be launched by ISRO in near future. DECU and VP had earlier circulated concept papers on the need for a dedicated science channel and production of software respectively. The meeting was chaired by Prof. V. S. Ramamurthy, Secretary, Department of Science & Technology, and Chairman, Governing Body, Vigyan Prasar. Shri B.S. Bhatia, Director, DECU, in his address brought out the need for a dedicated science channel and emphasized working out of a plan and strategy to feed the science channel. Shri Shankara, Director, Space Applications Centre, ISRO, Ahmedabad, made a presentation on the technical aspects of EDUSAT. Dr. V.B. Kamble proposed the plan and methodology to feed the science channel. Well known TV producer of Surabhi fame, Shri Siddharth Kak, emphasized the need to effectively communicate with the audience, maintaining at the same time high standards in production of a programme. The meeting was attended, among others, by well known scientists and educationists like Prof. Yash Pal, Prof. A.R. Verma, Prof. L.S. Kothari, Dr. Saroj Ghose, and several well known academicians and media persons like Dr. Amit Roy, Director, Nuclear Science Centre, Dr. R. Sreedher, Director, EMPC (IGNOU), Ms. Jai Chandiram, Shri Ashok Ogra, Shri Pradeep Kaul, Director, CEC (UGC), Prof. P.K. Bhattacharya, NCERT, and Dr. Biman Basu, Later, during the brain storming session, participants presented their views on the types of programmes and the ways and means to produce programmes which could feed the science channel. ❑

(L to R) Dr. Amit Roy, Prof. Yash Pal and Shri Siddharth Kak

(L to R) Dr. V.B. Kamble, Prof. V.S. Ramamurthy, Shri Shankara and Shri B.S. Bhatia

Inside

EDITORIAL

- Acharya Prafulla Chandra Ray Page...30
- Wonder Worm Page... 23
- Know more about DTV Page...20
- Recent Developments in Science and Technology Page...18
- Regional Coconut Research Station at Ratnagiri Page...17

Shri Bachi Singh Rawat, the Hon'ble Minister of State (S&T), reviewed the activities of Vigyan Prasar at a meeting held on December 11, 2002 at Technology Bhawan. In the picture, the Hon,ble Minister is seen at the Ham Radio Club Station at Technology Bhawan jointly maintained by VP and NCSTC, which he visited on 12 December 2002

...think scientifically, act scientifically ... think scientifically, act scientifically ... think scientifically, act...

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016
Printed at Rakmo Press Pvt. Ltd, C-59, Okhla Industrial Area Phase-I, New Delhi-110 020. Editor: Dr. V.B.Kamble

CMYK

Why Popular Science Writing Is So Unpopular

How is it that despite continuous efforts and sustained encouragement from several Government and non-Government organizations over the years, the number of popular science writers has remained minuscule? Does it imply that there is little demand for it? Or is it that the popular science writing today, especially in the regional languages, has not been able to meet the expectations of the general public? Why does the younger crop of scientists shy away from taking up popular scientific writing as a career? Why it is that translation of an article, especially from English to a regional language, more often than not, looks like Greek and Latin?

Well, it was in this backdrop that a seminar was organized in Delhi jointly by Institution of Electronics and Telecommunication Engineers (IETE) and Commission for Scientific and Technical Terminology (CSTT) in Delhi on December 5-6, 2002, sponsored by the Ministry of Information Technology (MIT) on the theme 'Making scientific / technical writing in Hindi interesting'. The topics ranged from what is a popular scientific article and how to make it interesting, to the difficulties faced while searching for acceptable scientific / technical terminology – both while writing an original article to translating an article from another language into Hindi.

To begin with, let us realize that there is a sizeable demand for popular science literature, especially among the children – both in urban as well rural areas. This could be judged from the speed with which popular science books brought out by Vigyan Prasar and other publishers get sold out in book exhibitions in different parts of the country. We do not need to create a demand, it already exists.

The basic question is - what ails the popular science writing in our country? We continue to think in English but try to popularize science in local languages! Often we first write an article in English and then translate it in the local language! In the process, it no longer remains popular! Until we begin to think in the local language, write in the local language (*Matri Bhasha*, as was pointed out in the January 2002 issue of *Dream 2047*) popular science writing will continue to be unpopular.

Indeed, it was through reading popular science literature that many great scientists were first introduced to the thrill and excitement of science. However, inspiring and igniting the young minds through popular science writing is yet to find a place as a career or profession in our country. It is true that as of today, popular science writing is not as lucrative as other professions, but it is a highly rewarding and a satisfying profession. It is only the mindset that needs to change. We do have examples wherein individuals have dedicated themselves fully to popular science writing and yet made a decent living and led a highly meaningful life. One example is that of the well known popular science writer Gunakar Muley.

In any case, one cannot but overemphasize the importance of translating scientific articles / books into local languages Equally important is to make available to our children and the general public the inspiring popular scientific articles / books by great science communicators from all over the world, say, George Gamow, Arthur C. Clarke, Carl Sagan, Isaac Asimov, Stephen Hawking etc. in the local languages. Alas! It is just not available. The hard fact is that we do not even have enough number of accomplished persons who can translate a popular scientific article into a regional language which can be understood with relative ease by a lay person. Translation of scientific articles from English into Hindi or any other regional language that is palatable, itself could be a lucrative profession. CSTT has been putting in efforts to develop scientific / technical terminologies for various Indian languages, but it is likely that many of the terms may not even be acceptable in the local language. When we shall begin to think and write in the local language, the acceptable terminology would automatically develop. We may even need translation bureaus for translation of articles from one Indian language into another.

J.B.S. Haldane once said that writing a popular science article is like organic chemical synthesis. The method to be adopted depends on the product required, the raw material and the apparatus available. Further, since the apparatus is the brain, the method may vary from person to person. Undoubtedly, it is a difficult task, and one cannot expect to be successful at the first attempt. It is an art to be developed and cultivated. What is important is the fact that the article communicates to the reader - which in all likelihood is the lay public - the essence of the subject matter in a friendly manner without sacrificing the scientific accuracy. Further, it should describe a concept or a phenomenon through everyday experience leading from known to the unknown. It is assumed here that the article is written in a language the reader understands.

Popular science writing must aim at helping people organize, analyze, and help apply information to arrive at a solution. This may even include addressing issues that may directly affect their lives, say, CNG, transgenic crops and so on. It is also worthwhile showing continuity of human thought by giving references / examples from other spheres of human activity as well, social or economic. Further, it is necessary to emphasize unity of human knowledge and endeavour, at their best. It is then that popular science writing would truly become 'popular'. It is gratifying to note that a few well known scientists in our country have taken upon themselves this task and in the process inspired many to follow the suit.

❑ **Vinay B. Kamble**

Editor : V.B. Kamble

Address for correspondence : *Vigyan Prasar*
C-24, Qutab Institutional Area, New Delhi-110 016
Tel: 6967532; Fax: 6965986
e-mail : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

Vigyan Prasar is not responsible for the statements and opinions expressed by the authors in their articles/write-ups published in "Dream 2047"

Articles, excerpts from articles published in "Dream 2047" may be freely reproduced with due acknowledgement/credit.

Acharya Prafulla Chandra Ray

The Founder of the Indian Chemical School

Subodh Mahanti

It says in the *Upanishads* that the Supreme One wanted to be many. The urge for self-dispersal is at the root of this creation. It was through this kind of creative urge that Prafulla Chandra became many in the minds of his pupils by diffusing and thereby reactivating himself in many younger minds. But this would hardly have been possible unless he had the capacity to give himself away fully to others.

Rabindranath Tagore (Quoted in *P. C. Ray* by J. Sen Gupta, National Book Trust, 1972)

As pioneer of chemical education, chemical research and chemical industries in India, and more possibly as a self-denying and dedicated worker for the uplift and emancipation of the country, and last but not least as a man of austere habits and sterling character with dynamic sympathy for the poor and down-trodden, ever alert to the call of humanity, Prafulla Chandra Ray occupied a unique position in India in his days.

P. Ray in *Biographical Memoirs of Fellows of the National Institute of Sciences of India (1966)*

Acharya Ray was one of the giants of old, and more particularly, he was a shining light in the field of science. His frail figure, his ardent patriotism, his scholarship and his simplicity impressed me greatly in my youth.

Jawaharlal Nehru

"A more remarkable career than that of P.C. Ray could not well be chronicled", wrote *Nature*, the famous international scientific journal, while commenting on the first volume of Ray's autobiography. Prafulla Chandra Ray was the founder of the Indian School of modern chemistry. He was a pioneer of chemical industries in India. Ray's activities were not confined to his laboratory and teaching. His activities concerned with all spheres of human interest—educational reform, industrial development, employment generation & poverty alleviation, economic freedom and political advancement of the country. He was a pioneer in social reform in the country. He took to social service with a missionary zeal. He was a great critique of the prevailing caste system in the Hindu society. In his Presidential address to the Indian National Social Conference in 1917 he made a passionate appeal for removal of the caste system from the Hindu society.

P.C. Ray

Ray was an ardent advocate of the use of the mother tongue as medium of instruction in schools and colleges. In recognition of his contribution towards the advancement and enrichment of Bengali language, he was elected the General President of the *Bangiya Sahitya Parishad* (1931-34). Ray symbolized the best of Indian tradition and philosophy. He lived a life of extreme self-denial. He became a symbol of plain living. Mahatma Gandhi said: "It is difficult to believe that the man in simple Indian dress wearing simple manners could possibly be the great scientist and professor." He lived in a single room at the University College of Science. Its furniture consisted of an iron bedstead, a small table, a smaller chair and an almirah with shelves full of books, most of which were English classics.

Ray was a voracious reader of literature, history and biography. He could read half-a-dozen languages. He once claimed that he 'became a chemist almost by mistake.'

There is no better document to know about Ray and his thoughts and accomplishments than his autobiography entitled *Life and Experiences of a Bengali Chemist* in two volumes. Besides giving his life-sketch, it gives glimpses of the intellectual history of Bengal in particular and India in general. "It is, in fact, a history of intellectual renaissance in Bengal as part of the larger enlightenment of India in the nineteenth century and in the early decades of the twentieth century." In the preface to his autobiography Ray wrote: "While a student at Edinburgh I found to my regret that every civilized country including Japan was adding to the world's stock of knowledge but that unhappy India was lagging behind. I dreamt a dream that, God willing, a time would come when she too would contribute her quota.

Half-a-century has since then rolled by. My dream I have now the gratification of finding fairly materialized. A new era has evidently dawned upon India. Her sons have taken kindly to the zealous pursuit of different branches of science. May the torch thus kindled burn with greater brilliance from generation to generation."

Prafulla Chandra Ray was born on August 2, 1861 in a village in the district of Jessore (subsequently of Khulna), now in Bangladesh. About his village Ray, in his autobiography, wrote: "My native village is Raruli, in the district of Jessore (at present Khulna). It is situated on the banks of the river Kapotakshi, which follows a meandering course for forty miles (only 16 miles as the crow flies) till it reaches Sagardari, the birth place of our great poet Madhusudan Datta. And higher up lies the village of Polua-Magura known of late years as Amrita-bazaar, the birth place of Sisir Kumar Ghosh, the veteran journalist. The village adjoining Raruli on the north is Katipara, the residence of the Zemindars of the Ghosh family, from which came the mother of Madhusudan. These two villages are often hyphened together and called Raruli-Katipara." Ray was

greatly influenced by his parents. His father Harish Chandra Ray, a scion of a local zemindar, was a man of taste, learning and liberal views. He was an accomplished violin player. He was proficient in Persian and English languages and he had also workable knowledge of Sanskrit and Arabic. Harish Chandra was closely associated with the cultural and intellectual leaders of those days in Bengal. For his liberal views Harish Chandra was branded a *mlechcha* (foreign heretic) by his fellow villagers. Ray's mother, Bhubanmohini Devi was also an accomplished lady of enlightened views.

Inner quadrangle of P.C. Ray's ancestral House

The decade of 1860-69 the nineteenth century was very important in India's history. Thus, Animesh Chakraborty, a well-known inorganic chemist, wrote : "It was the best of times – the second half of the nineteenth century. The decade of 1860-69 alone saw the birth of Rabindranath Tagore, Motilal Nehru, Swami Vivekananda, Madan Mohan Malaviya, Asutosh Mookerjee, Lala Lajpat Rai, Srinivasa Sastri and Mohandas Karamchand Gandhi. And of Prafulla Chandra Ray. A season of light and hope was descending on a languishing India."

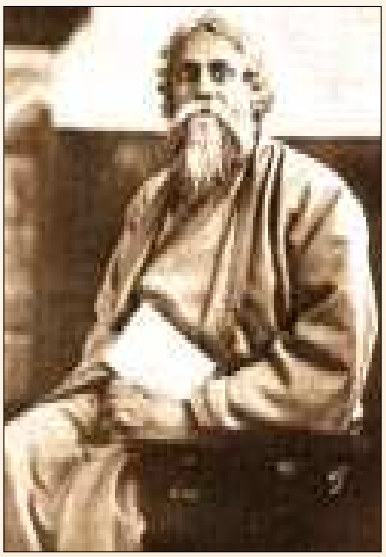
Ray's early education was in his village school, founded by his father. However, he made very little progress in this school as he used to be frequently absent from the school. In 1870 his father permanently shifted to Kolkata (then Calcutta) mainly for proper education of his children. Describing his first impression of Kolkata, Ray, in his autobiography, wrote: "In August 1870, I came to Calcutta for the first time…I spent the month of August in Calcutta, to my great joy, almost every day seeing new sights. I caught glimpses of a new world. A panorama of gorgeous vistas was opened to me. The new water-works had just been completed and the town enjoyed the blessings of a liberal supply of filtered drinking water; the orthodox Hindu still hesitated to make use of it as being impure; but the superior quality of water carried its own recommendation; by slow degrees, reason and convenience triumphed over prejudice, and its use became almost universal. The construction of underground drains had just been taken in hand."

In 1871, Ray and his elder brother Nalinikanta, were admitted into the Hare School, founded by David Hare, then located in the one-story building. The school was shifted to its present location in 1872. David Hare was also associated with the establishment of Hindu College. David Hare himself was not educated. He was neither a Government servant nor a Christian missionary. However, he played a very important role in spreading western education in Bengal. S. K. Dey in an article entitled 'The Hindu College and the Reforming Young Bengal' in *Acharya Ray 70th Birthday Commemoration Volume* wrote: "The facts of David Hare's life are very few and can be told very briefly. Son of a watchmaker in London, who had married an Aberdeen lady, Hare came out to Calcutta in 1800 at the age of twenty-five as a watchmaker; and, after following that profession for several years he made over his concern (before 1816) to his friend, one Mr. Grey, under whose roof he led his bachelor life till his death on June 1, 1842 at the age of sixty-seven. Instead of returning to his native country, like the rest of his countrymen, with the competence he had acquired, he adopted for his own the country of his sojourn, and cheerfully devoted the remainder of his life to the one object dear to himself, namely, the spread of Western education, for which he spared neither personal trouble, nor money, nor influence."

Mahatma Gandhi

From his autobiography we know that he used to be ridiculed by his classmates in Hare School. To quote Ray: "When my class-mates came to know that I hailed from the district of Jessore, I at once became their laughing-stock and the butt of ridicule. I was nick-named *Bangal* and various faults of omission ascribed to the unfortunate people of East Bengal began to be laid at my door. A Scotch rustic or a Yorkshire lad with his peculiar brogue and queer manners, when he suddenly found himself in the midst of cockney youngsters, a century ago, was I suppose somewhat in a similar predicament. At that time even the very germs of what is known as the national awakening did not exist, and a very few people cared to know that my native district had begotten and sheltered in its bossom two great warriors (Raja Protapaditya and Raja Sitaram Ray), who had raised the standard of revolt against the Great Moghul, or his Viceroy…." In fact two other luminaries namely Madhusudan Datta, the great poet (regarded as Milton of Bengal) and Dinabandhu Mitra, the then greatest living dramatist hailed from his district. It is important to take note of Ray's observation because even today in India people of one region are ignorant of historical and cultural background of the other regions. This kind of ignorance is a stumbling block in the way of national integration. Ray did not stay long in this school. A violent attack of dysentery not only forced him to leave the school but made him to interrupt his regular study for two years. However, he fully utilized this time by reading English classics and the literary and historical writings in Bengali. During this period

he also learnt Latin and Greek. Ray was a voracious reader. To quote him: "The prescribed text-books never satisfied my craving. I was a voracious devourer of books and, when I was barely 12 years old, I sometimes used to get up at 3 or 4 o'clock in the morning so that I might pore over the contents of a favourite author without disturbance…History and biography have even now a fascination for me. I read *Chambers' Biography* right through several times. The lives of Newton, Galileo—although at that time I did not understand or realize the value of their contributions—interested me much. Sir Wm. Jones, John Leyden and their linguistic attainments deeply impressed me as also the life of Franklin. The answer of Jones' mother to his interrogations "read and you will know" also was not lost upon me. Benjamin Franklin has been my special favourite ever since my boyhood…The career of this great Pennsylvanian—how he began his life as an ill-paid compositor and by sheer perseverance and indomitable energy rose to be a leading man in his country—has ever been an object-lesson to me."



Rabindranath Tagore

In 1874 Ray resumed his regular study but not in Hare School. He joined the Albert School of Keshab Chandra Sen, the founder of *Brahmo Samaj*. In 1879 he passed the Entrance Examination from Albert School. He took admission in the First Arts (FA) Class of the Metropolitan College (now named Vidyasagar College), founded by Pandit Iswarchandra Vidyasagar. One of the reasons for taking admission in this colleges was the low tuition fees. Because by that time Ray's father's financial situation had considerably deteriorated. In fact he had to close down his Calcutta establishment and return to his native village and his sons started living in lodges. But then the financial situation was not the only consideration. In the Metropolitan College, Ray came under the influence of Surendra Nath Banerjee, widely regarded as the father of Indian nationalism. Surendra Nath, who used to be regarded as an 'idol' by the students of Bengal, taught English literature in the Metropolitan College. Ray, while explaining the reasons for taking admission in this college, wrote: "I took my admission into the Metropolitan Institution of Pandit Iswarchandra Vidyasagar, the college department of which had recently been opened. This was the first bold experiment in India of making high education as cheap as secondary education. The fee in the college was same as in the school, namely three rupees. More than one reason determined my choice of Vidyasagar's College. In the first place the Metropolitan Institution was a national institution and something we could look upon as our own; in the second place Surendranath Bannerjee, who was almost the god of our idolatry, was Professor of English prose literature and Prasanta Kumar Lahiri, a distinguished pupil of Tawney (of the Presidency College, a learned Shakesperean scholar) was Professor of poetry. I took care, however, to attend lectures on Chemistry in the First Arts Course and both Chemistry and Physics in the Bachelor of Arts Course in the Presidency College as an external student. Chemistry was then a compulsory branch in the F.A. Course. Mr. (afterwards Sir Alexander) Pedler was a first-rate hand in experiments; his manipulative skill was of a high order. I began almost unconsciously to be attracted to this branch of science." Ray even tried to perform some experiments himself. Thus he wrote in his autobiography: "Not content with merely seeing the experiments performed in the class-room, myself and a fellow student set up a miniature laboratory in the lodgings of the latter and we took delight in reproducing some of them. Once we improved an oxy-hydrogen blow-pipe out of an ordinary thin tinned sheet of iron with the aid of a tinker. With such crude apparatus the leakage of oxygen into the hydrogen tube could not be prevented and a terrible explosion took place when the mixture was lighted. Fortunately, we escaped unhurt. Although Roscoe's *Elementary Lessons* was the text, I took care to have about me and go through as many works on Chemistry as I lay my hands on."

Dinabandhu Mitra

Ray's father Harish Chandra used to harbour an ambition to send at least one of his sons to England for higher education. As his economic situation deteriorated he had no scope to realize his dreams. However, Prafulla Chandra knew about his father's dreams and decided to prepare for the Gilchrist Scholarship — a scholarship awarded by the Edinburgh University, which was open to students all over the world. While the examination for the scholarship was equivalent to the Matriculation standard of the London University, it required knowledge of at least four languages. It is said that though being ridiculed by his classmates, Ray continued with the preparation for the examination. Ray came out successfully in the competition. He was one of the two winners of the Scholarship from India. The other candidate was one Bahadurjee from Mumbai. They were the first Gilchrist Scholars from India. Ray's parents were too glad to give their consent for his going to England. And so armed with the Scholarship Ray sailed for England by *S.S. California* in the middle of 1882. Ray was received in England by Jagadis Chandra Bose, who had already been a student of the Cambridge University for about couple of years. Cambridge was expensive and it was meant for the elite. Both Bose and Ray became great friends for the rest of their lives. In England he joined the University of Edinburgh as a student in the BSc class. He was taught by Alexander Crum Brown (1838-1922).

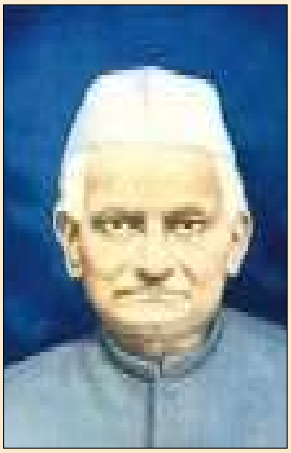
While a student in BSc Ray decided to take part in the essay competition announced by the Lord Rector of the Edinburgh University. The title of the essay to be written was "India before and after the Mutiny". The essay was very critical of the British Rule in India. In those days it required a lot of conviction and courage to write such an essay. It demonstrated Ray's patriotic vigour. Ray did not get the prize. In his autobiography

he wrote: "The prize was awarded to a rival competitor, but my essay as well another's was bracketed together as *proxime accesserunt (nearest approach to the best)*."

In his essay Ray wrote: "…The English people has yet to be roused to an adequate sense of importance of events which are now taking place in India. Thoughts and ideas which pervade the upper strata of society, are now percolating through the lower; even the masses are now beginning to be moved and influenced. The latter element, it would no longer do to treat as *une quantite negligeable*. England unfortunately now refuses to recognize the hard and irrestible logic of facts and does her best to strangle and smother the nascent aspiration of a rising nationality… Between the ideal and actual, he (i.e. an Indian) sees a gulf intervening; he finds it difficult to reconcile the practice of British statesmen with their profession…Compromises, half-measures and halting policies have been tried elsewhere with signal failure. Fifty years of concession to Ireland have only served to embitter her feelings against Great Britain. Will the lesson which the sister island has taught us be lost upon India?"

Lala Lajpat Rai

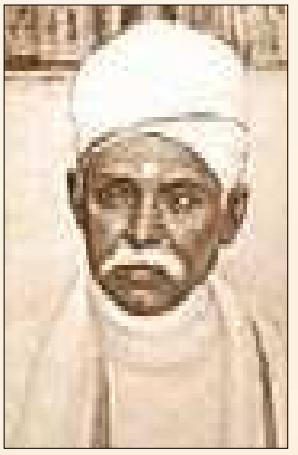
Ray distributed copies of his printed essay among the University students and the general public. The October 28, 1886 issue of *The Scotsman* remarked: "It is most interesting little volume and we do not profess to wonder in the least that it has earned a considerable amount of popularity. It contains information in reference to India which will not be found elsewhere, and it is deserving of the utmost notice." Ray also sent a copy of his Essay to John Bright, the great parliamentarian. Bright not only acknowledged the receipt but also stated that he agreed with the views expressed by Ray in his essay. A summary of Bright's letter flashed by *Reuter* is quoted below: "I regret with you and condemn the course of Lord Dufferin in Burma. It is a renewal of the old system of crime and guilt, which we had hoped, had been for ever abandoned. There is an ignorance on the part of public in this country and great selfishness here and in India as to our true interests in India. The departures from morality and true statesmanship will bring about calamity and perhaps ruin, which our children may witness and deplore." It was published in all the leading newspapers of England under the head-line "John Bright's letter to an Indian Student". The letter was hotly debated in the political circle of England. In 1886 Ray published his "Essay on India" in the form of a booklet.



Motilal Nehru

In 1885 Ray obtained his BSc degree and in 1887 he was awarded the DSc degree of the University of Edinburgh in recognition of his work on "Conjugated (gepaarte) Sulphates of the Copper-magnesium Group: A Study of Isomorphous Mixtures and Molecular Combinations." He was awarded the Hope Prize Scholarship which enabled him to stay one more year in England. He was also elected Vice President of the Chemical Society of the Edinburgh University.

After spending about 6 years Ray returned to India in 1888. His aim was to pursue his researches in chemistry and share his knowledge with others, to be in a chemistry class or a laboratory. But in those days Indian science was at its infancy. In chemistry there was not much career prospects. Moreover it was extremely difficult for an Indian to secure a berth in the Educational Service. The situation was aptly described by Ray himself. Ray in his autobiography wrote: "Chemistry was obtaining slow recognition as an important branch of study in our colleges; but the Presidency College was the only institution where systematic courses of lectures illustrated with experiments were given. Private colleges were few in number and their resources being limited could not afford to open Science Departments. Students from these colleges were, however, allowed to attend the lectures at the Presidency College on payment of nominal fees. The Indian Association for the Cultivation of Science, founded by Dr. Mahendralal Sircar in 1876, also made arrangements for courses of lecture in Chemistry and Physics and as these were open to public, Dr. Sircar, I believe, made a representation to the Government requesting it to discontinue allowing students from private colleges to attend lectures at the Presidency College as otherwise the Science Association lecture benches could be more or less empty. This is no reflection on the Science Association but rather on the mentality of the average Indian youth; unless a subject is prescribed for examination no one would care to have anything to do with it. The Government also would have compelled to adopt this course on its own initiative as admissions where getting larger year to year and B. Course (science) growing to be popular. In the eighties of the last century chemistry had made gigantic strides and it was realized that the mere delivery of elementary courses of lecture would not be adequate to cope with the requirements and that special arrangements must be made for practical and laboratory teaching. Peddler had on these grounds written to the Director of Public Instruction to move the Bengal Government for the sanction of an additional Professor. It was at this psychological moment that I returned from Edinburgh as an applicant for a post."



Pt. Madan Mohan Malaviya

Whatever opportunities were available in the educational institutions were mostly for Britishers. The existing situation was described by Ray in the following words: "Indians of approved merit and sometimes aristocratic `noodles', were drafted into the Civil Service who would draw two-thirds the pay of the grade. The competitive examination in England was to be thrown open only to Britons (including of course the Irish). These regulations also permeated the Educational Service. Jagadis Chandra Bose, who had returned home three years before me, after a brilliant career at Cambridge and London, and who had to

encounter untold hardships in entering the Higher Service in the land of his birth, was only allowed to cross its threshold on condition that he should waive his claim to the full pay of the grade and draw on the two-thirds scale. It was only in rare cases that the children of the soil were admitted to the Higher services, which made darkness more visible. As a rule Indians of even approved merit could only enter the subordinate branch of the service. Agitation in India as also in the British Parliament by friends of India against the virtual exclusion of Indians could no longer be ignored. The government of Lord Dufferin under instructions from the Secretary of State appointed the "Public Service Commission" with a view to devise means for finding extended employments for Indians. The recommendations of the Commission were of the nature of a compromise; whatever might be done to satisfy he aspirations of the Indians, every care must be taken to safeguard the interests and privileges of the dominant race. Two distinct services were created—one the Imperial and the other the Provincial. The former was meant to be reserved for Britishers and the latter for the Indians; in the former again the average emoluments worked out to nearly double that of the latter."

Gopal Krishna Gokhale

Under the circumstances described above Ray could not think of a bright prospect. From England he had brought a letter of recommendation from his teacher Crum Brown. He had also obtained assurance of assistance from Sir Charles Bernard, Member, Indian Council, in securing a position. Sir Bernard also introduced Ray to B. H. Tawney, the Principal of Presidency College, the premier college of Kolkata, who was on leave in London. Tawney, who happened to be a relation of Sir Bernard, wrote to Sir Alfred Croft, the Director of Public Instruction, recommending the case of Ray. Tawney wrote: "I am sure Dr. Ray would prove a valuable acquisition to the Department if he could be taken in." After coming to Kolkata Ray met Alfred Croft, Tawney and Sir Alexander Pedler, the then Professor of Chemistry in the Presidency College. He also tried to get an audience with the then Governor of Bengal, Sir Stewart Bayley. Finally he was given a temporary appointment as Assistant Professor of Chemistry at the Presidency College on a monthly salary of Rs.250/- under the Provincial Educational Service. Unlike his friend Jagadis Chandra Bose, Ray accepted the appointment and took up his duties at the Presidency College in July 1889.

Keshab Chandra Sen

So for about a year that is from August 1888 to June 1889 Ray was without any occupation. To know how he spent the time we quote Ray: "During this period I was mostly under the hospitable roof of Dr. and Mrs. Jagadis Chandra Bose and I spent the time in reading chemical literature and in botanising. I collected and identified several specimens of plants round about Calcutta with the aid of Roxburgh's *Flora Indica* and Hokker's *Genera Plantarum*." Ray retired from the Presidency College in 1916 as Professor and Head of the Department of Chemistry.

After retiring from the Presidency College Ray joined the University College of Science. As early as in 1912 Asutosh Mookerjee had invited Ray to join the University College of Science as the first University Professor. In his invitation letter, Mookerjee wrote: "It may be in your recollection that on the 24th February last, when the question of the establishment of University Professorships was before the Senate you expressed your regret that no provision was made for a Chair of Science. I assured you, on the spur of the moment, that a Chair of Science might come sooner than you expected. You will be pleased to hear that my prophecy has been literary fulfilled and that what was your ambition and my ambition has been realized. We have founded two Professorships, one of Chemistry, the other of Physics. We have also decided to establish—at once a University Research Laboratory. All this we are able to do by reason of the munificence of Mr. Palit, supplemented by a grant of two and a half lacs from our Reserve Fund. The whole position is explained in the statement I made before the Senate last Saturday; a copy is enclosed herewith. I have now great pleasure in inviting you to be the first University Professor of Chemistry, and I feel confident that you will accept my offer. I need hardly add that I shall arrange matters in such a way that you be not a loser from a pecuniary point of view. As soon as you return, we shall, with your assistance, prepare plans for the proposed laboratory and begin to build as early and as quickly as practicable. It would be an advantage, if before your return, you could make time to see some of the best laboratories in Great Britain or on the Continent."

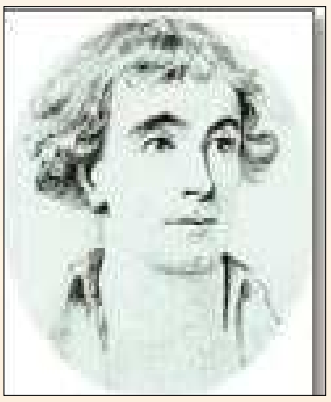
Ray received the letter in England, where he had gone as delegate of the Calcutta University to the Congress of the Universities of the British Empire and also to the 250th anniversary of the Royal Society. In response to Asutosh Mookerjee's letter Ray wrote to the following effect: "I look upon the proposed College of Science as the realization of the dream of my life and it will not only be my duty but a source of gratification to me to join it and place my humble service at its disposal."

In 1936 Ray retired from his service in the University College of Science but he continued as Emeritus Professor of Chemistry till his death.

Ray was a staunch patriot. In many ways he was connected with the movement for India's independence. Being a Government servant he could not directly participate in politics. He subscribed whole-heartedly to the policy of constructive work formulated by the Indian National Congress during the Non-cooperation Movement. He was in regular contact with the top leaders of the Indian National Congress, which was spearheading the freedom struggle. It was Ray who took initiative to bring Mahatma Gandhi for the first time to Kolkata. Here we quote Ray on his association with Gopal Krishna Gokhale and Mahatma Gandhi. Ray wrote: "Sometimes in 1901 Gopal Kirshna Gokhale came to Calcutta to attend the session of the viceregal council. One fine morning Dr. Nilratan Sarkar called on me and asked me to be at once ready to accompany him to the Howrah station to receive the eminent statesman. Gokhale used now and then to see me in my little

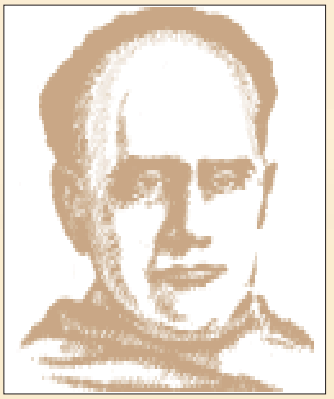
retreat at premises No. 91Upper Circular Road in which was also located the office and factory of the Bengal Chemical and Pharmaceutical Works then in its infancy. He took particular delight in calling me a "scientific recluse."…Gokhale was several years junior to me in age and I naturally in accordance with oriental ideas used to take liberties with him." Ray's patriotism reflected in his saying: "Science can wait but Swaraj cannot."

On his association with Mahatma Gandhi Ray wrote: "I was thus in a manner responsible for Mr. Gandhi's first appearance on a Calcutta platform…The frequent conversations which I used to have with Mr. Gandhi made a deep and lasting impression on me. He was earning as a barrister several thousand rupees a month but he was utterly regardless of worldliness — 'I always make it a point to travel third class in my railway journeys, so that I might be in close personal touch with the masses—my own countrymen—and get to know their sorrows and sufferings.' "Even after the lapse of thirty years, these words still ring in my years. Truth lived is a far greater force than truth merely spoken"



William Jones

Ray published about 120 research papers mostly in research journals of international repute. Ray conducted systematic chemical analysis of a number of rare Indian minerals with the object of discovering in them some of the missing elements in Mendeleev's Periodic Table. In this process he isolated mercurous nitrite in 1896, which brought him international recognition, as it was a compound, which was not known then. Describing this event Ray wrote in his autobiography : "the discovery of mercurous nitrite opened a new chapter in my life." The discovery of mercurous nitrite was an accidental one. Ray wanted to prepare water soluble mercurous nitrate as an intermediate for the synthesis of calomel, $Hg_2C\ I_2$. Ray first published his findings in the *Journal of Asiatic Society of Bengal* and which immediately noticed by *Nature,* the famous international science journal. This discovery of mercurous nitrite led to many significant publications. Another notable contribution made by Ray was the synthesis of ammonium nitrite in pure form. Before Ray's synthesis it used to be believed that ammonium nitrite (NH_4NO_2) undergoes fast thermal decomposition yielding nitrogen (N_2) and water (H_2O). Ray presented his findings in a meeting of the Chemical Society of London. William Ramsay was greatly impressed by Ray's findings. Commenting on Ray's scientific achievements Professor W. E. Armstrong wrote: "In type of Sir Prafulla Ray is perhaps more like a Frenchman than an Englishman in his receptive habit of mind : the nearest comparison I can make is to contrast him with Berthelot, not only a many-sided chemist but also an agronomist, man of letters and politician. Let me say frankly, Ray is not great as a chemical specialist nor was Berthelot: he has been occupied in too many directions, too much kept aloof from the field of chemical discovery and its masters, to have lost himself in the contemplation of the maze of chemical experience to the extent necessary to be entirely overcome by the magic and immunity of its problems. None the less, he is the founder of the Indian chemical school." Similar sentiments, were voiced by Priyadaranjan Ray: "one must not, however, lose sight of the important fact that Ray's real contribution to the development of chemical research in India rests not so much on his own personal research publication as on his inspiring and initiating a generation of young workers, who, dedicating themselves to a scientific career succeeded in building up what is now known as the Indian School of Chemistry."



Pandit Iswarchandra Vidyasagar

The first volume of Ray's celebrated work, *The History of Hindu Chemistry,* was published in 1902. The second volume was published in 1908. It was Marcellin Pierre Eugene Berthelot (1827-1907), who inspired Ray to undertake this monumental work. In the preface to the first edition Ray wrote:" ...I was brought into communication with M. Berthelot some five years ago – a circumstance which has proved to be a turning point, if I may so say, in my career as a student of the history of chemistry. The illustrious French savant, the Doyen of the chemical world, who has done more than any other persons to clear up the sources and trace the progress of chemical science in the West, expressed a strong desire to know all about the contribution of the Hindus, even went the length of making a personal appeal to me to help him with information on the subject. In response to his sacred call I submitted to him, in 1898, a short monograph on Indian alchemy; it was based chiefly on *Rasendra Samgraha*, a work which I have since then found to be a minor importance and not calculated to throw much light on the vexed question as to the origin of the Hindu Chemistry. M. Berthelot not only did me the honour of reviewing it at length but very kindly presented me with a complete set of his monumental work, in three volumes, on the chemistry of the Middle Ages, dealing chiefly with the Arabian and Syrian contributions on the subject, the very existence of which I was not till then aware of. On perusing the contents of these works I was filled with the ambition of supplementing them with one on Hindu chemistry." Ray's *Hindu Chemistry* was immediately recognized as a unique contribution in annals of history of science. Berthelot himself wrote a 15-page review in *Journal des Savant* in its issue of January 1903. Renowned international journals like *Nature* and *Knowledge* wrote very highly of the book. In 1912 the Vice Chancellor of Durham University, while conferring the Honorary DSc degree on Prafulla Chandra Ray, noted: "…his fame chiefly rests on his monumental *History of Hindu Chemistry*, a work of which both the scientific and linguistic attainments are equally remarkable, and of which, if on any book, we may pronounce that it is definitive."

Ray started his Bengal Chemical and Pharmaceutical Works Ltd. (or Bengal Chemical as it is popularly known) in 1892 with a view, that it would create jobs for the unemployed youth. To establish it, he had to work under the most adverse circumstances. But he worked hard. To quote him: "Every afternoon on returning from the college (4:30 pm) I used to go through the previous day's orders and to see that they were executed promptly. The migration from my college laboratory to the pharmacy laboratory was to me a recreation and a change of occupation. I would at once throw myself into my new `job'

and work at a stretch from 4:30 pm to 7 pm and clear the file. When work is coupled with a keen sense of enjoyment it does not tell upon your health; the very idea of locally manufacturing pharmaceutical preparation, which hitherto had to be imported, acted like a tonic."

Sir John Cumming in *Review of the Industrial Position and Prospects in Bengal* in 1908 observed: "The Bengal Chemical & Pharmaceutical Works Ltd., is one of the most go-ahead young enterprises in Bengal. Dr. Prafulla Chandra Ray, D.Sc., FCS., started it as a small private concern in Upper Circular Road about 15 years ago and made drugs from indigenous materials. About six years ago it was made into a limited liability company, with a capital of two lakhs. Many of the leading chemists are share-holders. It has now a well-thought out and well-managed factory with about 70 workmen, at 90 Maniktala Main Road. Babu Rajshekhar Bose, the Manager, is an M.A. in Chemistry. The variety of manufacturers of laboratory apparatus, which requires skilled craftsmen in wood and metal, has been taken up. The latest development is in perfumes. The enterprise shows signs of resourcefulness and business capacity, which should be an object lesson to capitalists of this province."

Ray had great fascination for rural life and he had a deep concern for the people living in rural areas. He used to frequently visit the houses of poor peasants and took interest in their agricultural pursuits. He wrote: "Although I instinctively avoided the society of those who used to frequent my father's drawing room, I threw off reserve when in the company of unsophisticated rural folk. I often would visit them in their thatched homes. In those days there were scarcely any grocer's shops in the village, Sago, arrow-root, and sugar candy which have so largely entered into the dietary of the sick could not be had for love or money and I always took particular pleasure in distributing these and laying my mother's stores under heavy contribution, but she gladly used to second me in my ministration."

Nagarjuna

Ray is remembered for his part in the Bengal famine of 1922. A correspondent for *Mancnester Guardian* wrote: "In these circumstances, a professor of chemistry, Sir P. C. Ray, stepped forward and called upon his countrymen to make good the Government's omission. His call was answered with enthusiasm. The public of Bengal, in one month gave three lakhs of rupees, rich women giving their silk and ornaments and the poor giving their garments. Hundreds of young men volunteered to go down and carry out the distribution of relief to the villages, a task which involved a considerable amount of hard work and bodily discomfort in a malarious country. The enthusiasms of the response to Shri P. C. Ray's appeal was due partly to the Bengal's natural desire to scare off the foreign Government, partly to genuine sympathy for the sufferers, but very largely to Sir P. C. Ray's remarkable personality and position. He is a real organiser and a real teacher. I heard a European saying: `If Mr. Gandhi had been able to create two more Sir P. C. Ray, he would have succeeded in getting *Swaraj* within this year."

Ray wrote extensively on a variety of subjects both in English and Bengali. He wrote a book on Zoology titled *Simple Zoology* in 1893. For writing this book he not only studied many authoritative books on zoology but also visited museums and zoos. It has been reported that he even went to the extent of dissecting a few carcasses with the help of Nilratan Sarkar, the famous physician. Ray wrote a series of scholarly articles on Shakespeare in *Calcutta Review* during 1939-41. Ray frequently contributed article in many Bengali periodicals like *Basumati*, *Bharatbarsha*, *Bangabani*, *Banglarbani*, *Prabashi*, *Anandabazar Patrika*, *Manashi* etc.

Ray gave away most of his earnings in charity. According to one estimate Ray spent nine-tenths of his income on charity. In 1922 he made an endowment of Rs.10,000 for an annual prize in chemistry, named after the great Indian alchemist Nagarjuna. He also made an endowment of Rs.10,000 in 1936 for a research prize in zoology and botany named after Asutosh Mookerjee. He supported many poor students. At the time of his retirement Ray donated Rs.180,000 to the Calcutta University for the extension and development of the Chemistry Department. He did not accept any salary from Bengal Chemicals, which he donated for the welfare of the workers.

Ray died on June 16, 1942 in his living room in the University College of Science of the Calcutta University surrounded by his students (whom he loved most), friends and admirers. Ray's philosophy of life was beautifully summed up by Professor F. G. Donnan of the University College of Science, London on the occasion of Ray's 70th birthday. Donnan wrote: "Sir P. C. Ray, however, has been throughout his life no narrow laboratory specialist…His ideals have always been hard work and practical good in service of his country. Though devoted to the cause of pure science, he has never been unpractical dreamer in the clouds. But he has never asked much for himself, living always a life of Spartan simplicity and frugality—Saint Francis of Indian Science. I hope that future ages will cherish his name as one band of self-denying and devoted men who received and handed on the flame that once burnt so brightly in India, the search for truth and hidden mysteries of things."

We would like to end this article by quoting Ray : "I have no sense of success on any large scale in things achieved…but have the sense of having worked and having found happiness in doing so."

For Further Reading

1. *Life and Experiences of a Bengali Chemist* (Vol. 1 & 2) by P. C. Ray, The Asiatic Society, Kolkata, 1996 (first published in 1932)
2. *Prafulla Chandra Ray* by P. Ray in *Biographical Memoirs of Fellows of the National Institute of Sciences of India* (Vol.1), New Delhi, 1966.
3. *P. C. Ray* by J Sen Gupta, National Book Trust, India, New Delhi, 1972.
4. *A History of Hindu Chemistry* (Vol. 1 & 2) by P. C. Ray, Kolkata (The first volume was published in 1902 and the second volume in 1909. A new revised edition was published by Priyadaranjan Ray in 1956}
5. *Acharya Ray 70th Birthday Commemoration Volume*, Calcutta Orient Press, Kolkata, 1932.
6. Acharya Prafulla Chnadra Ray : Birth Centenary Souvenir volume, Calcutta University, 1962.
7. Acharya Prafulla Chandra at the College of Science, by Gurunath Mukherjee, *Resonance*, January 2001.
8. Chemical Research of Sir Prafulla Chandra Ray by Sreebrata Goswami and Samaresh Bhattacharya, *Resonance*, January 2001.
9. Prafulla Chandra Ray by Animesh Chakravorty, *Resonance*, January 2001.

Wonder Worm

Rintu Nath

The Nobel Prize in Physiology or Medicine for the year 2002 was jointly awarded to Sydney Brenner of UK, H. Robert Horvitz of USA and John E. Sulston of UK, for their significant discoveries concerning genetic regulation of organ development and programmed cell death using C. elegans as model organism.

The Nobel Committee in their citation said that this year's Nobel Laureates in Physiology or Medicine have made seminal discoveries concerning the genetic regulation of organ development and programmed cell death. By establishing and using the nematode C. elegans as an experimental model system, possibilities were opened to follow cell division and differentiation from the fertilized egg to the adult. The laureates trio have identified key genes regulating organ development and programmed cell death and have shown that corresponding genes exist in higher species, including man. The discoveries are important for medical research and have shed new light on the pathogenesis of many diseases.

Differentiation and Development

C. elegans is a tiny little worm which is the subject of research activities of a significant number of research groups. It is a round worm and scientifically called as Caenorhabditis elegans. Indeed this worm is an elegant example of nature. Scientists all over the world made significant discoveries with this simple round worm, which has led to many new understandings of physiological mechanisms of as complex organism as human being. The significant importance of research findings in C. elegans is reflected in the announcement of this year Nobel Prize in Physiology or Medicine.

Cell is the basic unit of every living organism. Each living organism's life start with an embryo, produced as a result of fertilization of an ovum or egg cell from female by a sperm from male. All cells in our body originate from this single fertilized egg cell and continue throughout our adulthood. The one-celled embryo multiplies several times by mitotic division where identical cells are produced. From one cell to two cells, from two to four and so on. Thus one cell gives rise to thousands of cells.

During the embryonic and foetal stages, the number of cells increases manifold. As time advances, all these cells mature and differentiate and become specialized to form various tissues and organs of our body. For example, cells differentiate to form heart, lungs, liver, nervous system, muscles, skin etc. Our body consists of several hundreds of such cell types. The interesting feature is that there is pre-defined perfect coordination between these specialized cells that makes the body function as an integrated unit. However, to synchronize the functions in ideal integrated way, cells must differentiate into a correct cell type in a proper manner and at the right time during development.

Cell Suicide

The cell cycle is a continuous process. Our body is continually producing new cells through mitosis or meiotic cell division process. But excess of everything is bad. So it is very essential that the appropriate number of cells in tissues or organs of our body be maintained. Apoptosis or programmed cell death is the control mechanism by which the fine-tuned balance between the cell division and cell death is maintained. In an adult human being, more than a thousand billion cells are created every day. At the same time, an equal number of cells die through the controlled suicide process or apoptosis.

Some Facts on Caenorhabditis elegans

Taxonomy

Super kingdom	:	Eucaryotes
Kingdom	:	Metazoa
Phylum	:	Nematoda
Class	:	Chromadorea
Order	:	Rhabditida
Super family	:	Rhabditoidea
Family	:	Rhabditidae
Sub family	:	Peloderinae
Genus	:	Caenorhabditis
Species	:	elegans

Morphology

- It is only 1 mm long and may be handled as a microorganism.
- In laboratory, it is usually grown on petri plates seeded with bacteria.
- The worm is conceived as a single cell, which undergoes a complex process of development, starting with embryonic cleavage, proceeding through morphogenesis and growth to the adult.
- All 959 somatic cells of its transparent body are visible with a microscope.
- The adult essentially comprises a tube, the exterior cuticle, containing two smaller tubes, the pharynx and gut, and the reproductive system. Most of the volume of the animal is taken up by the reproductive system.
- It has a nervous system with a 'brain'. It exhibits behavior and is even capable of rudimentary learning.
- Of the 959 somatic cells of the hermaphrodite, some 300 are neurons. Neural structures include a battery of sense organs in the head, which mediate responses to taste, smell, temperature and touch - and although C. elegans has no eyes, it might respond slightly to light.
- There are 81 muscle cells. C. elegans moves by means of four longitudinal bands of muscle paired sub-dorsally and sub-ventrally. Alternative flexing and relaxation generates dorsal-ventral waves along the body, propelling the animal along.

Physiology

- There are two sexes: a self-fertilizing hermaphrodite and a male.
- It produces sperm and eggs, mates and reproduces.
- After reproduction it gradually ages, loses vigor and finally dies.

A Fine Balance

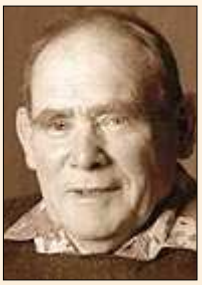
Both cell division and cell death are important part for maintaining normal physiological conditions of our body. In some diseases like AIDS, neurodegenerative diseases, stroke, cells are lost as a result of excessive cell death. On the other

hand, diseases like autoimmune conditions and cancer are characterized by a reduction in cell death, leading to the survival of enormous number of cells, which are normally destined to die.

Hence it is of considerable medical and biological importance to know how these complex mechanisms of development and specialization of cells to organ and tissue along with programmed cells deaths occur and how those events are controlled to make the fine coordination between tissues and organs. However, to study this phenomenon in human being is difficult, since our body is composed of enormous number of cells and those are too complex for basic studies.

Elegant C. elegans

In 1963, Sydney Brenner realized that fundamental questions regarding cell differentiation and organ development were difficult to answer considering any higher animals as experimental models. Therefore, a genetically amenable and multi-cellular experimental model organism simpler than mammals was required. A multi-cellular organism, which has a short life cycle, can be easily cultivated, and is small enough to be handled in large numbers, like a microorganism. It should have relatively few cells, so that exhaustive studies of lineage, patterns and other genetic analysis can be carried out very easily.


Sydney Brenner

The nematode C. elegans is a multi-cellular organism, yet relatively simple. A simple animal with very few cells, yet it has many functions similar to higher organisms. It moves, it eats, it senses its environment, and it becomes old with times. This round worm is approximately 1 mm long; easy to grow in the laboratory with a rapid life cycle and a mode of reproduction that facilitates genetic experiments. It is transparent which made it possible to follow cell division directly under the microscope. It was therefore chosen as the most appropriate model system

In 1974, Brenner reported that specific gene mutations could be induced in the genome of C. elegans by the chemical compound ethyl methane sulphonate or EMS. He observed that the presence or absence of specific genes could be linked to specific effects on organ development. This significant information combining genetic analysis and visualization of cell divisions initiated several important discoveries later by his followers.

Forty years ago, Brenner had introduced C. elegans, and it is still the ideal experimental tool for hundred of scientists all over the world because of its uniqueness. Therefore, in his statement after winning the Nobel Prize, he aptly said, "I offer my thanks for Nature's gift of C. elegans". Indeed, C. elegans has inspired a new era of scientific research.

Sydney Brenner also worked in several fields of biology in his illustrious career. Beginning in the 1950s, he made many significant contributions to the development of the field of molecular biology. His seminal contributions to the elucidation of the genetic code and the identification of messenger ribonucleic acid (mRNA) revolutionized the concept and techniques in molecular biology. He also made great contributions to the understanding of antibody diversity. During the 1980s and 1990s, he was one of the most responsible scientist for the genome sequencing projects.

Sketching Biography of Worm

John Sulston extended Brenner's work with C. elegans and developed new techniques to study all cell divisions in the nematode. Sulston's first major contribution was to document the lineage of every cell in C. elegans - right from the fertilized egg to the 959 cells in the adult organism. In 1976, Sulston described the cell lineage in relation to the development of nervous system. He showed that the cell lineage is invariant, i.e. every nematode underwent exactly the same program of cell division and differentiation. As a result of these findings Sulston made the seminal discovery that specific cells in the cell lineage always die through programmed cell death and that this could be monitored in the living organism. The excitement of these new findings was evident. In his words, "We could actually see programmed cell death in action, so beautiful, so clear and so reproducible. These qualities meant we could predict the moment of death, and begin the search for mutants to understand how this happened". He described the visible steps in the cellular death process and demonstrated the effect of alteration of genes participating in programmed cell death. Sulston also showed that the protein encoded by the nuc-1 gene is required for degradation of the deoxy ribonucleic acid (DNA) of the dead cell.

John E. Sulston

In 1989, Sulston collaborated with other workers to make a complete physical map of the worm's six chromosomes. Later on he continued his work to sequence the whole genome of the worm. In December 1998, he and his colleagues published the complete genome sequence of C. elegans, the first genome map of a multi-cellular organism.

Death Genes

Robert Horvitz continued Brenner's and Sulston's work on the genetics and cell lineage of C. elegans. Horvitz worked on several aspects like molecular, developmental and behavioral genetics of the nematode. He analyzed the genetic control of programmed cell death, signal transduction, cell lineage, cell fate, and morphogenesis in the nematode. He also studied the cellular and molecular mechanisms that control animal behavior like locomotion, egg laying, regulation of muscle contraction, memory and learning.

H. Robert Horvitz

From 1970s onwards, Horvitz carried out a series of elegant experiments using C. elegans to investigate whether there was a genetic program controlling cell death. In 1986, he first identified two genes, ced-3 and ced-4, that are directly linked to death of cells. He showed that the alteration of ced-3 and ced-4 genes in the organism made those genes non-functional and as a result process of cell death is halted in the organism. Later, Horvitz showed that another gene, ced-9, protects against cell death by interacting with ced-4 and ced-3. He also identified a number of genes that direct how the dead cell is eliminated from the body of the organism.

He also collaborated with other groups in human molecular genetics, with particular focus on the neurodegenerative

disease. Their fundamental work showed that the genes involved in C. elegans have equivalents in cancer, neurodegeneration and other diseases of humans. Horvitz showed that the human genome contains a ced-3-like gene. It is now well known that most genes that are involved in controlling cell death in C. elegans, have counterparts in humans.

Life Cycle

- In common with other nematodes, C. elegans develops through four larval stages (also called juveniles), which are separated by moults. The lifecycle takes about 3 days at 20 degree celsius.
- Its average life span is a 2-3 weeks.

Genetics

- It has six pairs of chromosomes - five pairs are autosomes (named I, II, III, IV and V) and one pair of sex chromosome (X).
- The gender of the worm is determined by an XX (hermaphrodite i.e. both male and female reproductive system in the same body) and XO (male).
- Males are found rarely (about 0.05% of normal lab population)
- The commonest lab strain is designated as 'wild type' and called N2.
- Current release of C. elegans sequence has 96,893,008 accredited and verified base pairs.
- The genome size of C. elegans is 97 Megabase (Mb) in comparison to 3,000 Mb of humans genome.
- An estimated 17,800 distinct genes encode the development and function of this diploid organism.
- An estimated 40% of its genes are closely related to human ones.

Miscellaneous

- AceDB is "A C elegans database", written by Richard Durbin and Jean Thierry-Mieg as part of the Caenorhabditis elegans genome mapping and sequencing project.
- Caenorhabditis elegans WWW Server is at http://elegans.swmed.edu/
- Around the world many hundreds of scientists are working full time investigating the biology of C. elegans. Between October, 1994 and January, 1995, 73 scientific articles about this creature appeared in international science journals.

Future Implications

The development of C. elegans as a novel experimental model system, the characterization of its invariant cell lineage, and the possibility to link this to genetic analysis have proven valuable for many research disciplines. Since the genes discovered in the nematode have equivalents in humans, therefore these works will have a major impact on the understanding of human diseases in coming years.

Knowledge of programmed cell death has helped us to understand the mechanisms by which some viruses and bacteria invade our cells. Research on programmed cell death is particularly important in the field of cancer. The cancerous tissue has excessive number of cells due to uncontrolled cell division or reduced rate of cell death. Therefore, one approach in cancer treatment strategy is based on stimulation of the cellular suicide program and thus balancing the cell division and cell death.

The characterization of genes controlling programmed cell death in C. elegans made it possible to identify related genes with similar functions in humans. It is now clear that one of the signaling pathways in humans leading to cell death is evolutionarily well conserved. Understanding detailed mechanisms of the signaling pathways controlling cell death are of prime importance for medicine. It is hoped that these important discoveries will accelerate further research activities in that direction, which in turn will help to eradicate some deadly diseases of mankind in future.

Letters to the Editor

The editorial published in "Dream 2047", October 2002 issue **Surviving New Drugs** is up to date editorial. I am also a sufferer of potentially harmful drugs administered to my Mother-in Law. A general awareness should be created among people through rapid publication of restrictive uses of medicines for common diseses in different media including electronic media.

Supriyo Saha
Chief coordinator,
Anusandihitsu Science Club,
Super Market, P.O. Raiganj - 733139

Recently I had the chance to see your monthly Newsletter "DREAM-2047". This is so informative in the field of science and also has the rare photographs of scientists. If it reaches the young generation or if it is utilized by the young generation definitely our Mother India will get so many Abdul Kalams in future.

T. Balasundar
116, Staff Quarters, CLT&RI,
Tirumani, Chengalpattu, 603001 Tamil Nadu

"Dream-2047", the monthly newsletter of Vigyan Prasar is a very informative and also knowledge packed publication. Articles such as History of science and Recent Developments in Science & Technology in your newsletter are very interesting. As a reader of rural area, I hope the newsletter "Dream-2047" will be very helpful for rural people particularly those who are interested in science.

Prashanta Kumar Das
PO. Charali 784176, DT. Sonitpur, Assam

Know More About DTV

Kinkini Dasgupta Misra

In the October 2002 issue of “Dream 2047” the first part of the Digital Television (DTV) had appeared. There we briefly talked about the digital transmission through cable, satellite and terrestrial. In this article "Know more about DTV” there are further details of these transmissions and some additional facilities that can be added to the existing and new services.

Digital television technology offers major benefits to both broadcasters and viewers. The technology enables a greater number of broadcast services to be carried over any transmission channel whether cable, satellite or terrestrial, potentially offering far greater choice to the viewer. Digital TV allows both existing and new services, such as near-video-on-demand, pay-per-view and interactive services to the home in high quality. Digital terrestrial, satellite and cable each have their own advantages and disadvantages and present different challenges. It is likely that no one system will dominate in the digital age, but the different mixes of these services will exist in different countries.

Digital Terrestrial Television (DTT) is digital TV through your aerial. DTT system requires a set-top box and a rooftop or set-top aerial. Digital Terrestrial TV delivers new services from land-based transmitters and viewers will be able to use their existing antennas to pick up these new services by connecting to a digital set-top box. DTT was standardized by the Digital Video Broadcast Project (DVB) working under the auspices of the European Broadcasting Union(EBU). DVB or Digital Video Broadcasting is the world wide standard for Digital TV. Any set-top-box or digital TV that carries the DVB kitemark will meet this standard, and will be able to receive digital broadcasts from either digital terrestrial, digital cable or digital satellite transmissions.

The greatest virtue of terrestrial television is the ease with which it can reach households with minimal expenditure at the household end. Terrestrial delivery can also require the use of a satellite to facilitate re-transmission of a central signal onto a wide national. Terrestrial transmission technology is mature, largely because specifications for such transmission were standardized long ago and are now built in to a significant amount of existing equipment.

To access DTT services, viewers have two options. They can add a set-top box which receives the DTT signal, demodulate it, extract the desired programs from the broadcast signal, decompress it and convert it back to an analogue signal which can be handled by their existing receiver. Alternatively and increasingly in the future, viewers can receive digital services by replacing their existing analogue TV set with a fully integrated digital TV.

The set-top box is a very complex piece of equipment with processing requirements comparable to a modern desktop computer. It must incorporate the full range of digital processes needed to recover and display any one of the services on offer. These processes must, however, be realized in a way that minimizes production costs, and the use of large scale integrated circuit technology is a key element in this process.

The benefits of Digital Terrestrial Television

- 'Plug and watch'- no satellite dish is needed and you do not need to live in area only where cable connections are already available.
- Use of existing analog structure can be applied to the digital technology
- Cheaper transmissions

Schematic of Digital Terrestrial System Architecture
source: visioninaction.net

- Universal solution for TV households where up to 100% of population can receive extra free-to-air and pay TV services, by simply using a digital receiver as set-top box with your existing TV set or as an integrated (iDTV) television
- Excellent sound and picture quality
- Mobile reception at high speed

Digital Satellite Television is digital TV via a satellite dish. All the programming, which is delivered to your home, via cable actually starts on a satellite. For instance when you are watching a STAR channel, the signal originates out of the STAR headquarters, goes up to a satellite and then is received by your local cable provider. Satellite television is more like broadcast television. It is a wireless system for delivering television programming directly to a viewer. Both broadcast television and satellite stations transmit programming via a radio signal. Broadcast stations use a powerful antenna to transmit radio waves to the surrounding area. Viewers can pick up the signal with a much smaller antenna. The main limitation of broadcast television is range. The radio signals used to broadcast television shoot out from the broadcast antenna in a straight line. In order to receive these signals, you have to be in the direct "line of sight" of the antenna. The other problem with broadcast television is that the signal is often distorted even in the viewing area. Satellite television solves both of these problems by transmitting broadcast signals from orbiting the earth. Satellite television systems transmit and receive radio signals using specialized antennas called Satellite dishes.

The Television satellites are all in geosynchronous orbit, 22,300 miles with experience to the equator, staying in the same position above the ground at all times. This allows satellite antennas that transmit and receive signals to be aimed at an orbiting satellite and left in a fixed position.

Satellite programmers broadcast, or uplink, signals to a satellite which they either own or lease channel space. The signals are often scrambled, or encrypted, to prevent unauthorized reception before they are retransmitted to a home antenna. The uplinked signals are received by a transponder located on the satellite, a device that receives the signals and

transmits them back to the earth after converting them to a frequency that can be received by a ground-based antenna. Typically there are 24 to 32 transponders on each satellite. In order to minimize interference between the transponders, the signals are transmitted with alternately polarized antennas.

Today, most satellite TV viewers get their programming through a direct broadcast satellite (DBS) provider such as DirecTV or the Dish Network. The provider selects the programme and broadcasts them to subscribers as a set package. Basically the provider's goal is to bring dozens of channels to your television in a form that approximates the competition, cable TV. Earlier, satellite television was broadcast in C band radio–radio in the 3.4 gigahertz to 7 gigahertz frequency range. Digital broadcast satellite transmits programming in the Ku frequency range(12 GHz to 14GHz).

There are five major components involved in a direct to home (DTH) satellite system: the programming source, the broadcast center, the satellite, the satellite dish and the receiver.

- Programming Sources are simply the channels that provide programming for broadcast. The provider does not create original programming itself; it pays other companies like HBO or ESPN for the right to broadcast their content via satellite.
- The broadcast centre is the central hub of the system where the television provider receives signals from various programming sources and beams a broadcast signal to satellites in geostationary orbit. The broadcast center converts all of this programming into a high-quality, uncompressed digital stream. At this point, the stream contains a vast quantity of data -- about 270 megabits per second (Mbps) for each channel. In order to transmit the signal from there, the broadcast center has to compress it.
- The satellites receive the signals from the broadcast station and rebroadcast them to the ground.
- The viewer's dish picks up the signal from the satellite and passes it on to the receiver in the house.
- The receiver processes the signal and passes it on to a standard television.

Direct-to-home (DTH) broadcasting requires powerful transmission capabilities to deliver digital quality video and audio to antennas as small as 75 cm. The Direct-to-home service is technically superior to the normal satellite television service. Direct-to-home services are offered in the Ku Band. The band is defined as the frequency spectrum of 11.7 to 12.2 GHz (for Fixed Satellite Service) and 12.2 to 12.7 GHz (for Broadcast Satellite Service).

Government of India recently opened up Ku-band direct-to-home television broadcasting. Star TV gave preview of Sky TV, India's first direct-to-home service. The Sky service demonstration was on the C band in view of the government's recent licencing requirements for Ku band equipment. DTH, Star TV's latest offering to Indian viewers will broadcast compressed digital signals from the PanAmSat 4 Satellite, which assure laser-disc quality pictures and compact-disc quality sound.

Components of DTH Satellite System
Source: howstuffworks.com

The new service will provide an array of features including an on-screen program guide and a parental lock to make television viewing enjoyable and selective. Programming covers a 40-channel menu and will include regional language channels, exclusive news, film and entertainment channels, plus special channels with music, computers, business and children's programs. In future, several value-added services will be provided to address specific audience groups, including rural communities for education, health, agriculture and social welfare programs.

Sky's DTH service uses digital technology to compress and code satellite signals that are beamed directly to a small 65 cm-to-95 cm satellite dish antenna installed at a subscriber's residence, The signal is then transmitted to a sophisticated decoder which unscrambles it before it reaches the television set, Digitization ensures there is no transmission loss and the signal received by the subscriber is as distortion free as it was at the source. This accounts for the enhanced clarity of picture and sound. Access to the service is provided by a microchip enabled viewing card, which acts as a key and also stores information about the viewing, as well as messages from the service provider, including listings of forthcoming programs.

The direct to home channels would offer better quality transmission, as they would be using a better band. The broadcasters would be in direct contact with consumers, which shall enable them to gauge customer response and demands directly. Consumer would need to buy a dish and receiver to be able to watch the offerings. The essentials for receiving the transmission would cost in the region of Rs. 10,000. The viewer would need to shell out another Rs. 500-700 for the bouquet of channels of his choice.

Cable TV : Digital cable is digital TV through your cable system. It is an information and entertainment medium that receives video signals from satellites and transmits them through a central head system via cable line to subscribers. There are well over 100 channels on offer, covering entertainment, movies, history, documentaries and children's programmes among others. Unlike other digital providers, you will need to rent the equipment to receive the free-to-air channels. Cable also offers additional services, including pay TV channels and interactivity. It requires a set-top box for digital services. Cable's Basic and Expanded Basic services are all analog but you can upgrade to Digital Cable. However, when you upgrade, the analog channels will remain analog even though you have digital equipment. Digital cable provides an electronic Program Guide. In general it has less interactive features. Cable TV provides high speed Broadband Internet connection.

Tomorrow we will have more new digital television services on the menu which will feature standard to high definition pictures, multi channels sound, impulse pay-per-view, interactive programme guides. Quantum increases in choice and interactivity will become the principles by which the new broadcasting market will live.

Sources:

1. Daedalus Media Services, 04-01, United House, W Kramat lane, Singapore
2. www.Howstuffsworks.com
3. Guidelines to Digital Television,version 0.4-English, by Oftel publications, Oftel Press Office, London

Recent Developments in Science and Technology

Earth is Getting Wider Near Equator

Researchers from the National Aeronautical and Space Administration (NASA), USA, have observed that the Earth has been getting a little bulkier around the equator . The researchers analysed observations made by nine satellites and found that Earth's gravity around the equator has become slightly stronger. It implies that its circumference has expanded by something like a millimeter.

According to the researchers there can be two possible reasons behind the change. One is that changes in ocean circulation have shifted a large mass of water towards the equatorial region. The second cause could be the flipping of the Earth's magnetic field. These electromagnetic jerks occur about once a decade, when the Earth's liquid metal core moves.

The researchers asserted that this problem is probably just a passing phase and is not a result of human activity. It is a part of long term natural variation in climate and the Oceans and things will probably return to normal again.

Source :New Scientist

Face Transplants possible:

It has been reported that face transplants will be technically possible within six to nine months. Peter Butler of the Royal Free Hospital in London is of the opinion that face transplantation will be the only effective way of treating some severely disfigured patients, such as those who have suffered extensive burns or facial cancer. While undergoing of face transplants the recipient would not look like the donor. Butler stresses that "the musculature of a face is particular to a skull as it develops. Muscles in the face of one person would have to be re-sculpted if they were to be transplanted onto another skull and face would not look the same."

A face transplant would involve removing the facial appearance, facial muscles and subcutaneous fat from the patient. The donor face of a recently dead person with lips, chin, ear, nose, eight major blood vessels and even some bones would then be grafted into place.

New Scientist, Nov. 2002

Polio Virus Created

Researchers in New York have created for the first time a functional virus, the infectious polio virus from ordinary ,inert chemical, like starch. This has raised a host of new scientific and ethical concerns.

The polio virus genome , though tiny, consists of 7,500 bases of RNA. The human genome by contrast has more than billion units. The new virus when injected into the brains of mice gave them a paralytic disease equivalent to poliomyelitis.

Process of viral cloning and production are documented and kept for quite some time. Other viruses like HIV and smallpox have genomes hundreds of times larger than of polio and their synthesis from starch is far more difficult.

Source; Scientific American oct, 2002

Corrigendum

Inadvertently, a mistake crept into the editorial of the November 2002 issue of *Dream 2002*. In second paragraph, the third sentence (line 4) should have read, 'Exposure to respirable suspended particulate matter to the level of 100 microgram per cubic metre (100 µg / m^3) results in headache and reduced mental acuity'. Incidentally, the size of such particles may be less than 10 microns (1 micron=10^{-6} metres) , and when breathed in, can lodge in our lungs and cause lung damage and respiratory problems. The mistake is sincerely regretted.

Editor

Dozens of New Frog Species

On a global scale the amphibian population has been waning. But according to a report published in Science, an international science journal, researchers have discovered more than 100 new species of frogs in the rain forest of Sri Lanka.

An international team led by Madhava Meegaskumbura working at Boston University categorized all the amphibians they could find in a 750-square kilometer patch of remaining rain forest in Sri Lanka. By comparing the specimens to Sri-Lankan sample stored in museums around the world and analyzing differences in appearance, genetics and behavior, the scientists identified 120 new species. The majority of these lay eggs that undergo a process what is known as terrestrial direct development. In this process the eggs incubate on land before the frog hatch as miniature adults, skipping the tadpole stage completely.

Source: Scientific American Oct,2002

Metamaterial bends Microwaves into Beam

Microwave signals are currently converted into narrow beam by broadcasting them from parabolic reflector. By this process a lot of interferences occurs and it is a time consuming process. Scientists of the Institute Fresnel in Marseille, Paris developed a new metamaterial consisting of copper wires arrayed in grids of 5millimeter squares. These grids are stacked in layers separated by 6 millimeter thick slab of foam. The wire focus the microwave emitted from a cable embedded between the layers. This new metametrial would offer a very compact and easy to manufacture alternative. It might also work as an interference -free receiver.

Source: Nature Oct 2002

compiled by : Kapil Tripahi

Vigyan Prasar stall at Rashtriya Pustak Mela, Jaipur, Rajasthan held during November 30-December08, 2002. The Pustak Mela (Book Fair) was organised by *Rajasthan Patrika.*

Regional Coconut Research Station at Ratnagiri

Generating Employment Thro Coconut

Dilip M. Salwi

Some meters away from the frothing waves of the Arabian sea, not far from the locally popular Bhatye beach on one side, on the Ratnagiri-Goa highway, and Bhatye creek waters on the other, it ensconced, in a systematically planned coconut palm grove, the Regional Coconut Research Station – the only one in entire Maharashtra. Separated from the idyllic, coastal town of Ratnagiri, the birthplace of Swaraj leader B.G. Tilak, by creek waters, it is one of the twelve research stations in India, where efforts to produce high yielding varieties of coconut are in progress. "We've produced a novel variety called `Pratap" said proudly the Incharge of the station, Dr. Dilip D. Nagwekar, "which is very much in demand in Maharashtra and elsewhere". Efforts are also in progress at the station as to how it could be optimally grown along with spice trees and vegetables to generate self-employment among the rural masses.

A panoramaic view of the Regional Coconut Research Station, Ratnagiri.

Spread over 65 acres of what was once sandy soil now systematically planted with rows of coconut palms, the main building of the station is housed in a typical, large sized Konkan hut with titled roof. Apart from rooms for its staff, it contains all the necessary laboratory facilities for hybridization, grafting, etc. Neighbouring the main hut are two godowns for keeping coconut and spice tree saplings. The station was set up in 1955 on the recommendation of the Indian Central Coconut Committee. Initially, it was under the umbrella of Mahatma Phule Krishi Vidyapeeth, Rahuri, but since the establishment of the Konkan Krishi Vidyapeeth at Depoli in 1972, it became its part. Funded by the Indian Council of Agricultural Research, New Delhi, and the state government, it falls under the All India Coordinated Coconut and Arecanut Improvement Project.

An equipment to climb up a coconut tree developed at the station.

The station has been conducting research on standardizing agro-techniques for coconut cultivation; developing suitable inter and mixed-cropping systems with the locally grown vegetables and spice trees and studying the effects of these systems on soil fertility. It has also developed effective and efficient disease and pest control measures for coconut and tried cultivating the coconut palm in a variety of irrigation techniques. Collecting, conserving, cataloguing and evaluating germplasms of new hybrids and high yielding varieties of coconut palm is also in progress. We're maintaining a gene bank of coconuts at an all India level," said Dr. Nagwekar proudly, "We've a germ plasm collection of 27 varieties". In recent years, the station has undertaken new projects to conduct similar researches on tree spices like nutmeg, clove, cinnamon and pimenta.

The high yielding 'Pratap' coconut variety developed at the station.

Today, coconut is not simply a source for the sweet coconut water available as a drink on beaches or its dried, soft inner core 'copra' for hair oil or cooking a variety of foods. Its leaves, husk and hard outer nut are also used for making several products, namely, showpieces, charcoal, ropes, etc. As a single tree can live upto 70 to 80 years and yield upto 140 coconuts in a year, 4 to 5 trees can easily produce enough revenue for the survival of a small family. The researchers at the station have therefore been experimenting over the years with several novel ideas on how to provide self-employment to farmers by cultivating coconut alongside spice trees so that the fertility of the soil is maintained over the years. For instance, through the scheme called 'Lakhi bagh, a farmer can earn one lakh rupees for one acre of land by cultivating coconut, spices and vegetables without affecting the fertility of the land. " It's an employment guarante scheme", said Dr. V.S. Savant, Research Officer, showing the various experimental plots at the station. Unfortunately, Konkan region is not flat, table land required for such an intercropping scheme because a proper distance between trees is a must for optimal results. However, to popularize the scheme among farmers, youth and students, all the experimental plots have been properly marked in the compound of the station with self-explanatory boards for all to see and believe.

"We also sell sapings," added Dr. Nagwekar with a twinkle in his eyes, emphasizing the point that their station is doing research which is reaching the common farmer both through government and private channels, " Our revenue is increasing every year, Often, the customer knocks at out gate!" ❑