EVERYMAN'S SCIENCE

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COVER PHOTOGRAPHS ***(From the Left)***

Past General Presidents of ISCA

1. Prof. N. R. Dhar	**(1961)**
2. Dr. B. C. Guha (died pre-maturely)	**(1962)**
3. Dr. B. Mukerji	**(1962)**
4. Prof. D. S. Kothari	**(1963)**
5. Prof. Humayun Kabir	**(1964-65)**
6. Prof. B. N. Prasad	**(1966)**
7. Prof. T. R. Seshadri	**(1967)**

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EDITORIAL

HIGHER EDUCATION SCENARIO IN INDIA

Despite manifold increase in the number of seats in higher education institutions in India since independence, with a corresponding increase in Gross Enrolment Ratio (GER), the decline in quality is quite worrisome. It is quite apparent that the universities (and affiliated colleges) are not able to maintain competitive high standards globally. The higher education system in India at present consists of more than 500 universities and university level institutions. These include 42 central universities, 243 state universities, 130 deemed to be universities and 33 institutions of national importance. Besides there are around 26000 colleges which provide undergraduate, postgraduate and research programs in almost all the disciplines. Majority of these colleges are privately owned colleges running under self finance system and are affiliated to the state universities. Thus India has the third largest higher education system after USA and China.

It is evident that all is not well with the Indian Higher Education System. The malaise or deficiencies include mushrooming of sub standard higher education institutions, shortage of qualified faculty, teachers and staff, almost all the universities arehaving 30 -50% vacant faculty positions, very poor infrastructure for teaching and research, incomprehensive curricula, very narrow range of course options being available, lack of autonomy, lack of accountability (both academic and financial), access and equity being seriously compromised due to high fee structure in private engineering, medical and other vocational courses, poor quality of graduates with lack of skills required for employability, ineffective quality control, poor governance structure (with built in bureaucratic impediments for reform), declining research performance and productivity.

India does have some institutions of national and international repute producing quality graduates, delivering quality education and conducting high quality research such as Indian Institutes of Technology (IIT's), Indian Institutes of Management (IIM's) and Indian Institute of Science etc., however, the quality of education delivered in majority of higher education institutions is very poor. In the latest of The Times Higher Education, world ranking report, published in March 2011, sadly, none of the Indian institution of higher education figure in the world top 200. China has performed quite well with six of its universities figuring in the list of 200. The list is dominated by U.S. universities. The world rankings are based on the global survey where 13000 experienced academics from 131 countries had given their opinion on the points scored by universities for teaching, research, citation, innovation and international mix of students and teachers.

The Gross Enrolment Ratio (GER) is around 13% at present and the central government wants to achieve 21% GER by the end of 12th Plan period and 30% GER by the year 2020. This move aims to triple enrolments in the tertiary sector from around 13 million to 40 million. Human Resource

Development minister Kapil Sibal while speaking at the inaugural function of the Indian Science Congress at SRM University, Chennai said that this will require massive capacity building both institutional as well as human. Besides increasing the number of faculty and teachers in universities and colleges we will have to improve their quality. The minister further said that "The growing demand for higher education will necessitate many more universities and colleges to be opened in the years to come which are estimated minimum doubling over the next decade. We must also broaden our skill base beyond a few centers of excellence and foster innovation on a national scale. We need to enhance our competitive edge. For this to happen, quality and merit-based education for the entire population is a must". Mr. Sibal assured that a quality assurance system will be in place and that will provide a common frame of reference for students and others to obtain credible information on academic quality across institutions, domestic as well as international.

The suggestions given by the two important committees appointed by the central government *viz*. the Yashpal Committee and the National Knowledge Commission (NKC) headed by Sam Pitroda , after examining the various issues affecting the higher education system in the country, are primarily concerned with the improvements in the institutional and policy reforms. Yashpal Committee has suggested an over arching regulatory body *viz*. National Commission on Higher Education Research (NCHER), which would subsume the existing bodies like UGC, AICTE, NCTE. This commission should be a constitutional body like Election Commission which is not under any government department either in the center or in the state. The Commission is only for co-operation and helping as a catalyst not as a Czar. Based on the suggestions and recommendations of the Yashpal Committee and NKC, the central government is bringing several bills in the education sector such as (i) establishment of educational tribunals (ii) to curb unfair practices in technical/medical education (iii) to provide for mandatory accreditation of higher education institutions (iv) regulation for entry and operation of foreign educational institutions.

During the ongoing debates, discussion and interviews several interesting and provocative views have been expressed by noted academicians and policy makers. I am quoting them randomly for the benefit of readers to draw their own conclusions.

Environment Minister Jairam Ramesh an alumnus of I.I.T. Bombay has slammed the faculty of the country's premier institutions IITs and IIMs The minister said that these educational institutions are "not world class" but are "excellent" because of the quality of students only. He further said "there is hardly any worthwhile research from the IITs. The faculty is not world class. It is the students in IITs who are world class. So the IITs and IIMs are excellent because of the quality of students not because of the quality of research of faculty". He added "we cannot build world class research center in a Governmental set up. The governmental set up can never attract young people. Let us understand our experience in the last 60 years. Government research institutions can never attract young talent. So we want to think differently. We have to think differently, how we are going to organize our research institutions. And this is one way of building PPP". (India Education Review, May 2011)

Mr. N.R. Narayana Murthy while speaking at IIT Gandhinagar said "the Indian Institutes of

Technology have lost their sheen with a steep decline in the quality that was once there in the 60s and 70s. Very few world class researches came out of IITs and IIMs in the last decade. In 2004 China produced 2,652 PhDs in computer science and in that year the figure was 24 in our country. This is truly worrisome. Focus on researches has diminished in the IITs and they have become just a teaching institution and we all know that it is not the way to go about it". Continuing to speak on the flaws of the Indian education system Narayana Murthy said "our system lacks focus on problem solving. The primary difference that I have found between the system of education in India and other countries, particularly the US, is that focus on problem solving and relating theories to reality around them. These two things are lacking in the education system in India". (India Education Review, July 2011).

Mr. Kapil Sibal, Human Resource Development minister while responding to the questions regarding the controversy over environment minister Jairam Ramesh's criticism of the faculty of IITs and IIMs said that the sole focus of government on graduation was a key factor for lack of research in leading institutions of the country. The minister said this while defending the faculties of Indian Institues of Technology (IITs) and Indian Institutes of Management (IIMs). Sibal said that initially most of the courses offered by the IITs were of graduation level and those who wanted to pursue further studies went abroad. He added that the research studies began at post-graduation level and India has lagged behind in giving priority to research. The country spends only eight billion dollars for research, while United States spends 250 billion dollars and China also spends over 50 billion dollars on research. Research was not the focus area when it came to IITs and IIMs. Even postgraduate courses were out of focus at these institutions.(India Education Review, May 2011).

Prof. Yashpal in a recent interview given to India Education Review (31 December 2010) has opined as follows :

Q. Do you think that too much of political intervention has also played a bigger role in degrading the quality of education in Indian universities?

Prof. Yashpal–Bureaucratic and political. It is quite common for political people to influence who should be appointed as vice chancellor etc. That is why, I wanted it to be that kind of commission, that unfortunately seems may not come, I don't know. It's a pity that it doesn't come that means that people will always think that the central government, state governments are equally obnoxious in terms of interference, interference is from everywhere and that has to reduce.

Q. What are the key challenges faced by the higher education institutions in India presently?

Prof. Yashpal — The key challenge is there is too much interference, there are not enough resources, and not teachers of teachers are produced.. IITs have become undergraduate factories, the focus is not on producing researchers and some universities feel poor cousins of IITs, they don't have enough money, enough resources and so on. I think we have to move in that direction.

Sam Pitroda, Advisor to the Prime Minister of India has expressed that "I am seriously concerned as to where we are in higher education. Higher education has been on the national agenda of this government for the last five years. Prime Minister Manmohan Singh is genuinely concerned about higher education. As a result six years ago he

decided to launch National Knowledge Commission (NKC) with clear focus on education that is in the agenda for the 11th five year plan. He himself took personal interest in drafting the commission, looking at the guidelines and regularly sat with the commission for hours and hours. He was very clear from the day one that without focus on higher education, we will not be able to meet our growth targets for the next 20-25 years to come". He further adds that "on higher education I believe everything that needs to be done is pretty much known plus or minus 10-20 percent. We all are very clear about the challenges in front of us but we still keep debating, discussing, tweeting and not acting. I personally do not see any need to debate any more".

Pitroda emphasizes that "we need to set up a National Commission on Higher Education, where one body will be responsible for looking at all aspects of higher education. The institutions that we created 50-60 years ago essentially these institutions are obsolete, they don't work, some are corrupt and we know it all but we are not willing to accept this in public. One of our recommendations in the knowledge commission was to scrap Medical Council of India and everyone said it can't be done, why, nobody knows. Finally, the head of the council was caught taking bribe and the result was restructuring of Medical Council. Today our institutions need more autonomy, our vice chancellors or head of the institutions need more freedom and flexibility. We need to trust them up and not try to manage them from Delhi or from state capital". Pitroda further says that there are really three challenges before the higher education : one-expansion we need more colleges, more teachers, more doctors, more engineers and more scientists, two-we need to improve quality so besides expansion excellence, leaving aside 5-10 percent of our universities quality of education is pretty bad. Many of these graduates are not employable. And the third is activity-we have to make sure that the poorest of the poor can get the best education possible. How do we get to buy all these three basic ideas. (India Education Review 2011)

Dr. Narendra Jadhav, Member National Advisory Council and Member Planning Commission has opined that establishment of National Commission of Higher Education and Research (NCHER) will bring in unrecognizable difference to the Indian Education system. In addition to NCHER, he further stated that within two years various bills in the education sector including establishment of turbulence at state and central level, compulsory accreditation, bill for prevention of malpractices in engineering and medical institutions, will bring in a metamorphic change in the entire education system. These initiatives hold importance in the light of fact that the Gross Enrolment Ratio (GER) of 12.5% as against the world average of 24%. To further strengthen the system, initiatives like student exchange programs, faculty exchange programs, with foreign institutions are imperative. (India Education Review, Jan 2011)

Prof. C. N. R. Rao, Chairman of the Scientific Advisory Council to the Prime Minister of India in an exclusive interview with India Education Review shared his 60 years of long journey with the Indian Scientific Space. Given below are some of excerpts of this interview.

Q. Do you think we lack hard working, dedicated and committed people?

Prof. C. N. R. Rao — Because they want quick result, they just want to become Crorepati in two

days, while I have never been after money or some position. Though, I am in the Advisory Board of the Prime Minister of India, otherwise I am happy being all the time in the lab.

Q. What policy reforms are needed to improve the research scenario in the Indian Higher Education system?

Prof. C. N. R. Rao — I have just prepared a document which has ten essential steps for the higher education sector. For example, with several million additional students likely to come for higher education in the next two to three decades, it is necessary to make serious manpower planning effort so that young people get directed to different areas of study, instead of all of them going for standard university courses in science, engineering and other subjects. Secondly, we have to develop institutions which are at par with the best institutions in the developed countries. Thirdly, as I say we have an examination system but not education system , thus we need only one national examination which should be able to assess the eligibility of the candidates. Fourthly, administration of the education system requires a serious overhaul, unfortunate is that education and research institutions are administered by people with IAS or similar administrative backgrounds, many without any real interest in education. Administrative autonomy, dedicated budget for R & D, recruitment and promotion of faculty are some of the other issues that require attention. Fifth, high quality continuing education and training program for teachers at all levels be provided on a massive scale.

Q. What are your views about setting up of National Commission for Higher Education and Research?

Prof. C. N. R. Rao. — Setting up a commission is a good idea, but just setting up a commission will not help. Setting up this commission will bring AICTE, UGC, MCI etc. all under its umbrella, I do not understand this idea as all the policy will be decided by it. For example, we have central government which is so centralized, why it is not that effective. At present there are 500 universities, 15 IITs, IIMs, IISc, medical institutions etc. how can you control them by sitting at one office in Delhi? You can see all the successful universities in Europe and America, there are no central commission. The universities administration controls itself. There is complete autonomy, freedom to compete, freedom to excel. For anybody to excel if he or she requires government's permission, he won't. The people who have proposed this have very little to do with education, neither have they had very long experience working in the education sector. The real thinking people should worry about India. This is the way to streamline school education, technical education and professional education of various kinds. Increasing the number of IITs will not work. Look at some of the newly created ones, there is not even an office, forget about classrooms and lab. These are not IIT.

Q. And you can't even keep politicians and bureaucrats away from it ?

Prof. C. N. R. Rao — Look at the MHRD, there is not a single person from technical background, all are IAS, who are making educational policies. All IIT directors stand there like servants and they decide what IITs should do. I have advised the minister of HRD, Kapil Sibal, to have at least person from technical and scientific background. These directors have to be nice to them as they have to take grants for their institution.

Q. What message you would like to convey to young researchers?

Prof. C. N. R. Rao — From the beginning the environment of innovation and research is not there in India. We have to create an environment in our education system because innovation is the only thing which will make India a better place. We have to encourage our students to think original. If our children are made curious and innovative from the beginning, that alone is enough. Give them the opportunity, provide them good schools, good colleges, they will take care of everything. Government control should go off from institutions and it should be only limited to giving grants. An atmosphere should be there which will not support corruption. We need good administration, good directors, vice chancellors, who will not encourage corruption and mismanagement. The entire country has to be like that. At present, the entire atmosphere is vitiated, all the top people are corrupt then how can we expect babus to be good. For education, freedom is the first requirement. You cannot teach in an environment where everything is dictated, everybody tells you what to do and you are not given a chance to think.

Sarvagya S. Katiyar

I never did anything worth doing by accident, nor did any of my inventions come by accident ; they came by work.

— Thomas Alva Edision

PRESIDENTIAL ADDRESS

SCIENCE IN INDIA

DR. B. N. PRASAD ES. SC. (PARIS), PH.D. (LIVERPOOL), F.N.I., F.N.A.Sc., M.P.

I feel greatly honoured to have been called upon to preside over this 53rd Session of the Indian Science Congress and I should like to express my sincere thanks to my scientist colleagues for my election to this exalted office. Following the usual convention, I shall be availing of this opportunity to present before you a brief survey of the recent researches that have been done in a specialised field of work with which of late myself and my pupils have been intimately associated. I am also utilising this occasion for sharing my thoughts and hopes with the august assembly regarding the advancement of Science and scientific research in India.

There was a time when Science was the pre-occupation of lone scientists trying to unravel the mysteries of nature. Their purpose possibly had been to derive ethereal sense of pleasure by contributing in some measure towards the intellectual growth of mankind. Recent past has brought about revolutionary change in the scientific outlook of the people, specially after realising that nature is a great source of power, and it is Science alone that can assist in placing that power in the hands of man for promoting the human welfare. Science today has developed a very real and concrete objective, the objective of human progress, prosperity and well being. Science, technology and inventions are now rightly regarded as the most important means for improving the material welfare of the people. The agency of Science as a major force of social reconstruction now stands universally accepted. It is no wonder, therefore, that the scientific development of a country becomes the yard-stick of its progress and greatness.

Realising fully the paramount importance of Science and technology in the reconstruction of modern India, the Government of India gave attention to its development immediately after the attainment of Independence. A separate portfolio for scientific research was created at the center on the very day of the advent of Freedom to India, and was placed under the direct charge of the late Prime Minister, Jawaharlal Nehru, who through his vision and faith in Science did so much to promote the scientific development in the country. The Department of Scientific Research was established in June, 1948, and three years later a full-fledged Ministry of National Resources and Scientific Research was created. The spirit and enthusiasm of the people in India for scientific pursuits received great stimulus when a very comprehensive resolution, known as the Scientific Policy Resolution was brought forth in 1958 in the Parliament embodying the considered scientific policy of the Government of India. Thus, this Scientific Policy Resolution demonstrated both a declaration of faith in Science and technology and an instrument of national progress as well as a directive for specific steps to be taken.

In pursuance of this Policy a large number of scientific and technological activities have sprung

* General President, Fifty-Third Indian Science Congress held during January 1966 at Chandigarh.

up in the country. A chain of National Laboratories has been set up by the Council of Scientific and Industrial Research all over the country for doing fundamental and applied research in the field of Science and industry. These laboratories provide facilities for team work which is so essential these days to carry on investigations of substantial character. Numerous research institutes have come into existence which deal with specific problems of agriculture, medicine, engineering, fuel, power, etc. The Atomic Energy Commission was set up to develop atomic energy for peaceful purposes.

In 1956 was set up the University Grants Commission by an Act of the parliament to look after higher education and research in universities. An important function of the Commission is to take suitable steps for the coordination, improvement and raising of the quality and standard of higher education and research in our universities. The Commission has been giving good consideration to help and finance universities in the matter of scientific equipments, libraries, and award of research fellowship. It has established a number of Centres of Advanced Study with the objective to encourage "the pursuit of excellence" and to improve quality and raise standards at the postgraduate and research levels.

The main objective of all these scientific activities sponsored by the Government is apparently to achieve high standard of scientific and technological developments which are ultimately expected to raise the efficiency and output of industry and thereby enhance the welfare of the people. There being here and there some sort of misgivings, it may not be out of place to consider carefully if the desired degree of success has been achieved. Exceptions apart, is the general level of our scientific and technological output favourably comparable with that of some of the advanced countries of the world. Are all these efforts and investments assigned to these undertakings, yielding reasonably high returns? Is our scientific machinery correctly geared cent percent? Is the ladder to climb to the heights of our scientific and technological objectives firmly based on the ground?

For accomplishing our task successfully, it is necessary to give due attention to all the aspects of researches—pure, applied and development. Essentially these are inseparably inter-connected and one generates the other. But the starting point for all these is a sound scientific training and researches in pure sciences, often termed as fundamental researches. Having remained for more than four decades in intimate contact with this aspect of researches, I may be permitted to make some observations to improve the state of affairs in the training and preparation of our scientific personnel.

It is the universities which form the main source from which emanate young men and women who after completing their postgraduate studies may take to advanced study and research in different branches of various Sciences. It is, therefore, of foremost importance that the universities should be highly efficient and run on proper lines. Apart from modern equipment, library, etc., it is necessary that the universities should have right type of Vice-Chancellors and highly qualified staff. For Vice-Chancellorship only those persons should be selected who have got an established reputation of eminent scholarship, breadth of vision, administrative ability, missionary spirit, freedom from the so-called university politics and a deep conviction in the importance of scientific research and technical development for the country.

Regarding the selection of Professors, it may be suggested that the Professor, who has to be responsible for the organisation of teaching and research in his Department, should be selected very carefully on an all-India basis. He should be an eminent scholar abreast with modern trends in his subject, a distinguished researcher of high order and one who can inspire his colleagues and pupils

in scientific research. The other teachers also should be selected on an all-India basis and should be such as have done researches themselves and are capable of guiding and inspiring young students to take to the profession of teaching and research. To ensure that teachers continue their research activities even after their appointment on the staff, an efficiency bar should be imposed at suitable intervals. For promotion to higher posts and grades, the merit and claims of a scientist or a university teacher should be judged not only on the basis of his own publications but also by the kind of students trained and inspired by him and the work published by his students. Care should be taken that no fresh M.A. or M.Sc., however bright his examination result might have been, should be appointed to teach degree and postgraduate classes unless and until he has devoted a period of at least two years, after taking his Master's degree, to advanced studies and research. While it is customary for a young man who enters any other type of service or profession to undergo a rigorous training to enable him to do his job efficiently, it is rather strange that in India universities are the only place where young men, immediately after passing the Master's degree examination, are employed at once to teach even the postgraduate classes. The result of this is not very happy. In order to overcome this difficulty, it is, therefore, very necessary that institutes of the type of *Ecole Normale Superieur* of Paris be established in the country. Staffed by scientists of the highest strata in the country, these institutes may also engage on suitable terms distinguished scientists from abroad. Fresh postgraduates wishing to take up a career of teaching and research should be admitted to these institutes for being trained into advanced courses of studies and research for a period of at least two years to become well-equipped for teaching university classes.

It will not be out of place to mention here that the great rapidity, with which the number of universities is multiplying in India every year, must be reasonably checked. On account of this rapid increase, it is not being found possible for the new universities to get efficient and qualified staff in sufficient number and to equip their laboratories properly, with the result that the teachers are unable to keep pace with the trend of the latest developments and the knowledge they impart to the students becomes rather shallow and is generally not conductive to create interest and enthusiasm among them.

It is well-known that teaching and research flourish best in coordination. In order that the atmosphere in any department be congenial for this purpose, it is essential to avoid two categories of staff in the universities—one teaching and the other non-teaching—since such a state widens the gap between the research scholars and the teachers. The assignment of some teaching work to research scholars and the insistence on carrying on research by teachers would bridge this gap. But there are several difficulties involved in this. In most of the universities a teacher, even at the postgraduate level, is burdened with such a heavy amount of routine teaching that the leisure at his disposal is not enough even for the satisfactory preparation of his teaching responsibilities, not to mention of creative research.

Among the brighter students there is still a reluctance or lack of enthusiasm to take to research career. It is due to several factors. More often than not, the real researcher is tragically ignored, and it is not surprising to find the genuinely devoted researcher who normally spends a number of years after his graduation in the pursuit of knowledge, placed behind the plodder, thereby losing not only claims to seniority but, what is worse, even the usual incremental rise in salary. The feeling of insecurity in getting a suitable job in keeping with his qualifications keeps hanging on him.

In view of these difficulties, suitable steps, for attracting brilliant young men and women to

scientific research career, may be considered, such as :

1. Initially a large number of brilliant students, after they have obtained the Master's degree, may be given handsome research fellowships comparable to the salary they would have got on their appointment as University Lecturers or administrative officers. There ought to be an assurance that should their work prove satisfactory, they will be absorbed in permanent assignment. This will serve to attract them to take up Research Fellowship in preference to taking teaching or other jobs.
2. After some time, say every three years, the work of these Research Fellows should be looked into and those who show outstanding capacity for research may be awarded emoluments comparable to that of a University Reader and later on of a University Professor, in case they be found specially dedicated to research for life.
3. When a Research Fellow joins a teaching post, the period spent by him in research should be given due recognition while his initial salary is being fixed.
4. A very useful step will be that brilliant researchers up to a certain age, say 40 years, be not allowed, either by a rule or convention, to get elected to many committees and become "Committee Men", except those in which the use of their very specialized knowledge of the subject is required.

The constituting of a Scientists' Pool by the Ministry of Education of the Government of India to prevent young scientists returning from abroad from feeling stranded, though a laudable one in spirit, is unfortunately proving yet another source of discouragement to the researchers working in India. Although, theoretically, persons with Indian qualifications are also eligible to this Pool, for all practical purposes the selection is limited to those returning from abroad. There are several points in this connection which need be considered very carefully. With certain exceptions, those who have been trained abroad do not seem to be in anyway superior to those trained in India. So, in the first place, this Pool arrangement places a premium on a foreign doctorate and continues to draw people away from the country even in such cases in which proper facilities exist in our own universities. It is a matter of common experience that the best students at present immediately receive a Fellowship within the country and remain in India. Others who fail to get these, look for one from outside the country, particularly form the U.S.A. But on return these latter ones receive in the pool Rs. 600/- or so per month, while those working in India, even if potentially more capable, are given only Rs. 400/- per month as a Post-Doctoral Fellowship. It may, therefore, be suggested that while a Pool post must be available for persons immediately on returning from abroad, it may be provided for a limited period, say one year, and its value should normally be not higher than that of the post-doctoral fellowships given generally in India.

Of late there has been a craze among young research workers, and even among some of the older persons, in India to go abroad for advanced studies and research even in subjects in which ample facilities exist in the country. A good number of these scientists is at present working abroad. Some of them prefer to stay abroad for personal reasons; but quite a substantial number of them do not propose to return to India on various justifiable and unjustifiable grounds, like

1. lack of facilities for employment in the country,
2. lack of facilities and opportunities for continuing the work they started abroad,
3. payment of lower salaries than what a foreign government could offer to them,
4. apathy of the Government toward starting research projects in the universities,

5. distrust in Heads of Departments, both in the universities and in the Government institutions, in matters of allotment of funds and recruitment of scientific personnel;
6. having foreign wives, etc.

This situation can be met with by giving careful consideration to the matter. First of all efforts should be made to persuade those settled abroad to come back to India and reasonable working facilities and prospects be offered to them. Also as a rule younger people should not be allowed to proceed to foreign countries for research work up to the doctorate standard in subjects in which facilities for research exist in India. Even in cases of people wishing to go abroad for post-doctoral research, passports should be issued for limited periods and normally not for a period longer than that prescribed for a particular course. Since individual freedom has got to be consistent with national requirements, understanding on a diplomatic level may be reached with the country concerned to discourage the Research Fellow going there to take up an appointment or marry a foreign wife. The main criteria for permission to go abroad should be the non-availability of the facility for working out any specific problem in the country and the importance of the problem from the point of view of national interest; but before doing so, efforts should be made to see if it would not be worthwhile arranging for the facilities to be provided in the country itself instead of allowing the student to go abroad.

Bearing in mind that, with certain exceptions, those trained in foreign countries are not necessarily superior to those trained in our own, we really need not feel much worried over the so-called "brain-drain" from India, which is not at all as serious as is generally feared. It is not only from India that people have migrated and settled abroad, but it is also from countries like England, France, Germany, Russia etc., that for various reasons scientists have migrated to various other countries, specially to the U.S.A. It is high time that we give up being fetish about the degrees obtained in foreign countries. Science is international and a good piece of research done anywhere in the world should be considered equally creditable.

I would like to give special emphasis to a certain suggestion. Just as the Government has been launching different projects costing crores of rupees, it is worthwhile launching a project in this direction also. It may be suggested that a number of high-rank Institutes for Advanced Studies and Research be set up in different regions of the country. Instead of allowing our young researchers to go abroad, we may invite eminent scientists from abroad to come and join these Institutes on a contract basis and train our researchers. This should be done on a very elaborate and magnificient scale and the selection of eminent scientists to be invited from abroad to join these Institutes should be made in a very careful manner, so that with their help and cooperation, it may become possible to produce in a few years a large band of bright young men and women fully qualified to teach in universities various modern scientific subjects. With the good will that India enjoys in different countries of the world, our fellow scientists from abroad will be quite willing to help us in this matter. If this could be done, we shall be able to prevent the younger people almost completely from going abroad to study for a research degree. We shall, through such a project, not only save a good deal of foreign exchange, but shall also, in years to come, find that people trained on right lines under Indian conditions will be much more useful to the country.

I must emphasize, however, that we should not be against sending our scientists abroad. On the other hand, once they get trained in some field and gain a little maturity, they may be permitted to go abroad off and on for coming in contact with fellow workers and for exchange of ideas and broadening of outlook.

Further, if we, as a policy, decide not to give any preferential treatment to a person simply

because he has obtained his degree from a foreign country, and base his financial claims and prospects entirely on his research merit, whether acquired in India or abroad, the craze among a large number of young people to go abroad will subside.

The financial prospects of a scientist, who sticks to teaching and research in a University, are not sufficiently attractive when compared with those who take up administrative jobs, or some other technical profession or join Research Institutes. On account of this, qualified professors are migrating in large numbers from universities to these Institutes, Laboratories and Industries. To describe this state of deterioration of universities on account of migration of well-trained scientific personnel to Research Institutes and Industry for the sake of higher salaries, I feel tempted to quote here a few lines from an address of Ambassador Chester Bowles delivered recently to the Parliamentary Scientific Committee.

"Recently the President's Advisory council on Education warned that 'unless enough of the nation's ablest man-power is reinvested in the educational enterprise, its human resources will remain underdeveloped and specialized man-power shortages in every field will be compounded ... Our nation, like the prodigal farmer, is consuming the seed corn needed for future harvests'."

Large amount of money is naturally needed for the proper execution of modern elaborate plans of scientific and technological researches. Unfortunately the funds allotted for this purpose by the Government are very meagre and insufficient and seem almost negligible when we look at the figures available in scientifically advanced countries. The amount that is now spent on research and development by the United States Government comes to 18 billion dollars or nearly 20 per cent of its annual budget in comparison with only 2 per cent in 1945, while another 5 billions becomes available each year from private industry and the non-profit foundations to be spent for this purpose. The U.S.S.R. is equally thoughtful and enthusiastic in allocating a very substantial percentage of its national income on scientific and technological developments. Other advanced countries are following more or less the same pattern on such expenditure. The sense of feeling of disappointment of scientific workers in this country can be easily realized when we are given to understand that so far even 1 per cent of the National Income is not assigned for this purpose. It is, therefore high time that Government should realize the necessity of raising substantially the amount of money for scientific and technological developments.

Our country has now entered the 19th year of her political independence, and today, thanks to the zealous efforts of our national leaders, India occupies a respectable position in the Comity of Nations. But as we all know, political freedom by itself is not enough; we have to be independent also in the items of food, defence, medicine and various other essential requirements of life, the acquisition of which all depends on the proper applications of Science and technology. We have marched ahead, but we should be also fully conscious of the distance we have yet to cover and the tasks we have yet to accomplish if we aspire to acquire for our Republic a position in the scientific world, compatible and in keeping with our rising prestige in the international sphere.

RECENT RESEARCHES IN THE ABSOLUTE SUMMABILITY OF INFINITE SERIES AND THEIR APPLICATIONS

I deeply appreciate the honour and privilege of getting this opportunity to speak as President of this 53rd Session of the Indian Science Congress on certain mathematical topics in which I and my pupils have been actively interested. I propose to present before you a brief account of an aspect of the recent developments in the theory of divergent series—the aspect of its *absolute summability.* In 1945, while presiding over the Section of Mathematics and Statistics of the 32nd Session of the Indian Science Congress and in 1960 as

President of the Section of Physical Sciences of the National Academy of Sciences of India, I had discussed the various types of summability problems of Fourier series alone. Today I proceed to discuss in details the absolute summability of infinite series in general and some of their important applications.

With the appearance of Cauchy's *Analyse Algèbrique* in 1821 and Abel's researches on the Binomial Series* in 1826, the old hazy notion of convergence of infinite series was put on sound foundation. It was, however, noticed that there were certain non-convergent series which, particularly in Dynamical Astronomy, furnished nearly correct results. After persistent efforts in which a number of celebrated leading mathematicians took part, it was only in the closing decade of the last century and in the early years of the present century that satisfactory methods were devised so as to associate with them by processes closely connected with Cauchy's concept of convergence, certain values which may be called their "sums" in a reasonable way. Such processes of summation of series which were formerly tabooed being divergent, have given rise to the modern rigorous theory of *summability.*

The idea of convergence having been thus generalized, it was but natural to enquire if the notion of absolute convergence also was capable of similar generalization. Fortunately, the answer to this question has been found in the affirmative, and, in fact, just as the notion of convergence was instrumental to the development of various summability methods, so also the concept of absolute convergence led to the formulation of the various processes of *absolute summability.* Practically the whole of the work on this subject has been done during the last three decades, of which, in what follows, I proceed to give a brief account.

BASIC PROCESSES

Some of the most familiar methods of absolute summability, and with which we shall be concerned in the sequel, are those that are known as methods of Abel, Cesaro, Nörlund and Riesz. It may, however, be mentioned that all these methods can be derived from two basic general processes which are termed as

1. *T*-processs;

2. ϕ-processs;

T-methods are based on the formation of an auxiliary sequence $\{t_m\}$, defined by the sequence-to-sequence transformation, such that

$$t_m = \sum_n C_{m,n} S_n, \quad (m = 0,1,2, \ldots) \tag{1.11}$$

where s_n is the nth partial sum of a given series Σa_n. The matrix $\|T\| = \{C_{m,n}\}$, in which $C_{m,n}$ is the element in the mth row and nth column, is usually called the matrix of T.

The ϕ-methods are based upon the formation of a functional transform $t(x)$ defined by a sequence-to-function transformation

$$t(x) = \sum_n \phi_n(x) s_n \tag{1.12}$$

or, more generally by the integral transformation

$$t(x) = \int_0^\infty \phi(x,y) s(y)\, dy, \tag{1.13}$$

where x is a continuous parameter and the function $\phi_n(x)$ [or $\phi(x,y)$] is defined over a suitable interval of x [or x and y].

A series Σa_n or the sequence $\{s_n\}$ is said to be convergent if

$$\lim_{n\to\infty} s_n = s.$$

By analogy, a series Σa_n is said to be summable by T method (or ϕ-method) to the sum s if

$$\lim_{m\to\infty} t_m = s \,[\text{or} \quad \lim_{x\to a} t(x) = s],$$

where s is a suitable number.

We know that a series Σa_n or the sequence $\{s_n\}$ is absolutely convergent if the sequence $\{s_n\}$ is of bounded variation i.e,

* 1

$$\sum |s_n - s_{n-1}| < \infty$$

Defining similarly the absolute summability of an infinite series, we say that a series Σa_n is absolutely summable by a *T*-method, or simply summable $|T|$, if the corresponding auxiliary sequence $\{t_m\}$ bounded variation, i.e.

$$\sum |t_m - t_{m-1}| < \infty$$

Absolute summability by a ϕ-method, or summability $|\phi|$, is defined in the same way with the obvious difference that in this case the corresponding function $t(x)$ should be a function of bounded variation in an interval or continuous parameter x.

The sequence to-sequence transformation T is said to be regular if

$$\lim_{n\to\infty} s_n = s \Rightarrow \lim_{m\to\infty} t_m = s.$$

In order that T-method may be regular, it is necessary and sufficient that

1. $\gamma_m = \sum_{n=1}^{\infty} |C_{m,n}| < H,$

where H is independent of m,

2. $\lim_{m\to\infty} C_{m,n} = 0$, for each n, and

3. $\lim_{m\to\infty} C_m = \lim_{m\to\infty} \sum_{n=1}^{\infty} C_{m,n} - 1.$

Toeplitz provede that result for triangular matrix while extension to the general case is due to Steinhause.

Similarly the sequence-to-function transformation ϕ is said to regular if

$$\lim_{n\to\infty} s_n = s \Rightarrow \lim_{x\to a} t(x) = s.$$

Regularity conditions for this transformation are analogous to those of the *T*-transformation.

Thus if x is a continuous parameter which tends to infinity and $t(x) = \Sigma\phi_n(x)s_n$, $x \geq 0$ then, the necessary and sufficient consitions that

$$\lim_{n\to\infty} s_n = s \Rightarrow \lim_{x\to a} t(x) = s,$$

are

1. $\sum|\phi_n(x)|$ is convergent for $x \geq 0$ and

   $\sum|\phi_n(x)| < H,$

   where H is independent of x for $x \geq x_0$;

2. $\lim_{x\to\infty} \phi_n(x) = 0$ for every n;

3. $\lim_{x\to\infty} \sum \phi_n(x) = 1.$

The transformation T is said to be absolutely regular if T is regular and the bounded variation of $\{s_n\}$ implies the bounded variation $\{t_m\}$.

The problem of absolute regularity of *T*-processes was first of all studied by Mears in 1937, later on by Knopp and Lorentz and Sunouchi, Mears proved that :

The necessary and sufficient conditions for the absolute regularity of *T*-method, defined by (1.11) are that

1. $\sum_{k=1}^{\infty} C_{n,k}$ converges for all values of n,

2. $\sum_{n=1}^{\infty} |\sum_{p=1}^{k} (C_{n,p} - C_{n-1,p})| \leq C$

for all k, where C is an absolute constant.

Subsequent results of Knopp and Lorentz, and Sunouchi bear close parallelism to that to Mears, and my be considered simplified versions of Mears' result. The problem of absolute regularity for integral transforms has been studied by Tatchell, and Sunouchi and Tschikura.

ABSOLUTE ABEL SUMMABILITY

A series Σa_n is said to be *Abel summable or summable (A)* to the sum s if $\Sigma a_n x^n$ is covergent in $0 \leq x < 1$, and $\lim_{x\to 1-0} f(x) = s$, where $f(x)$ is the sim of the serices $\Sigma a_n x^n$. This definition, although named

after the celebrated mathematician Abel, is also sometimes called Poisson's method of summability for the reasons that Poisson studied its application to Fourier Series. It can also be traced through Euler back to Leibnitz.

In 1930, Whittaker defined absolute Abel summability in the following form :

The series Σa_n is said to be absolutely Abel summable, or summable $|A|$ if $\Sigma a_n x^n$ is convergent is $0 \le x < 1$ and its sum function f(x) is of bounded variation in (0, 1).

The inclusion relation $|A| \subset (A)$ is evident in view of that fact that if a function $f(x)$ is of bounded variation in any interval, then the limits $f(x \pm 0)$ exist of every point of the interval. Whittaker also proved the result analogous to Abel's[1] classical result that the method A is absolutely regular i.e. any infinite series which is absolutely convergent is summable $|A|$. It was shown by Whittaker with the help of an example that a Fourier series may converge at a point without being summable $|A|$ at that point. On the other hand, Prasad constructed an example of a Fourier series to show that a series can be summable $|A|$ at a point without being covergent at that point.

Zygmund extended further the scope of Abel summability by introducing a parameter. According to Zygmund :

If $\{\lambda_n\}$ is positive monotonic increasing sequence tending to infinity with n then the series Σa_n is said to be *absolutely summable* (A, λ) or *summable* $|A, \lambda|$ if the series $\sum a_n e^{-\lambda_n x}$ is convergent for all positive x and the sumfunction $f(x) = \sum a_n e^{-\lambda_n x}$ is of bounded variation in $(0, \infty)$.

Quite recently the correct of $|A|$ summability has been further extended by Flett n the following form :

A series Σa_n is said to be summable $|A, \gamma|_k$, where $k \ge 1$ and γ is a real number, if the series $\Sigma a_n x^n$ is convergent for $0 \le x < 1$, and its sumfunction satisfies the condition.

$$\int_0^1 (1-x)^{k-k\gamma-1} |f'(x)|^k \, dx < \infty.$$

When $\gamma = 0$, we have $|A, 0|_k$, which is the same as the summability $|A|_k$ defined earlier by the same author. It is evident that the summability $|A|$ is the particular case of the summability $|A|_k$ for $k = 1$. It has been shown by Flett that for a fixed γ, summability $|A, \gamma|_m$ does not imply summability $|A, \gamma|_k$ for $m > k$. The problem, whether sumability $|A, \gamma|_k \Rightarrow$ summability $|A, \gamma|_m$, remains still unanswered. Flett, Agnew and Fuchs[2] have also considered the inclusion relation between two indexed Abel summabilities.

ABSOLUTE CESÀRO SUMMABILITY

The most commonly used method of summability is the familiar method of arithmetic means. For positive intergral order k, Hölder and cesaro extended this method of arithmetic means to two other which are respectively indicated as H_k and (C, k) methods. knopp and Schnee later showed that $H_k \sim (C, k)$. Subsequently the scope of (C, k) summability was further extended for the positive fractional orders by Knopp and Chapman and for negative order $k > -1$, by Chapman, and Chapman and Hardy.

In 1911, Fekete defined the absolute Cesàro summability for integral orders. Later in 1925 Kogbetliantz extended this definition to fractional and negative orders. According to this definition of Kogbetliantz, the series Σa_n is said to be *absolutely summable by Cesàro means of order k, or summable* $|C, k|$, $k > -1$, if

$$\sum |\sigma_n^k - \sigma_{n-1}^k| < \infty \text{ where } \sigma_n^k = \frac{1}{A_n^k} \sum_{v=1}^{n} A_{n-v}^{k-1} s_v,$$

and

$$A_n^k = \binom{n+k}{n} = \frac{(k+1)(k+2)\ldots(k+n)}{|\underline{n}}$$

1. **1**
2. **2**

Kogbetliantz established the consistency theorem for the absolute Cesàro summability, namely, $|C, \alpha| \subset |C, \beta|$, for $\beta > \alpha$. He also showed that $|C, \alpha|$ does not necessarily imply $(C, a - \in) \in > 0$, and that if $\beta < \alpha > 0$, and Σa_n is summable $|C, \beta|$, then the (C, α) transformed series of Σa_n is summable $|C, \beta - \alpha|$. Morely extended and supplied shorter proofs of some of these results.

In 1933 Fekete showed that $|C, \alpha| \subset |A|$, but not conversely. It being known, as mentioned already, that convergence does not imply absolute Abel summability, Bhatt[3] showed a deeper insight by demonstrating that even a negative order summability does not necessarily imply $|A|$. Hyslop, Chow, Bosanquet and Chow[4] and Obrechkoff have obtained a number of interesting results on $|C|$ summability.

Recently Flett extended the definition of absolute Cesàro summability by introducing parameters and named his method as *index summability*. According to him a series Σa_n is said to be *summable* $|C, \alpha, \gamma|_k$ $k \geq 1$, $\alpha > -1$, γ a real number, if $\sum n^{k+k\gamma-1} |\sigma_n^{\alpha} - \sigma_{n-1}^{\alpha}|^k < \infty$. By definition, for g = 0, the summability $|C, \alpha, \gamma|_k$ is the same as the summability $|C, \alpha|_k$ defined by him previously; and for $\gamma = 0$, $k = 1$, it reduces to be summability $|C, \alpha|$. He has further demonstrated that most of the results known for summability $|C, \alpha|$ can caisly be extended to the summability $|C, \alpha|_k$. He also obtained a number of results bearing on consistency theorems relating to his method of indeed summability.

Following the lines of Flett, Borwein[5] and Kanno and Tsuchikura framed other definitions of absolute Ceàsro summability.

ABSOLUTE NÖRLUND SUMMABILITY

Nörlund Summability, though originally initiated in 1902 by Worono and having remained unknown till pointed out by Tamarkin in 1932, was independently introduced by Nörlund in 1919, and it has now become customary to associate it with his name. In 1937 Mears developed the concept of absolute Nörlund summability. Denoting by $\{p_n\}$ a sequence of constants, real or complex, and writing $P_n = p_0 + p_1 + ... p_n$, $P_{-1} = p_{-1} = 0$, we call $\{t_n\}$ the Nörlund transformed of a sequence $\{s_n\}$, generated by the coefficients $\{p_n\}$, if $t_n = \sum_{v=0}^{n} \frac{p_{n-v} s_v}{P_n}$, $P_n \neq 0$, The series Σa_n is said to be (N, p_n) summable to s, if $\lim_{n\to\infty} t_n = s$, and is said to be absolutely summable (N, p_n), or summable $|N, p_n|$, if $\sum |t_n - t_{n-1}| < \infty$.

It may be noted that the Nörlund method is not absolutely regular for all types of $\{p_n\}$ sequences. However conditions for absolute regularity can be deduced from a theorem of Mears on matrix summability. Necessary and sufficient conditions, as stated by Peyerimhoff, for the absolute regularity of the $|N, p_n|$ method are :

1. $\lim_{n\to\infty} \frac{p_n}{P_n} = 0$ and

2. $\sum_{n=\mu}^{\infty} \left|\frac{P_{n-\mu}}{P_n} - \frac{P_{n-1-\mu}}{P_{n-1}}\right| < \infty.$

for all positive integral values of μ.

In the special case in which

$$p_n = \binom{p + \alpha - 1}{\alpha - 1} = \frac{\Gamma(n + \alpha)}{\Gamma(n + 1)\Gamma(\alpha)}, \quad \alpha < 0,$$

the Nörlund means reduced to the familiar (C, α) mean, and the summability $|N, p_n| \sim |C, \alpha|$. On the other hand, if $p_n = 1/(n + 1)$, the Norlund summability reduces to the method known as the harmonic summability.

The problem of inclusion for summabilities $|N, q_n|$ was discussed by McFadden and Peyrimhoff.

3. **12**
4. **45**
5. **29**

Some of their results are of necessary and sufficient type. Knopp and Vanderburg have introduced another definition by replacing the sequences $\{p_n\}$ by sequences of functions $\{p_n(x)\}$. It seems that so far this definition has not been discussed for absolute summability,

ABSOLUTE RIESZ SUMMABILITY

In 1919, Riesz introduced another important method of summability which is now associated with his name. Assuming $\{\lambda_n\}$ to be a positive, steadily increasing, monotonic function of n tending to infinity with n and writing.

$$A_\lambda(\omega) = A_\lambda^0(\omega) = \sum_{\lambda_n<\omega} a_n, \quad \omega > 0.$$

$$A_\lambda^\alpha(\omega) = \sum_{\lambda_n<\omega} (\omega - \lambda_n)^\alpha a_n, \quad \alpha > 0.$$

and

$$C_\lambda^\alpha(\omega) = A_\lambda^\alpha(\omega) / \omega^\alpha,$$

the function $C_\lambda^\alpha(\omega)$ is called the Riesz mean of type λ and order α of the series Σa_n. If

$$\lim_{\omega\to\infty} C_\lambda^\alpha(\omega) = s,$$

where s is finite, Σa_n is said to be summable (R, λ, α) $\alpha > 0$ to the sum s. In 1928 Obrechkoff developed the concept of absolute Riesz summability. According to him, if $C_\lambda^\alpha(\omega)$ is of bounded variation in (h, ∞), that is to say, if

$$\int_h^\infty |dC_\lambda^\alpha(\omega)| < \infty,$$

where h his a convenient positive number, the series Σa_n *is said to be absolutely summable* (R, λ, α) or *summable* $|R, \lambda, \alpha|$ $\alpha \geq 0$. Obviously, the summability $|R, \lambda, 0|$ is the same as the absolute convergence. Hyslop showed that for $\lambda_n = n$, $|R, n, k| \sim |C, k|$ $k \geq 0$.

Consistency theorems : Theorems of consistency for summability $|R, \lambda, \alpha|$ may be classified as

1. the first theorem of consistency,
2. the second theorem of consistency, and
3. the unified theorem of consistency.

To Obrechkoff is due the first theorem of consistency for absolute Risez summability which asserts that if a series is summable $|R, \lambda, \alpha|$, $\alpha \geq 0$, then it is also summable $|R, \lambda, \beta|$ for every $\beta > \alpha$. The consequence of this theorem is that if the type remains unchanged, the effectiveness of absolute Riesz summability method increases with the order. Since summability $|R, \lambda, 0|$ is equivalent to absolute convergence, it is obvious that the Riesz summability method is an absolutely regular one. The inclusion relation of the kind

$$|R, \lambda_n, k| \subset |R, \phi(\lambda_n), k|,$$

where the types are different but orders are identical, constitute what is called the second theorem of consistency for the absolute Riesz summability. The general results in this direction is that if the order of the summability remains the same, then for the absolute summability, the efficiency of the Riesz means increases, or at any rate does not decrease, as the rate of increase of the type decreases. The first theorem in this direction was obtained in 1942 by Chandrashekharan as analogue for absolute summability of Hardy's well-known extension of the classical "Second theorem of Consistency" for ordinary Riesz summability. In 1954, this result was generalised by Pati for integral orders. An improvement upon Pati's theorem was effected by Guha who prove that if $\phi(t)$ be a non-negative, monotonic increasing function of $t \geq 0$, tending to infinity with t, and be as many times differentiable as one may require, and if

$$t^k \phi^{(k)}(t) = 0 \ (\phi(t))$$

as $t \to \infty$ then if the series San summable $|R, \lambda, k|$, it is also summable $|R, \phi(\lambda), k|$, where k is a positive integer, Guha established a result also for the case of non-integral order of summability, a shorter proof of which has been given by Pati. For non-integral orders Prasad and Pati have obtained results in which great simplicity has been

effected on the conditions required. They have proved :

If $\phi(t)$ is a non-negative, monotonic increasing function of t, for $t \geq 0$, steadily tending to infinity at $t \to \infty$, such that $\phi(t)$ is a $(k+1)$th indefinite integral, for $t \geq 0$, κ being the integral part of k (assumed non-integral).

$$t^{k+1}\phi^{(k+1)}(t) / \phi(t) \in B(h, \infty),$$

where h is a finite positive number, and, uniformly in $0 < \upsilon < 1$ and $s > 0$.

$$\Lambda = s^{\kappa}\left\{\frac{(1-\upsilon)t}{\phi(s+t)-\phi(s+\upsilon t)}\right\}^{k+1-\kappa}$$

$$\frac{\left|\phi^{(1)}(s+\upsilon t)t^{k+1}\right|}{\left|\phi(s+t)t^{\kappa}\right|} \in BV_t(h, \infty),$$

then any infinite series which is summable $|R, \lambda_n, \kappa|$ is also summable $|R, \phi(\lambda_n), \kappa|$. In particular, the result of the above theorem remains true if Λ is replaced by $\phi^{(1)}(t)$, monotonic and non-decreasing.

Denoting by (*) the hypotheses of these theorems, we observe that by virtue of the first theorem of consistency, $|R, \lambda_n, k| \subset |R, \phi(\lambda_n), k'|$, $k' > k$, under (*). Prased suggested the possibility of establishing the above theorem by taking less stringent conditions then those in (*). More generally, he suggested the investigation of problems what he termed the unified theorems of consistency which assert $|R, \lambda_n, k| \subset |R, \mu_n, k'|$, that is, when the type as well as order both vary. It seems, not much appreciable progress has been made so far in obtaining results of deeper character in this line. However, a special result that, for $0 < \alpha \leq 1$,

$$|R, e^{n^{\alpha}}, 1| \subset |R, n, 1-\alpha| \sim |C, 1-\alpha|,$$

can be deduced from a recent result of Dikshit.

Pramila Srivastava obtained a number of results bearing on absolute Riesz summability which are analogues of certain theorem of Zygmund and Hardy for ordinary summability.

Discontinuous Riesz Means : An interesting line of work was opened by Hardy by introducing what are now termed as the "Discontinuous Riesz Means", in which ω is restricted to the sequence $\{\lambda_n\}$. Following the usual terminology, we say that the series San is summable by discontinuous Riesz means $(R, *\lambda, k)$ if

$$C^k(\lambda_n + 1) = \frac{1}{(\lambda_{n+1})^k}\sum_{v=1}^{n}(\lambda_{n+1} - \lambda_v)^k a_v \to s',$$

as $n \to \infty$, and summable $|R^*, \lambda\ k|$ if the series $\sum |C^k(\lambda_n) - C^k(\lambda_n + 1)| < \infty$. Unlike the case of the conbtinuous Riesz means, this concept of discontinuous Ruesz means enables us to extend the range of the order even to negative values. For $k \geq 0$, it is clear that $(R, \lambda, k) \subset (R^*, \lambda, k)$ and $|R, \lambda, k| \subset |R^*, \lambda, k|$ For $k = 1$, the converses of these impliations are also known to be true, but the prolbem in its general form for all orders k has yet to be explored. However, for particular types of sequences the equivalence of the above relations has been studied by Jurkar, Kuttner and Peyerimhoff.

Limitation Theorems : Associated with any useful method of summation there is a limitation theorem asserting that the method cannot sum too rapidly divergent ceries. Thus, for an infinite series $\sum a_n$, summable by a method (P), a limitation theorem involves a positive sequence $\{\phi_n\}$ with a property that $s_n = 0(\phi_n)$. By analogy, if the series $\sum a_n$ is absolutely summable by a method (P), the limitation theorem is expected to involve a positive sequence $\{\phi_n\}$ with a property that $\{s_n/\phi_n\}$ is of bounded variation. In 1951, Mohanty obtained a limitation theorem for absolute Riesz sum-mability of order one. Late, Dikshit extended this result for all integral orders.

It was shown by Hardy and Riesz that the summability (R, e^n, k), $k \geq 0$, is ineffective in the

sense that it sums only convergent series. The analogue of this theorem for absolute Riesz summability, in the special case $k = 1$, has been obtained independently by Sunouchi, Mohanty, and Obrechkoff. Dikshit has extended this result for all $k \geq 0$, and has shown that the summability $|R, c^n, k|$, $c > I$, $k \geq 0$, *is* ineffective. For discontinuous means Pati has shown that $|R^*, e^n, 2|$ is ineffective.

Absolute Riesz Summability with Indices: Working on the lines of Flett, Mazhar has extended the scope of summability $|R, \lambda, \alpha|$ by introducing a couple of parameters. According to him, a series $\sum a_n$ is summable $|R, \lambda, \alpha, \gamma|_k$, if the integral.

$$\int_h^{\infty} \omega^{k+\gamma k-1} \left| \frac{d}{d\omega} C_{\lambda}^{\alpha}(\omega) \right| d\omega < \infty,$$

where $k \geq 1$, $\alpha > 0$, $\alpha k' > 1$, γ a real number and $1/k + 1/k' = 1$. The summability $|R, \lambda, \alpha|_k$ is the same as the summability $|R, \lambda, \alpha|_k$ defined previously by him. Mazhar and Borwein[6] have independently proved that $|R, n, \alpha, \gamma|_k \sim |C, \alpha, \gamma|_k$, if $\alpha > 0$, $\alpha k' > 1$, $k \geq 1$, $1/k + 1/k' = 1$ and $\alpha \geq \gamma - 1/k$. Mazhara has also established a set of consistency theorems for the summability $|R, \lambda, \alpha, \gamma|_k$, from which follow, as special cases, the corresponding results of Obrechkoff and his own. Guha's result of the second theorem of consistency can also be derived from another result of Mazhar on the $|R, \lambda, \alpha, \gamma|_k$, summability.

It may be mentioned that for $\lambda_n = n$, the definition of $|R, \lambda, \alpha, \gamma|_k$, was also given by Borwein[7] which is covered by that of Mazhar. A similar definition, with some additional conditions, was introduced by Pramila Srivastava. Still in 1963, Boyer and Holder formulated a definition of absolute Riesz summability in another direction.

ABSOLUTE SUMMABILITY FACTORS

Given the series $\sum a_n$, if a series $\sum a_n \epsilon_n$ is summable in some sense, while in general $\sum a_n$ is itself not so summable, then $\{\epsilon_n\}$ is said to be a summability factor of the series $\sum a_n$. If the summability in question is absolute, the factors are naturally called absolute summability factors. The problem of summability factors received wide attention when in 1906, Hardy posed the problem: Given that $\sum a_n$ is summable (C, k), when is $\sum a_n \epsilon_n$ summable (C, k'), $k' \geq k$? In fact the problem was an extension of the classical results obtained much earlier by Abel, Dirichlet, and Dedekind on ordinary convergence. Hardy's problem for ordinary summability received immediate attention of various workers like Bohr[8], Moore, Chapman, Bromwich, Schur, Kogbetliantz, Anderson[9] and others.

It was Fekete who initiated the work on absolute summability factors in 1917. He obtained necessary and sufficient conditions for $\sum a_n \epsilon_n$ to continue being summable $|C, k|$, when the series $\sum a_n$ is summable $|C, k|$ and for $\sum a_n \epsilon_n$ to be summable $|C, k|$ or $|C, k + 1|$ when $\sum a_n$ is (C, k)-summable, k being a positive integer. In 1925, Kogbetliantz proved that if $\sum a_n$ is summable $|C, \delta|$ $\delta > 0$, then the series $\sum a_n n^{-\gamma}$, $0 < \gamma \geq \delta$, is summable $|C, \delta - y|$. Sunouchi extended the scope of this theorem by relaxing the condition $\gamma \geq \delta$. Peyerimhoff supplied simpler proofs of the above theorem of kogbetliantz. The work of Fekete and Kogbetliantz was carried further by Bosanquet[10], who extended the result of Fekete and established, amongst other, the following two theorems:

Theorem 1. *If* $0 \leq \rho \leq k$, *necessary and sufficient conditions for* $\sum a_n \epsilon_n$ *to be summable* $|C, \rho|$, *whenever* $\sum a_n$ *is summable* $|C, k|$, *are*

1. $\epsilon_n = O(n\rho^{-k})$ and 2. $\Delta^k \epsilon_n = O(n - k)$,

where ρ *and* k *are integers.*

6. **32** 9. **6, 7**
7. **32** 10. **40**
8. **25**

Theorem 2. *If* $0 \leq \rho \leq k+1$, *necessary and sufficient condition for* $\Sigma a_n \in_n$ *to be summable* $|C, \rho|$, *whenever* Σa_n is summable (C, k), are :

1. $\sum n^{k-\rho}|\in_n| < \infty$ and 2. $\sum n^k |\Delta^{k+1} \in_n| < \infty$,

where p and k are integers.

Peyerimhoff extended the scope of Theorem 1 for all non-negative values of k and ρ by establishing a theorem, the sufficiency part of which was stated by Anderson[11]. Chow has generalized this result in another direction. Chow also extended the second theorem of Bosanquet stated above, which was later generalized and extended in various directions by Bosanquet and Chow[12]. Pati and Ahmad and Ahmad[13], the results of Bosanquet, Chow and Peyerimhoff were extended by Mehdi for $|C,\beta|_k$ summability. Peyerimhoff has also obtained a number of interesting results some of which are analogues of the results proved by him and Jurkat and Peyerimhoff for ordinary summability.

Tatchell obtained a set of necessary and sufficient conditions on the sequence $\{\in_n\}$ for $|A|$ summability of the series $\sum a_n \in_n$ when $\sum a_n$ is convergent. Bosanquet and Tatchell further extended the scope of this result by replacing the condition of convergence of $\sum a_n$ by summability (C, k), $k \geq -1$.

It is know that strong Cesaro summability of order 1, symbolically summability $|C, 1|$, does not necessarily imply $|C, 1|$ summability, and also that boundedness of the sequence $\{t_n^a\}$ does not ensure $|C, \alpha|$ summability, where t_n^a denotes the n-th Cesaro mean of order α of the sequence $\{na_n\}$. Led by these considerations, Pati obtained a couple of theorems for $|C, \alpha|$ summability of the series $\sum a_n \in_n$ whenever is $|C, 11$ summable or t_n^a is bounded. These results were further extended and generalised by Prasad and Bhatt and Pati. Sunouchi studied the problem of 1C, al summability of the series $\sum a_n \in_n$ when the series $\sum_{v=1}^{n} |\sigma_v^\alpha - \sigma_{v-1}^\alpha|$ is not bounded, that is to say, $\sum a_n$ is not summable $|C, \alpha|$. This result of Sunouchi was further extended by Dikshit. Tayler obtained a result for absolute summability factors of a sequence which is an analogue of a resulf of Bosanquet[14] for ordinary summability. Hyslop has obtained necessary and sufficient. conditions for the summability $|C, k|$ of the series $\sum n\rho a_n$.

Quite recently work has been started in investigating summability factors for absolute Nörlund summability. The work has been done on the special case of harmonic summability by Lal and Singh. The results of Lal have been extended by Mehrotra and Tripathi to $|N, p_n|$ summability. Recently Nand Kishore has obtained a result for $|N, p_n|$ summability which generalises all the previous results.

The second theorem of consistency for absolute Riesz summability raises the problem of investigating the nature of the summability factors $\{\in_n\}$ which will make the factored series $\Sigma a_n \in_n$ summable $|R, \phi(\lambda), k|$ whenever Σa_n is summable $|R, \lambda, k|$ if $\phi(\lambda)$ increases rather too rapidly. In this direction the first result, due to Mohanty, is for order one. This result was further extended by Tatchel for all positive orders which is an analogue for absolute Riesz summability of a theorem due to Hardy and Riesz, Matsumoto extended the result of Mohanty in a different direction. Bridging the gulf between the theorems relating to the second theorem of consistency and the theorem of Tatchell for integral orders, Guha established a result, which has been subsequently generalised by Dikshit, by obtaining a theorem which is an analogue of a recent result of Borwein[15] for ordinary summability. The more abstruse case of positive non-integral orders has also been dealt with by Dikshit, Ahmad[16], and Borwein and Shawyer[17]. In 1962, Mazhar

11. **8**
12. **46**
13. **3**
14. **44**
15. **31**
16. **5**
17. **34**

extended Tatchell's theorem for indexed Riesz summability.

Quite recently Maddox has obtained necessary and sufficient conditions for absolute convergence of $\Sigma a_n \in_n$ when Σa_n is summable (R, λ, k), and has also established a sufficient condition for the series $\Sigma a_n \in_n$ to be summable $|R, \lambda, k|$ whenever the series Σa_n is bounded ordinarily (R, λ, k), k being an integer. In 1962, generalising his own result[18] on $|R, \log n, 1|$ summability factors, Bhatt[19] established a theorem which was subsequently extended by Mehrotra for summability $|R, \exp(\log\log n)^{\Delta}, 1|$, $\Delta > 1$.

It may be observed that in certain cases Riesz summability of series becomes similar with the Cesàro summability of Lebesuge-Stiltjes integrals. Use of this in dealing with the summability factors of integrals and Dirichlet series has been made in a number of paper published by Bosanquent[20], Seargent, Cossar, Austin[21], Borwein[22], Srivastava, and others.

TAUBERIAN THEOREMS

The concept of Tauberian theorems, as well-known, originated from a theorem of Tauber which states that if Σa_n is summable (A) and $a_n = o(1/n)$ then Σa_n is convergent. The idea behind this simple theorem, in course of time, developed into a class of theorems now called *Tauberian theorems,* their general nature being the determination of the conditions on $\{a_n\}$ that ensure the summability of the series Σa_n by a Q-process whenever it is summable by a P-process, $p \not\subset Q$. The first result of this type for absolute summability methods is due to Hyslop who proved that if the series Σa_n is summable $|A|$ and series $\Sigma\Delta(na_n)$ is summable $|C, k+1|$, when $k \geq 0$, then Σa_n is summable $1C, k|$. This result has been further extended by Sunouchi for $|\phi|$ summability. Lorentz has developed a general method for obtaining Tauberian conditions for absolute summability. He has also remarked that the result of Hyslop is the best possible in certain sense. Mazhar has generalised the above result of Hyslop for $|C, \alpha|_k$ summability. Quite recently Slipenuck and Bhatt[23] have obtained Tauberian theorems for absolute matrix summability and absolute Nörlund summability respectively. In 1949, Mohanty obtained Tauberian conditions under which $|R, \lambda_n, 1|$ implies $|C, 0|$. This result was further extended for all positive orders by Pati by establishing a result which is an analogue of a known Tauberian theorem of Hardy for ordinary summability. Later on, this result was generalized by Bhatt[24]. Pati also obtained necessary and sufficient Tauberian conditions under which $|R, \lambda_n, 1| \subset |C, 01$ and $|R, \lambda_n, 2| \subset |R, \lambda_n, 1|$. Generalising the result of Hyslop mentioned above, Pramila Srivastava has obtained absolute summability analogue of Tauberian theorems of Rajagopal and Schnee. A special feature of the extended Abel summability $|A, \lambda|$ and absolute Riesz summability consists in the fact that unlike the case of implying Abel by Cesàro, the summability $|R, \lambda, k|$ of the series Σa_n does not necessarily imply its $|A, \lambda|$ summability. However, Lorentz and Maephail have proved by imposing certain restrictions, namely that $\Sigma a_n e^{-\lambda_n z}$, $x > 0$, is convergent, it can be shown that $|R, \lambda, k| \subset |A, \lambda|$.

HIGH INDICES THEOREMS

In Tauberian theorems we ensure absolute convergence from the assumption of absolute summability of an infinite series Σa_n by imposing restrictions on $\{a_n\}$. Now tha problem arises whether the absolute convergence can be deduced from the summability $|A, \lambda|$ of a series Σa_n by imposing certain restrictions on $\{\lambda_n\}$ alone. The theorems of this nature have been termed as *High Indices Theorems* by Hardy and Littlewood. In this direction the first result is due to Zygmund who has established a result which is an analogue of the High Indices Theorem for ordinary summability

18. **17**
19. **18**
20. **41, 42**
21. **9**
22. **28, 29**
23. **22**
24. **14**

due to Hardy and Littlewood. He proved that if $\lambda_{n+1}/\lambda_n \geq q > 1$, *for* all n and if a series Σa_n is summable $|A, \lambda|$, then it is absolutely convergent. A similar result for the summability $|R, \lambda, k|$ has been obtained by Pramila Srivastava which is an analogue of a theorem of Hardy and Risz.

Extending a result of Zygmund for $|A|$ summability of a Lacunary series, Flett has proved that if $a_n = 0$, when $n \neq n_v$ $n_{v+1}/n_v > q > 1$, and the series Σa_n is summable $|A|_k$, then $\Sigma |a_n|^k < \infty$. Lorentz has shown that, when $k = 1$, the restriction imposed on the gap-conditions cannot be relaxed.

ABSOLUTE SUMMABILITY OF FOURIER SERIES

Perhaps nowhere was the inadequacy of the classical notion of convergence brought out more prominently and the usefulness of the concept of summability realised more significantly, than in their applications to Fourier series. The classical result that the Fourier series of a continuous function may not converge at points, which may even be everywhere dense, and in contrast to this the subsequent results of Fèjer and Lebesgue that the Fourier series is summable *(C,* 1) at all points of continuity and indeed almost everywhere, brought home clearly the distinct advantage of the methods of summability over that of convergence in their applications to Fourier series. In fact the development of the concept of ordinary as well as that of absolute summabil-ities received great stimulus from their application to Fourier series. From the beginning of the present century there has been very intensive and steadily growing work on the application of various methods of summability to Fourier series, an elaborate account of which was given in my Presidential Address to the section of Mathematics and Statistics of the Indian Science Congress in 1945. In the present Address my endeavour will be to dwell upon the aspect of absolute summability only.

25. **10**

Let

$$\frac{1}{2}a_0 + \sum_{n=1}^{\infty}\{a_n \cos nx + b_n \sin nx\} = \sum_{n=0}^{\infty} A_n(x),$$

where

$$\frac{a_n}{b_n} = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)\begin{matrix}\cos nx \\ \sin nx\end{matrix} dx \quad \text{and} \quad a_0 = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)dx,$$

be the Fourier series associated with the function $f(x)$ which is periodic and integrable in the sense of Lebesgue over the interval $(-\pi, \pi)$. Let

$$\Phi(t) = \frac{1}{2}[f(x+t) + f(x-t) - 2f(x)]$$

$$\phi(t) = \frac{1}{2}[f(x+t) + f(x-t)]$$

$$\phi_\alpha(t) = \frac{\alpha}{t^\alpha}\int_0^t (t-u)^{\alpha-1}\phi(u)du, \alpha > 0.$$

In 1914 Bernstein[25] proved that if $f(x) \in$ Lip α in $(0, 2\pi)$, then the Fourier series of $f(x)$ converges absolutely for $\alpha > \frac{1}{2}$, but not necessarily when $\alpha \leq \frac{1}{2}$. Later on, in 1928,

Zygmund established that if $f(x) \in BV$ $(0, \pi)$ and $f(x) \in$ lip α $(0 < \alpha \leq 1)$, then the Fourier series of $f(x)$ is absolutely convergent. He also demonstrated, by means of an example, that bounded variation of $f(x)$ alone is not sufficient to ensure the absolute convergence of the Fourier series of $f(x)$. These theorems of Bernstein and Zygmund have been subsequently generalised and improved in various ways by a number of worker like Szasz, Hardy and Littlewood, Tomic and others. Recently Nobel applied these ideas to the study of the absolute convergence of Lacunary-Fourier series, some of whose results have been generalized by Mazhar. In the light of the results of Bernstein and Zygmund it became natural to investigate when the Fourier series will become absolutely summable instead of being absolutely convergent.

Absolute Abel Summability : The earliest application of the notion of absolute summability to Fourier series is that of summability $|A|$ and is due to Whittaker who proved that every Fourier series which converges by virtue of Dini's condition is summable $|A|$. Immediately after, this result was generalised by Prasad who showed that at a point at which the integral

$$\int_0^\delta |\Phi(t)|/t^2\,dt$$

exists, where

$$\Phi(t) = \int_0^\delta [f(x+t) + f(x-t) - 2S]\,dt,$$

the Fourier series is summable $|A|$. Again he proved that a Fourier series which converges under Jordan's condition is summable $|A|$. This last result of Prasad was generalised by Misra who proved that the Fourier series is summable $|A|$ under de la Vallee Pqussin's condition. Later on, Bosanquet[26] generalised these results by proving that if $\bar{\phi}_\alpha(t)$, $\alpha \geq 0$, is of bounded variation in $(0, \pi)$ and tends to zero as $t \to 0$, then the Fourier series is summable $|A|$, where

$$\bar{\phi}_\alpha(t) = \frac{\alpha}{t^\alpha}\int_0^\delta (t-u)^{\alpha-1}\bar{\phi}(u)\,du.$$

Prasad studied for the first time the summability $|A|$ of the conjugate series. He proved that a conjugate series is summable $|A|$ at a point x at which the integral

$$\int_0^\delta |\Psi(t)|/t^2\,dt$$

exists where

$$\psi(t) = \int_0^t [f(x+t) = f(x-t)]\,dt.$$

Prasad's theorem for summability $|A|$ of the conjugate series has been later on represented in somewhat different forms by Takahashi and extended chiefly by Kuniyeda and Bosanquet and Hyslop[27]. There is a certain amount of overlapping between the results of Kuniyeda, which are earlier, and those of Bosanquet and Hyslop. Sinha in 1959, obtained a necessary and sufficient condition for the non-summabili-ty $|A|$, of the conjugate series.

In order to investigate the bounded variation and behaviour of a complex Fourier series on its radius and circle of converge, Prasad discussed the summability $|A|$ of Young's restricted Fourier series and proved that in the interval of restriction the restricted Fourier series of the second class behaves as the ordinary Fourier series for the purpose of summability $|A|$. Misra proved that the same is true for restricted Fourier series whatever be their class. Kuniyeda and Bhatnagar[28] have investigated conditions for the summability $|A|$ of the derived Fourier series and derived conjugate series. Results have also been established by Bhatt[29] and Gupta regarding the absolute summability of the Laplace series and the Ultra-spherical series respectively.

Absolute Cesàro summability : In 1936, Bosaquet[30] carried further the work of Prasad, Misra and his own and established general theorems for $|C|$ summability of Fourier series analogous to known results of Hardy and Littlewood concerning ordinary Cesàro summability. He proved that if $\phi_\alpha(t) \in BV\ (0, \pi)$, $\alpha > 0$, then the Fourier series of $f(t)$, at $t = x$ is summable $|C, \beta|$, $\beta > \alpha$, and conversely, if the Fourier series of $f(t)$, at $t = x$, is summable $|C, \alpha|$, $\alpha \geq 0$, then $\phi_\beta(t)$ is of bounded variation in $(0, \pi)$, for every $\beta > \alpha + 1$. In 1962, Hirokawa established that summability $|C, \alpha|$ of Fourier series to zero implies that $\phi_\alpha(t) = 0$ (1), for $\alpha > 1$. Quite recently Sinha has obtained a necessary and sufficient condition for the summability ICI of Fourier series which is an analogue of a result of Bosanque[31] for ordinary Cesàro summability. Bosanquet and Hyslop[32] studied the $|C|$ summability of conjugate series in detail and obtained several theorems. Analogous problems for $|C|$ summability

26. **36**
27. **47**
28. **11**
29. **13**
30. **37, 38**
31. **35**
32. **47**

of the *r*th derived Fourier series and the *r*th derived conjugate series were dealt with by Hyslop. Bosanquet[33] and Mohanty studied the $|C|$ summability of the derived Fourier series and derived conjugate series of a class of functions belonging to Cesàro-Lebesgue integral.

The behaviour of Fourier series regarding the $|C|$ summability of $f(t) \in$ Lip α was investigated by Hyslop and Chow. Hyslop showed that the Fourier series of $f(x) \in$ Lip $\alpha, 0 < \alpha \leq \frac{1}{2}$, is summable $|C, \frac{1}{2} - \alpha + \in|$, $\in > 0$ for every value of x. Bosanquet remarked that the theorem of Hyslop is the best possible in as much as that cannot be replaced by zero. In generalising this result Chow made use of the concept of Lip (k, p) class which was introduced for the first time by Hardy and Littlewood. According to them $f(t) \in$ Lip (k, p) if for $p \geq 1$, $0 < k \leq 1$,

$$W_p(h) = \left\{\frac{1}{2\pi}\int_{-\pi}^{\pi} |f(x+h) - f(x)|^p \, dx\right\}^{1/p}$$

$$= 0(|h|^k).$$

In fact Chow obtained this generalisation as a deducation from his result on $|C|$ summability of a power series on its circle of convergence. Inspired by a result of Hardy and Littlewood on absolute convergence, Chow obtained a further extension of his result which is applicable even to negative order summability. He proved that if, $p > 1$, $kp > 1$ and $f(x) \in$ Lip (k, p) then the Fourier series of $f(x)$ is summable C, for all values of x, and for every $\alpha > 1/p - k$ or $\frac{1}{2} - k$, according as $1 < p \leq 2$ or $p \geq 2$. With the help of this theorem and the one due to Hardy and Littlewood, Chow obtained a generalisation of Zygmund's result in the form that if $f(t) \in BV(0, \pi)$ and $f(t) \in$ Lip k, then the Fourier series of $f(t)$ is summable $|C, \alpha|$, $\alpha > -k/2$, for all values of t. Also Chet studied the negative order Cesàro summability of Fourier series and its conjugate series for functions of bounded variations and Lipschitz class. Matsuyama has generalised the earlier work of Bernstein and Szasz by obtaining results on $|C|$ -summability of Fourier series of the class of functions belonging to L^p in $(0, 2\pi)$ with an additional condition on $Wp(h)$. In 1955, Chow, by an appeal to theorem of Wang, deduced that if $W_2(t) = 0\left\{\log\frac{1}{|t|}\right\}^{-1-\delta}$, $\delta > 0$, then the Fourier series of $f(t)$ is summable $|C, \alpha|$, $\alpha > \frac{1}{2}$, almost everywhere, and obtained a further generalisation of this result in the form that if $1 \leq p \leq 2$, $f(t) \in L^p$ and

$$\int_{-\pi}^{\pi} \frac{W_p(t)}{|t|}\, dt < \infty,$$

then the Fourier series of $f(t)$ is summable $|C, \alpha|$ almost everywhere, for $\alpha > 1/p$. Yano obtained some interesting results in this line of work. Quite recently Hsiang has improved the above result of Chow, which has been subsequently generalised by Mazhar. The summability $|C|$ of power series has been dealt in detail by Chow, Loo and Flett.

In 1926 Hardy and Littlewood considered the Cesaro summability of the series $\Sigma(s_n(x) - s)/n$, where $s_n(x)$ denotes the nth partial sum of the Fourier series and s an appropriate number, which they termed as associated Fourier series. In 1956, Mohanty and Mahapatra studied the problem of $|C|$ -summability of this series. Subsequently their results were generalized by Mazhar.

Absolute Riesz Summability : In 1949, Mohanty began the study of absolute Riesz summability of Fourier series. He established several sufficient conditions for $|R, \lambda_n, \alpha|$ summability of Fourier series and its conjugate series for various types of sequences $\{\lambda_n\}$. Later on Pati generalised one of the results of Mohanty by obtaining an analogue for absolute Riesz summability of Wang's theorem

33. **39**

on ordinary summability and in 1957 he further improved his result. Subsequently Sinha extended the result of Pati by introducing a parametric constant into the type. He proved that if α is an integer ≥ 1, $\beta > 0$ and

$$\phi_\alpha(t)\left|\log\frac{k}{t}\right|^\beta \in BV(0,\pi),$$

then the Fourier series of $f(t)$, at $t = x$, is summable $|R, \exp(\log\omega)^{1+\beta/\alpha}, \alpha+\delta|$, for every $\delta > 0$. For $\beta = 1$ this result reduces to that of Pati. Matsumoto independently obtained a result applicable even for non-integral values of α. The result of Matsumoto also generalises a result due to Mohanty and Mishra. Theorems, analogous to their own results on Fourier series for absolute Riesz summability, have been obtained by Pati and Sinha for conjugate series, rth derived Fourier series and r-th derived conjugate series. Recently Mazhar has established a result which generalises a result due to Bosanquet and Hyslop and Sinha on conjugate series. Matsuyama has obtained result for the summability $|R, \exp(\log\omega)^\alpha, 1|$, of the Fourier series under the condition $\log(1/t) = 0$ (1), as $t \to 0$.

Regarding the absolute logarithmic summability of Fourier series Izumi and Kawata have proved that if $\bar{\phi}(t)(\log 1/t)^\beta = 0$ (1) as $t \to 0$, for some /$\beta > 0$, then the Fourier series of $f(t)$, at $t = x$, is summable $|R, \log n, 1|$. Izumi and Matsuyama further extended this result while Matsuyama has improved upon it by establishing that if $\bar{\phi}(t)(\log\log 1/t)^\delta = 0$ (1), $t \to 0$, $\delta > 1$, then the Fourier series of f(t) at $t = x$, is summable $|R, \log n, 1|$. Sunouchi studied the $|R, \log n, \alpha|$ summability of Fourier series when $\phi_\alpha(t) \in BV(0, \pi)$ for a $\alpha \geq 2$. In 1956 generalising their previous work Mohanty and Mahapatra proved that if

$$\left|\log\frac{2\pi}{t}\right|^{-1}\int_t^\pi \bar{\phi}(u).u^{-1}du \in BV(0,\pi),$$

then the Fourier series of $f(t)$, at $t = x$, is summable $|R, \log n, \delta|$, $\delta > 1$.

Absolute Norlund Summability: The absolute Norlund summability of Fourier series and its conjugate series for the class of function of bounded variation was first considered by Pati. He proved that if $\phi(t) \in BV(0, \pi)$ and if $\{p_n\}$ is a positive monot-onic sequence such that the sequences

$$\left\{\frac{(n+1)p_n}{p_n}\right\} \text{ and } \left\{\frac{1}{P_n}\sum_{k=0}^{n}\frac{P_k}{k+1}\right\}$$

are each of bounded variation, then the Fourier series of $f(t)$, at $t = x$, is summable $|N, p_n|$ This theorem includes as particular case a previous result of Bosanquet on $|C|$ summability. Pati has also established a corresponding theorem for conjugate series. Varshney has improved upon the theorem of Pati for Fourier series by relaxing conditions on $\{p_n\}$; this has been followed by another theorem published by Pati. Recently, Singh has obtained the same theorem as that of Pati but under a different set of conditions on $\{p_n\}$, namely $\{p_n\}$ is a non-negative and non-increasing sequence such that $\{p_n - p_{n+1}\}$ is a non-increasing sequence and the sequence

$$\left\{\frac{1}{P_n}\sum_{k=1}^{n}\frac{P_k}{k+1}\right\}$$

is bounded.

The absolute Nörlund summability of Fourier series and its conjugate series for functions belonging to Lipschitz class was first investigated by McFadden in 1942. He proved that if $\{p_n\}$ is non-negative, non-increasing sequence, such that $p_n \to 0$, as $n \to \infty$, $|\Delta p_n|$ is non-increasing, and

1. $\sum_{k=1}^{\infty} P_k^{2k-2} < \infty$,

2. $\sum_{k=1}^{\infty} P_k^{-1k-\alpha-\frac{1}{2}} < \infty$,

and if $f(t) \in$ Lip α, $0 < \alpha \leq 1$, then its Fourier series and its conjugate series are both summable $|N, p_n|$. This result includes, as special cases, the theorems of Bernstein and Hyslop on $|C|$ -summability of Fourier series. McFadden also studied the $|N, p_n|$ summability of Fourier series and its conjugate series for functions belonging to the more general class Lip (α, q), for $0 < \alpha \leq \alpha q > 1$. From his results he deduced a theorem on $|C|$ -summability which states that if $f(t) \in$ Lip (α, q), $\frac{1}{2} \geq \alpha > \frac{1}{q}, \beta + \alpha > \frac{1}{2}$, then the Fourier series is summable $|C, \beta|$ for all values of t. Recently Lal has generalised the result of McFadden for Fourier series replacing the condition of $f(t) \in$ Lip (α), by a set of conditions on modulus of continuity, $\omega(\delta)$, which is applicable in a wider range. In 1960, Varshney studied the absolute harmonic summability of Fourier series and proved that if $f(t)$ is of bounded variation and $\omega(\delta) \leq A \log^{-1} - \in \frac{1}{h}$, $\in > 0$, in $(0, 2\pi)$, then the Fourier series of $f(x)$ is absolutely harmonic summable. Subsequently, this result has been generalised by Shah.

Quite recently a beginning has been made by Mohanty to consider the absolute summability of Fourier series and its conjugate series by Borel Integral method $|B'|$ and he has obtained a couple of theorems.

LOCALISATION PROBLEMS FOR ABSOLUTE SUMMABILITY OF FOURIER SERIES

It is known that the behaviour of Fourier series regarding its convergence for a particular value of x depends on the behaviour of the function in the immediate neighbourhood of the point only. In other words, however small δ may be, the behaviour of $s_n(x)$ (the nth partial sum of a Fourier series) depends on the nature of the generating function $f(t)$ in the interval $(x - \delta, x + \delta)$ only, and is not affected by the values which it takes outside the interval. This property of the Fourier series is known as *Local Property.* In 1933 Prasad established that Jordan's criterion of convergence for a Fourier series is also its $|A|$ -summability criterion at a point. Thus, it follow that the summability $|A|$ of a Fourier series at a point depends only upon the behaviour of the generating function in the immediate neighbourhood of the point at which the absolute summability of the Fourier series is considered.

In 1936, Bosanquet[34] demonstrated that the summability $|C, \beta|$, $\beta > 1$, of a Fourier series, is a local property. Recently Bhatt[35] has extended this result for $|N, p_n|$ summability. On the other hand, Bosanquet and Kestelman[36], and Randels have proved that the summability $|C, 1|$ of a Fourier series at a point is not a local property. Thus it follows from the consistency theorem of $|C|$ summability that the summability $|C, \alpha|$, $-1 < \alpha \leq +1$, of a Fourier series is not a local property. Now the problem arises as to what should be the nature of the generating function $f(x)$ of the Fourier series so that its summability $|C, \alpha|$, $\alpha \leq 1$, may become a local property. An answer to this question, for the case $\alpha = 1$, was given by Mohanty who showed that if $\sum \frac{|A_n(x)|}{n} \log n < \infty$, then the summability $|C, 1|$ of a Fourier series can be ensured by a local condition. This result was subsequently generalised by Bhatt[37]. Bhatt's result is included in a more general result due to Jurkat and Peyerimhoff which states that if $\sum \frac{|A_n(x)|}{n} < \infty$, for $-1 < a \leq 1$, then the summability $|C, \alpha|$ of a Fourier series is a local property. It may be remarked that this condition is also necessary for $|C, \alpha|$ summability of Fourier series. For $0 \leq \alpha \leq 1$, Bhatt[38] has further extended this theorem by obtaining it for $|N, p_n|$ summability which has been extended by Johns in another direction.

34. **38**
35. **21**
36. **48**
37. **16**
38. **19**

Izumi and Mohanty have independently proved that the summability $|R, \log n, 1|$ of a Fourier series is not a local property. This generalises the corresponding result of Bosanquet and Kestelman[39] on $|C, 1|$ summability. Improving upon the result of Izumi, Mohanty and Izumi have established a result for localisation of $|R, \log n, 1|$ summability of Fourier series, which was subsequently generalised by Bhatt[40]. Quite recently Dikshit has extended the result of Bhatt for $|C, 1|$ and $|R, \log n, 1|$ summabilities, by establishing that if $\{\psi_n\} = \left\{\frac{\lambda_{n+1} - \lambda_n}{\lambda_{n+1}}\right\}$ is monotonic non-increasing the sequence $\{n^{1+\epsilon}\psi_n\}, \epsilon < 0$, is monotonic non-decreasing and if $(\Sigma|A_n(x)|\psi_n < \infty)$, then the summability $|R, \lambda_n, 1|$ of the Fourier series is a local property. He has also proved that the condition $\Sigma|A_n(x)|\psi_n < \infty$ is a necessary condition for $|R, \lambda_n, 1|$ summability of Fourier series.

The problem of localisation of derived Fourier series for various summability methods has been studied by Lal, Bhatt[41], Mehrotra, and Saxena. Quite recently Bhatt[42] has obtained results for localisation of $|C|$ summability of the rth derived Fourier series.

Localization Problems for Factored Fourier series : There is a line of approach of associating suitable factor λ_n with the general term of the series $\Sigma A_n(x)$, so that the factored Fourier series $\Sigma A_n(x)\lambda_n$ may be summable by a given method under local conditions. On the result of Bosanquet and Kastelman[43] that the summability $|C, 1|$ of a Fourier series is of non-local character, Mohanty has remarked that even this is so for the series $\sum \frac{A_n(t)}{\log(n+1)}$. Extending this result of Mohanty, Matsumoto has studied the problem of non-localisation of $|R, \lambda_n, 1|$ summability for a series of particular values of λ_n. Recently Dikshit has generalised this result for a wider class of sequence $\{\lambda_n\}$. The problem of selecting a suitable type of factor $\{\mu_n\}$ so that the summability $|R, \lambda_n, 1|$ of the Fourier series $\Sigma A_n(x)\mu_n$ may effectively become a local property, was considered by Matsumoto for a series of particular values of λ_n. For the particular cases $\lambda_n = \log n$ and $\lambda_n = \exp(\log\log n)^{\Delta}$ the result of Matsumoto was extended by Bhatt[44] and Mehrotra respectively. Extending a result of Lal on absolute harmonic summability, Tripathi has established a result for localisation of $|N, p_n|$ summability of the factored Fourier series. This result has been quite recently generalised by Nand Kishore for a wider class of sequence $\{p_n\}$. Quite recently Sinha has considered the localisation problem of a sequence associated with Fourier cosine constants $\{a_n^{(1)}\}$ of $\phi_1(t)$. He has proved that the bounded variation of $\{n^{\delta}a_n^{(1)}\}$, $0 < \delta < 1$, is not a local property.

Localisation Problem for functions of L^p class : We now come to the Fourier series of a function of the class L^p, $p > 1$. In 1941, Foa constructed an example to show that the summability $|C, 1/p|$, $p > 1$, of the Fourier series of this class of functions is not a local property, Yano also arrive at the same result by an appeal to a theorem of Banach-Steinhaus. In 1944, Sunouchi and Tsuchikura proved independently that the summability $|C, 1|$ of the Fourier series of a function of the class L^p, $p > 1$, at a point is a local property. Jurkat and Peyerimhoff have show that $|C, \frac{1}{2}|$ summability of the Fourier series belonging to L^p class, $p > 2$, is not a local property. In 1953, Tsuchikura obtained a sufficient criterion for the summability $|C|$ of the Fourier series of a function of class L^p, $p > 1$, at a point which states that if $f(t) \in L^p$, $(0, 2\pi)$, $1 < p \leq 2$, and if

$$\int_0^{\pi} \frac{|\bar{\phi}(t)|}{t}\left|\log\frac{1}{t}\right|^{\alpha} dt < \infty, \alpha > p - 1$$

39. **48** 42. **23**
40. **15** 43. **48**
41. **20** 44. **47**

then the Fourier series of $f(t)$, at $t = x$, is summable $|C, \delta|$, for every $\delta > 1/p$. An immediate consequence of the above result is that the summability $|C, 1/p + \epsilon|$, $\epsilon > 0$, for the Fourier series of the class L^p, $1 < p \leq 2$, at a point is a local property. He has also proved that for a continuous function summability $|C, \alpha|$, $\alpha \geq \frac{1}{2}$, is not a local property. Pati has studied certain properties of Fourier coefficients for the power series on the circle of convergence. Quite recently Tsuchikura has obtained a sufficient condition of local character, for $|C, 1/p + \delta|$ -summability for functions of L^p class, $1 < p \leq 2$ which is applicable over a set of points.

In 1959, Sulaxana Kumari has generalised Foa's result for the summability $|R, \log n, 1/p|$. Localisation problems of the absolute Cesàro summability with index have been studied in detail by Flett and also by Kanno.

ABSOLUTE SUMMABILITY FACTORS OF FOURIER SERIES

The first application of absolute summability factors of infinite series is due to Prasad who proved in 1933 that if $\{\lambda_n\}$ be any one of the sequences :

$$\left.\begin{array}{l} \{\log n)^{-1-\epsilon}\},\ \{\log n)^{-1}\ (\log\ \log n)^{-1-\epsilon}\},... \\ ...\ \{\log n)^{-1}(\log\ \log n)^{-1}...\ (\log\ \log\ ...\log_{p-1} n)^{-1} \\ \qquad (\log\ \log\ ...\ \log_p n)^{-1-\epsilon}\},\ \epsilon > 0, \end{array}\right\} \quad (11.11)$$

then $\Sigma_n A_n(t)$ is summable $|A|$ at every point $t = x$, where

$$\int_0^t |\phi(u)|\, du = o(t), \quad (11.12)$$

as $t \to 0$, and therefore, almost everywhere,

Izumi and Kawata showed that Prasad's result for Fourier series holds even when we replace the sequence of summability factors (11.11) by a more general sequency where $\{\lambda_n\}$ is a convex such that the series $\Sigma n^{-1}\ \lambda_n$ is convergent. Cheng generalised Prasad's result by proving that $\{\lambda_n\}$ is any one of the sequences (11.11) and condition (11.12) holds when the series $\Sigma\lambda_n A_n(t)$, at $t = x$, is summable $|C, 1 + \delta|$, $\delta > 0$. All these theorem have been generalised by Pati who extended Cheng's result to the case in which $\{\lambda_n\}$ is a convex sequence such that the series $\Sigma n^{-1}\lambda_n$ is convegent. Subsequently this result was extended by Dikshit. Pati's result has been recently generalised by Pati and Sinha by the introduction of a new concept of hyperconvexity. Making use of the concept of hyperconvexity Ahmad[45] has further extended Dikshit's result.

In 1941, Chow established that if $\{\lambda_n\}$ is a convex sequence that the series $\Sigma n^{-1}\lambda_n$ is convergent, then the series $\Sigma\lambda_n A_n(t)$ is summable $|C, 1|$ at points where

$$\sum_{v=0}^{n} \{s_v(t) - f(t)\}^2 = o(n), \quad (11.13)$$

Which, as shown by Marcinkiewicz, holds true for almost all values of t. It may be remarked that the set of points given by (11.13) is not always identical with the Lebesgue set given by (11.12). Thus it is natural to enquire whether the series of the type $\sum \frac{A_n(t)}{(\log n)^{1+\epsilon}}$ are summable $|C, 1|$ also at the Lebesgue set of points. This remains still an unanswered question. However, an analogous question for power series has been answered by pati in the affirimative by proving a theorem which has been subsequently improved upon by Rajagopal. Cheng has, however, proved that if the condition

$$\int_0^t |\phi(u)|\, du = O\left\{t \log \frac{1}{t}\right\}^{\beta}, \ \beta \geq 0, \quad (11.14)$$

as $t \to 0$, holds then the series $\Sigma A_n(t)/(\log n)^{3/2+\beta+\epsilon}$, at $t = x$, is summable $|C, 1|$. This result was further extended by Prasad and Bhatt. Recently Patti has obtained a necessary and sufficient condition for $|C, 1|$ summability in the Lebesgue set. The results of Cheng and Prasad and

45. **4**

Bhatt have been further extended by Sing. Rajagopal has obtained the summability factors for $|C, 1|$ and $|C, 1 + \in|$ summabilities of Fourier series of a certain class of functions. Pramila Srivastava has extended Cheng's result by replacing $\phi(u)$ by $\phi_\alpha(u)$.

Generalising the previous result of Izumi and Kawata, Chow has established a result for $f(t)$ belonging to class H, i.e. when $f(t)$ and its conjugate function are both integrable (L). Prasad and Cheng have also established results for absolute Cesàro summability of factored conjugate series of a Fourier series parallel to their own results for Fourier series. Pramila Srivastave has obtained a result for the factored conjugate series analogous of Pati's result for Fourier series.

Led by a theorem of Bosanquet, Cheng proved that if $\phi_\alpha(t)$ is of bounded variation in $(0, \pi)$, $0 \leq \alpha \leq 1$, then $\Sigma A_n(x) (\log n)^{-1-\epsilon}$, $\epsilon > 0$, is summable, $|C, \alpha|$. A corresponding result for the conjugate series has been obtained by Wang. Sunouchi extended the result of Cheng for $\alpha = 1$. Theorems of Cheng and Sunouchi were sub-sequently generalised respectively by Prasad and Bhatt and Dikshit by replacing the factor $(\log n)^{-1-\epsilon}$ by a wider class of summability factors, while Pramila Srivastava generalised Wang's result for the case $\alpha > 1$, by introducing a general class of summability factors $\{\lambda_n\}$. The result of Cheng referred to above was generalised by Matsumoto in another direction. The result of Matsumoto was further generalised by Mazhar whose theorems include as a special case also the theorem of Prasad and Bhatt. Prasad and Bhatt and Dikshit have also studied the $|C|$ -summability of the factored Fourier series even when $\phi_\alpha(t)$ is not of bounded variation. As a supplement to Hyslop's result for $|C|$ -summability, Cheng proved that if $f(t) \in$ Lip α, $0 < \alpha < \frac{1}{2}$, then the series $\Sigma A_n(t)(\log n)-1-\epsilon$, is summable $|C, \frac{1}{2} - \alpha|$ and that $\in$ cannot be replaced by zero.

Mohanty has obtained sufficient condition for the summability $|C|$ of the factored series $\Sigma n^\alpha A_n(t)$ and $\Sigma n^\alpha B_n(t)$. These results were subsequently generalised by Mazhar.

Concerning the absolute Riesz summability of the factored Fouries series Mohanty in 1951, proved that if $\phi(t) \in BV\ (0, \pi)$ then the series $\sum \frac{A_n(x)}{\log n}$ is summable $|\mathrm{Re}^{\omega^\alpha}, 1|$, $0 < \alpha < 1$. Subsequently Mohanty and Mishra established a result for the summability, $|R, \exp (\log n)^{1+1/\alpha}, 1|$, of the series $\sum \frac{A_n(x)}{\log n}$, when $\phi_\alpha(t) \in BV\ (0, \pi)$, $0 < \alpha < 1$, while Bhatt[46] has considered $|R, \log n, 1|$ summability of the factored Fourier series $\Sigma A_n(t) \in_n$, when $\phi_1(t) \in BV\ (0, \mu)$. Matsumoto has studied the summability $|\mathrm{R}, \lambda_n, 1|$ of the factored Fourier Series for various particular values of λ_n. These results were sub-sequently improved upon by Pramila Srivastava. Mazhar extended the result of Matsumoto for the summability $|R, \lambda_n, 1|_k$. Starting from the result of Matsumoto and Sinha on absolute Riesz summability, Dikshit has proved that if $\alpha \geq 0$, $\beta \geq 0$, and $\phi_\alpha(t) \left\{\log \frac{k}{t}\right\}^{\alpha\beta} \in BV\ (0, \pi)$, $k > \pi + 1$, then the series $\sum \frac{A_n(t)}{(\log n)^\delta}$ is summable $|R, \exp (\log \omega)^{1+\beta}, \alpha|$, where $\delta > + \alpha\beta$, and $\delta \geq \beta$ in the case $\beta > 1$, $0 < \alpha < (\beta - 1)/\beta$. When $\beta = 0$, this theorem reduces to the know results due to Cheng and Sunouchi. Quite recently Lal has extended and improved the above theorem of Dikshit for the case $\alpha = 1$.

In 1959, Varshney proved that if $\phi(t) \in BV$ $(0, \pi)$, then the series $\sum \frac{A_n(x)}{\log(n+1)}$ is summable $|N, 1/(n + 1)|$. Singh has generalised this result for general Nörlund summability. His result includes the theorem of Bosanquet on $|C|$ summability and

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that of Varshney on $|N, 1/(n + 1)|$ summability. H. P. Dikshit has also discussed such results. Lal has studied the problem of $|N, 1/(n + 1)|$ summability of $\Sigma A_n(x)\mu_n$, when $\phi_1(t) \in BV(0, \pi)$. Recently Bhatt[47] has extended this result when $\phi_\alpha(t) \in BV(0, \pi)$, $\alpha > 0$. Lal, Mehrota, Tripathi and Nand Kishore have also obtained interesting results for $|N, p_n|$ summability of factored Fourier series.

In 1961, Pati demonstrated that there exists a function $f(t)$ of class L such that $\phi(t) \log\frac{k}{t}$ $(k > 2\pi)$ is of bounded variation $(0, \pi)$ but its Fourier series, at $t = x$, is not summable $\left|N, \frac{1}{n+1}\right|$. Let by this result of Pati, Lal investigated a suitable factor $\{\in_n\}$ for $\left|N, \frac{1}{n+1}\right|$ summability of $\Sigma A_n(t) \in_n$ when $\phi(t) \log\frac{k}{t} \in BV(0, \pi)$.

ABSOLUTE SUMMABILITY OF DIRICHLET SERIES

The series

$$\sum_{n=1}^{\infty} a_n e^{-\lambda_n s}, \qquad (12.1)$$

where the coefficients an, are in general, complex, the sequence of exponents $\{\lambda_n\}$ is monotoic increasing sequence or real numbers tending to infinity as n tends to infinity and $s = \sigma + it$, is a complex variable, where real and imaginary parts are σ and t, is called Dirichlet series of type λ_n. This series (12.1) is also written as

$$\sum a_n l_n^{-s}, \quad l_n = e^{\lambda_n}.$$

When $\lambda_n = \log n$, the series (12.1) is known as on ordinary Dirichlet series. Ordinary Dirichlet series with real values of s were first introduced into analysis by Dirichlet. Earliest theorems involving complex values of s and general sequence $\{\lambda_n\}$ are due to Jensen and Cahen. In my Presidential Address delivered at the 27th conference of the Indian Mathematical Society in 1961, I have dealt in detail with the various aspects of summability of Dirichlet series. Here I shall confine myself only to the problem of its absolute summability.

It is usual to refer to summability (R, λ, k) of the series (12.1) as "Summability by Typical Means of the first kind" and to summability $(R, 1, k)$ as "Summability by Typical Means of the second kind". It is known that if the series (1.21) is summable (R, λ, k) for $s = s^* = \sigma^* + it^*$, then the series is also summable (R, λ, k) for all values of s such that $\sigma > \sigma^*$. Also there exists a number σ_k called abscissa of summability (R, λ, k), such that the series (12.1) is summable (R, λ, k) for $\sigma > \sigma_k$ and not summable (R, λ, k) for $\sigma < \sigma_k$. The analogue for absolute summability of the above theorem was obtained by Obrechkoff. He proved that if the series (12.1) is summable $|R, \lambda, k|$ for $s = s^* = \sigma^* + it^*$, then it is summable for all s such that $\sigma > \sigma_k$. This leads immediately to the existence of an abscissa g_k, said to be abscissa of summability $|R, \lambda, k|$, such that (12.1) is summable $|R, \lambda, k|$ at every point to the right of the line $\sigma = g_k$, and is not summable $|R, \lambda, k|$ at any point to the left of this line. If g_k is positive, then its value is given by.

$$g_k = \lim_{\omega \to \infty} \sup \left\{ \frac{1}{\omega} \log \int_1^{\omega} \left| dA^k \lambda \right| \omega \right\}$$

The above evaluation depends on certain limitation theorems which is very general form were given by Isaacs and Bosanquet[48] in 1953. On the other hand, if g_k is nagative, no such evaluation of it seems to have been obtained. Corresponding to the number g_k, the abscissa of summability $|R, \lambda, k|$, there also exists a number known as the abscissa of summability by Typical means $|R, 1, k|$. It follows from the results of Tatchell and Prasad and Pramila Srivastava that these two abscissae are identical. From the first theorem of consistency for absolute Riesz summability it follows that g_k is monotonic non-increasing function of k. Analogous

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to the classical result of Riesz that σ_k is a convex function of k, Pramila Srivastava has established that g_k is a convex function of k. Richert has obtained independently the same result for an ordinary Dirichlet series.

Obrechkoff investigated the behaviour of the sumfunction $f(s)$ of the series (12.1) when it is absolutely summable. He proved that if the series (12.1) is absolutely summable, then for,

$$\sigma \geq g_k + \epsilon, \epsilon > 0,$$

$$f(s) = 0\ (|t|^k).$$

Whether this estimate also cannot be improved upon, as happens to be the case with the corresponding estimate for ordinary summability, remains an open question. On the other hand, Brujin has studied the behaviour of the corresponding Dirchlet series (12.1) by imposing some restrictions upon $f(s)$. He proved that if

$$f(s) = \sum_{n=1}^{\infty} a_n e^{-\lambda_n s} = 0\left\{|t|^k\right\},\ |t| \to \infty,$$

$$\frac{1}{\lambda_{n+1} - \lambda_n} = 0\left\{e^{\lambda_n (l+\delta)}\right\}, \delta > 0,$$

where $s = \sigma + it$ and

$$\int_{-T}^{T} |f(\sigma^x + it)|^2\, dt = 0\left\{T^{2\nu+1}\right\},$$

then the Dirichlet series is absolutely convergent, for

$$\sigma > \sigma^x + \left(\nu + \frac{1}{2}\right) l.$$

This is improves a result due to Grandjot and is the best possible result of this kind. It seems that the field of converse theorems concerning the abscissa of absolute summability, and that of the theorems regarding summability, either ordinary or absolute, on this abscissa and beyond it on the left, remains so far entirely unexplored.

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Bosanque has considered the inter-connection between the abscissa σ_k of ordinary summability and the abscissa g_k of absolute summability. He has established that

$$\sigma_k \geq g_{k+1} \geq \sigma_{k+1}.$$

Considering only the integral values of k, he further proved that

$$g_k \leq \sigma_k + D = \sigma_k + \text{lim sup. } (\log n)/\lambda_n.$$

Subsequently Austin[49] proved that if $0 < x \leq 1$ and $k \geq 0$, then

$$g_{k+x} \leq \sigma_k + (1 - x)\, D.$$

He further proved that there is at most one value of k for which σ_k is both discontinuous and finite and he removed the restriction, $x \neq 0$, from the above result for all other values of k by proving that if k_0 denotes the lower bound of the numbers k such that $\sigma_k < +\infty$, then for all $k \neq k_0$.

$$g_k \leq \sigma_k + D.$$

Subsequently by employing a direct method, Borwein[50] succeeded in removing the restriction $k \neq k_0$.

DIRICHLET PRODUCT

Given two Dirichlet series $\sum a_n e^{-\lambda_n s}$ and $\sum b_n e^{-\mu_n s}$, we obtain, as formal product of these, another Dirichlet series $\sum c_n e^{-\nu_n s}$, where $c_n = \Sigma a_p b_q$; $\nu_n = \lambda_p + \mu_q$ and $\{\nu_n\}$ is the ascending sequence formed out of all the values of $\lambda_p + \mu_q$ ($p = 1, 2, ...$; $q = 1, 2, ...$). The series Σc_n defines the Dirichlet product of the series Σa_n and Σb_n of the type (λ, μ). When $\lambda_n = \mu_n = n$, the Dirichlet product is precisely the Cauchy product. For various kinds of summabilities of the Dirichlet product Σc_n, when Σa_n and Σb_n are summable, results, have been obtained by Cesàro, Knopp, Chapman, Hardy and Littlewood, Hardy and Riesz, and others. Obrechkoff has discussed the absolute Riesz summability of the series Σc_n. He proved that if

Σa_n is summable $|R, \lambda, k|$ and Σb_n is summable $|R, \mu, l|$, then the series Σc_n is summable $|R, v, k+l|$. Also it is known that if Σa_n is summable (R, λ, k) and Σb_n and is summable $|R, \mu, l|$, $l > 0$, then Σc_n is summable $|R, v, k + l|$. Quite recently this result has been generalised by Pramila Srivastava. Bohr[51] obtained in upper bound for the abscissa of ordinary summability of the product series $\Sigma c_n n^{-s}$ and had demonstrated that this estimate could be improved. The results of this nature for absolute summability were discussed by Pramila Srivastava. It follows from the result of Obrechkoff stated earlier that if $\sum a_n e^{-\lambda_n s}$ is summable $|R, \lambda, k|$ for $s = s_1$, and $\sum b_n e^{-\mu_n s}$ is absolutely convergent for $s = s_2$ when $\sigma_2 > \sigma_1 \geq 0$, then the series $\sum b_n e^{-\mu_n s}$ is summable $|R, v, k|$ for $\sigma = \sigma_2$. In case k is an integer, a direct proof of this result has been given by Pati. Again, a combination of a theorem of Obrechkoff and a theorem due to Isaacs gives us that if $\sum a_n e^{-\lambda_n s} 1$ is summable $|R, \lambda, k|$ and $\sum b_n e^{-\mu_n s} 2$ is summable $|R, \mu, l|$, $\sigma_2 \geq \sigma_1 > 0$, then

$$e^{-sx} x^{-(k+l)} c_v^{(k+l)}(x) \in BV(c, \infty), \quad \sigma > \sigma_2 \geq \sigma_1 \geq 0.$$

Prasad and Pati have proved that if k and l are integers, than the above holds for $\sigma = \sigma_2 = \sigma_1 > 0$.

It is known that $(R, \lambda, k) \subset (R, \log \lambda, k)$ and $|R, \lambda, k| \subset |R, \log \lambda, k|$. This discussion of the possibility of deducing results regarding the absolute summability of the Dirichlet product of the type (log λ, log μ) from the knowledge of absolute summability of the Dirichlet product of the type (λ, μ) may provide an interesting field for investigations, such results being not known even for ordinary summability.

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GREEN CHEMISTRY : AN APPROACH TO CLEAN, SAFE AND SUSTAINABLE FUTURE

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Green Chemistry is an approach to design the safe chemicals and chemical processes without causing harm to the Environment and Human life. This article describes an introductory account of the basic tenets on which the concept of the Green Chemistry is based.

INTRODUCTION

Chemistry is a branch of science which deals with various aspects of substances, viz., their structures, properties and chemical reactions. Chemical reactions are essential for the production of large number of compounds which are widely used in the synthesis of Medicines, Food materials, Textile fibers, Dyes, Paints, Cosmetics, Plastics and Agrochemicals etc. Almost all walks of human life have been improved qualitatively by chemistry. Availability of a number of excellent medicines has increased the average human life expectancy from 47 years in 1900 to 75 years in 1991[1]. Today a comfortable life of good quality can not be imagined without the use of chemistry and chemical reactions.

Chemical reactions involve the use of large number of reactants, reagents and solvents which are generally hazardous to health of human beings. In industrial chemical reactions, formation of the desired products is often accompanied by huge quantities of undesirable by-products or waste products causing environmental pollution as these are discharged into the atmosphere, rivers ,sea and land. Although chemical industries play an important role in providing us various essential chemicals required for research and development but on the other hand they are not free from risks, and sometimes they pose a serious threat to our life. A few examples of the hazards associated with chemicals and chemical reactions may be cited here[2]. The devastating leakage of lethal Methyl isocyanate (MIC) in Union Carbide Plant in Bhopal claimed the life of 2,500 persons and injured more than 1,50,000 persons on 3rd December, 1984. At one time the river Cuyahoga in Ohio was so much invested with chemical waste that it actually caught fire. The well known insecticide DDT was introduced during the second World War, and initially used for killing the lice in the bodies and clothes of war prisoners. DDT played a significant role in destruction of mosquitoes and eradication of malaria epidemic. But, now it is suspected to be a carcinogen, and its use is banned in many countries of the World. It has also been held responsible for reducing the population of bald eagles.

NEED FOR GREEN CHEMISTRY

The dangers associated with chemicals and chemical reactions motivated chemists to develop methodologies and formulate strategies to carry out chemical reactions in a safe and environmentally benign manner. Such chemical reactions carried out by environmentally benign procedures are

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known as ***green reactions*** and the area of chemistry involved in designing these reactions is known as ***Green Chemistry*.**

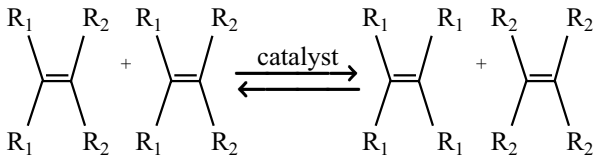
The term Green Chemistry was introduced in 1991 by an American chemist, Dr. Paul Anastas who is regarded as Father of Green Chemistry. He defined it as: "Green Chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products"[1]. However, later on some more relevant and useful issues were also included in the theme of Green Chemistry. The concept of Green Chemistry should not be confused with that of Environmental Chemistry. The former is related with the design of chemical products and processes in a hazardless of less hazardous manner while the later deals with study of various chemical reactions taking place in atmosphere. In fact, green chemistry started in 1990s as a mission in developed countries like USA, UK, Germany and Japan to make chemistry and Chemical reactions safe and hazardless upto maximum extent. Green chemistry is concerned not only with safety and pollution control, it gives due consideration to quality and cost of the products, and efficiency of adopted procedures as well. To make it more practical and widely acceptable, chemists all over the World are searching alternative reagents, solvents, catalysts and newer techniques.

METATHESIS : A CLASSICAL EXAMPLE OF GREEN CHEMISTRY

Metathesis is a useful green synthetic method of organic chemistry. This method has been in use since 1950, but it came into limelight in 2005, when Dr. Y. Chauvin, Professor R. H. Grubbs, and Professor R. R. Schrosk were jointly awarded Nobel Prize for their contributions to this field. The term 'metathesis' is derived from *Greek* words: *meta* (meaning change) and *thesis* (meaning positions). Thus, Metathesis is exchange of parts of two molecules of same or different substances :

$$A - B + C - D \longrightarrow A - C + B - D$$

This environmentally benign reaction is quite common in olefins and can be represented as given in Scheme 1.



Scheme 1.

Metathesis is widely used in the Pharmaceutical, Food, Chemical, Biotechnical, polymer and paper industries. It has also been used for the synthesis of Insect Pheromones.

THE TWELVE PRINCIPLES OF GREEN CHEMISTRY

Dr. Paul Anastas and Dr. John C. Warner developed twelve principles of Green Chemistry in 1997 which provide a frame work for developing methods and formulating strategies for safer chemical reactions and products[1, 3-5].

1. Prevention of formation of waste products : It is better to prevent the formation of waste products or by-products rather than wasting energy and money on their disposal.

2. Atom economy : Synthetic methods should be designed in such a way that maximum portion of the reactants is incorporated into the final products.

3. Less hazardous synthetic procedures : As far as possible synthetic methods should be designed to use and generate chemical substances having little or no toxicity to Human health and Environment.

4. Designing safer chemical products : Designed chemical products should have effective desired properties but they should be free from toxic properties.

5. Safer solvents and auxiliaries: Planned synthesis should not use toxic solvents and auxiliaries (separating agents and other chemicals).

6. Energy efficiency : As far as possible, reactions should be carried out at ambient temperature and pressure so that their energy requirement is minimized.

7. Renewable feedstock : Raw materials or resources for synthetic procedures should be renewable rather than depleting, whenever technically or economically feasible.

8. Avoiding derivative formation : Unnecessary derivative formation (use of blocking groups, protection and other temporary modifications) should be avoided because such steps require additional reagents and generate waste.

9. Use of catalysts : Catalytic reagents are superior to stoichiometric reagents and their use increase the efficiency of a reaction.

10. Design chemical products which are degradable after their use : Chemical products should be designed so that after their use they break down into innocuous substances and are not accumulated in atmosphere.

11. Real-time analysis for pollution control : Analytic techniques should be developed to enable real-time, in-process monitoring and control of pollution before the formation of hazardous substances.

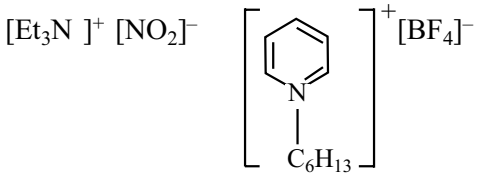
12. Accident prevention : Design chemicals and their forms (solid, liquid or gas) to minimize chemical accidents including explosions, fires and releases to the atmosphere.

SOME IMPORTANT ASPECTS OF GREEN CHEMISTRY

In order to make green chemistry more meaningful and significant, chemists are focusing their attention on following aspects :

● **Green solvents :** Solvents play a significant role in chemical reactions. Reactants can interact effectively if they are in homogenous solution. Besides facilitating stirring, shaking and uniform heating, solvents in many cases influence the course, mechanism and rate of a reaction. The harmful effects of commonly used volatile organic solvents (benzene, toluene, chloroform, carbon tetrachloride, perchloroethylene, methylene chloride, alcohol etc.) necessiated the search for safer solvents or green solvents. Some of the currently used green solvents are given below :

(i) Ionic liquids : These are usually salts of organic cations such as alkyl ammonium, alkyl pyridinium etc. Ionic liquids are liquids at room temperature or below exhibiting very low or no vapour pressure. I and II are the common examples of ionic liquids.



I II

Ionic liquids often act both as solvent and catalyst and require no special apparatus and methodologies. Chloroaluminate ionic liquids are highly active Friedel-Crafts catalysts in electrophilic alkylation and acylation reactions. They have been used in cationic polymerization also.

(ii) Supercritical carbon dioxide fluid ($scCO_2$)

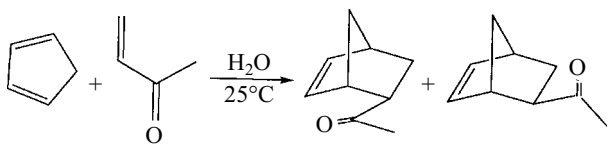
Above its critical temperature (Tc) and pressure (Pc) a fluid becomes supercritical and exists in a single condensed state with properties between those of a gas and a liquid. Due to its properties to diffuse though solids and to dissolve large number of organic compounds and catalysts,supercritical carbon dioxide is being used as solvent in many chemical reactions of industrial utility. One of the most widely established processes using $scCO_2$ is removal of caffeine from coffee and tea. It is also being used for isolation of essential oils and other natural products. In nanoelectronics, $scCO_2$ can replace ultra high purity water, as it does not influence the nanometric structure. It is safe due to its low toxicity and noninflammability.

(iii) Supercritical water (scH_2O)

At a temperature of 374°C and a pressure of 218 atm. water becomes supercritical. Most of the organic compounds are insoluble in water but they become soluble in scH_2O. In contrast to $scCO_2$, the conditions required to obtain scH_2O are very drastic which perclude its synthetic utility for most of the organic reactions. However, organic syntheses have been carried out in sub-critical but high temperature water. The synthesis of quartz crystal in scH_2O is an excellent achievement because these are used in mobile phones. The technique of Super Critical Water Oxidation (SCWO) has potential use in remediation and waste treatment.

(iv) Water as a reaction solvent

Water has many interesting properties by virtue of which it is now being used as a solvent in many organic reactions[6]. It has been observed that at temperature above 200°C (in liquid state) solvent properties of water resemble with those of organic solvents. Water is nontoxic naturally occuring, inexpensive and noninflammable. In many cases use of water as solvent increases rate of reactions. For example, Diels- Alder reaction of cylopentadiene and butenone (Scheme 2) in water is over 700 times faster than in many organic solvents. Use of LiCI in this aq. phase reaction increases reaction rate 1800 times more fast due to salting out effect.



Scheme 2.

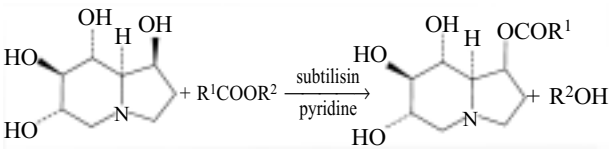
● **Reactions in solid phase**

There are large number of organic reactions which are possible in solid phase without using toxic organic solvents. Such reactions can be carried out using reactants alone or on solid surfaces such as special type of clays, zeolites, silica, alumina etc. When in a solid state reaction, two or more substances are involved, they are mixed together and ground or cocrystallized, and heated to get a homogeneous solution or molten mass. Depending upon the need of the reaction, suitable catalysts or radiations are also used. Solid phase reactions are simple to operate, environmentally benign, and economic as well.

In recent years, bromination reactions, Michael addition, Aldol condensation, dehydration of alcohols to akenes, etc. are being carried out in solid phase[5]. Some useful phthalides[7] and butenolides[8] have also been synthesized under solvent free conditions.

● **Catalysts, Biocatalysts and Phase Transfer Catalysts (PTC)**

Catalysts are capable of increasing selectivity of a chemical reaction, reducing the reaction temperature, preventing formation of reagent based waste, and avoiding undesirable side reactions. They play an important role to make a process clean and safe. Enzymes act as catalysts in biological transformations and often referred as biocatalysts. Recently, synthesis of the Amino Acid L-tert-leucine is carried out using the enzyme leucindehydrogenase (LeuDH).This Amino Acid does not occur in nature but it serves as a chiral auxiliary compound in the asymmetric synthesis and as a building block for synthesis of drugs for the treatment of cancer, inflammation and viral infections. Another important compound produced by enzymatic method is L-Dopa which is used as a drug for Parkinson's disease. Analogues of castanospermine, a potential AIDS drug have been synthesized by the use of enzyme subtilisin[9]



Scheme 3

Phase Transfer Catalysts (PTC) are used as a device for accelerating the reaction between water insoluble

organic compounds and water soluble reagents. The most useful catalysts for this purpose are quaternary ammonium salts, crown ethers and polyglycolethers. Use of PTC is associated with many possible Green advantages such as higher productivity, higher selectivity and use of less hazardous solvents.

● **Use of renewable feed stock**

Green Chemistry promotes the development of innovative technologies to utilize the potential of renewable resources, e.g., biomass rather than depleting resources (petroleum, natural gas, coal). Nature produces about 170 billion tons of plant biomass per annum globally which may be harvested for energy or as a chemical feedstock. Large number of chemical products such as lubricants, fibers, polymers, dyes, agrochemicals and pharmaceuticals are being obtained from renewable feedstock.

● **Energy efficiency**

Green Chemistry envisages that in order to make a chemical reaction Environmentally benign its energy requirement should be kept at minimum. For this purpose attempts were made to conduct chemical reactions under the influence of microwave radiation and ultrasound energy which gave rise to microwave chemistry and ultrasound chemistry or sonochemistry, respectively. In microwave reactions, rate of heating is 10°C per second and consequently, the overall reaction time is reduced drastically. For example the hydrolysis of N-phenylbenzamide takes 18-20 hours under usual condition but the reaction is completed only in 12 minutes under microwave condition. Interaction of ultrasound waves with a liquid medium creates a very high temperature (about 500°C) and pressure (over 1000 bar) which initiates the chemical reactions. The typical reactions assessed include oxidation, radial reactions and synthesis of Nanoparticles.

CONCLUDING REMARKS

During the last 15-20 years, Green Chemistry has gradually become recognized as a culture as well as a methodology for achieving sustainability. It is a chemical philosophy encouraging the design of the products and processes that eliminates the use and generation of hazardous chemicals. At present Chemists and Academicians all over the World are trying their best to adopt Green Chemistry. It is hoped that their endeavor will certainly lead us towards a better future.

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NANOTECHNOLOGY AND NANOSCALE DEVICES – APPLICATIONS IN THE TREATMENT OF CANCER

K. Laxmi*

Nanotechnology has found innumerable applications in the field of medicine, particularly in the treatment of cancer. Nanotechnology has the power to radically change the way cancer is diagnosed, imaged and treated. Research efforts world wide are developing nanoproducts aimed at cancer treatment thereby improving health care and advancing medical research.

INTRODUCTION

The term "Nanotechnology" has evolved over the years to mean "anything smaller than microtechnology", such as nano powders and other things that are nanoscale in size. This evolved version of the term is more properly labeled "Nanoscale Bulk Technology", while the original meaning is now labeled as "Molecular NanoTechnology" (MNT) or "Nanoscale Engineering" or "Molecular Mechanics" or "Molecular Machine systems" or "Molecular manufacturing".[1] An alternate term is suggested recently to represent the original meaning of Nanotechnology as "Zettatechnology".

Many materials once they are individually reduced below 100 nanometers, begin displaying a set of unique characteristics based on quantum mechanical forces that are exhibited at the level. Due to these quantum mechanical effects, materials may become more conducting, be able to transfer heat better or have modified mechanical properties. By taking advantage of quantum – level properties, MNT allows for unprecedented control of the material world, at the nanoscale, providing the means by which systems and materials can be built with exacting specifications and characteristics[1].

Definitions of Nanotechnology are as diverse as the applications[2]. Rolf Allenspach of Zurich Research Laboratory in Switzerland defines nanotechnology as "the ability to design and control the structure of an object at all length scales from the atom upto macro scale". George Robillard director of the Biological Materials and Devices say drug delivery system is Nanotechnology[2].

Nanotechnology will provide new tools for medicine[3]. It could radically change the way surgery is done. It will make it possible to do molecular scale surgery to replace defective cells, repair and rearrange cells. Since disease is the result of physical disorder, misarranged molecules and cells, medicine at this level should be able to cure most diseases. Mutations in DNA could be repaired and cancer cells, toxic chemicals and viruses could be destroyed through the use of medical Nanodevices.

Nanotechnology has the power to radically change the way cancer is diagnosed, imaged and treated[3]. Currently, there is a lot of research going on to design novel Nanodevices capable of detecting cancer at its earliest stages, pinpointing its location within the body and delivering Anticancer drugs specifically to malignant cells.

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NANOSCALE DEVICES

Nanoscale devices smaller than 50 nanometers can easily enter most cells, while those smaller than 20 nanometers can transit out of blood vessels[4]. As a result Nanoscale devices can readily interact with Biomolecules on both the cell surface and within the cell. Nanoscale devices are already proving that they can deliver therapeutic agents to target cells or even within specific organelles[4]. Inspite of its small size, a Nanoscale device is capable of holding tens of thousands of small molecules such as a contrast agent or drug.

The major areas in which Nanomedicine being developed in cancer include :

- Prevention and Control : Developing Nanoscale devices to deliver cancer prevention agents and designing multicomponent Anticancer vaccines.
- Early detection and Proteomics: Developing "smart" collection platforms for simultaneous mass analysis of cancer – associated markers.
- Imaging Diagnostics: Designing targeted contrast agents that improve the resolution of cancer to a single cell.
- Multifunctional Therapeutics: Creating therapeutic devices that can control the release of cancer fighting drugs and optimally deliver medications.

In recent years, Nanotechnology has found innumerable applications in the field of medicine – from drug delivery systems, nanorobots and cell repair machines to imaging, nanoparticles and nanonephrology. Owing to the extensive use of nano materials in medical equipments and devices, nanomedicine has become a significant branch of Nanotechnology. Other potential applications of Nanoscience are

- Rapid, efficient Genome Sequencing, revolutionizing diagnostics and therapeutics.
- Effective and less expensive healthcare using remote and *in-vivo* devices.
- New formulations and routes for drug delivery that enormously broaden their therapeutic potential by effecting delivery of new types of medicine to a previously in accessible sites in the body.
- More durable, rejection – resistant artificial tissues and organs.

Some of the important uses of Nanotechnology in the field of Medicine are,

DRUG DELIVERY SYSTEM AND NANOPARTICLES

The primary objective of the drug delivery system is to make the life – saving drug available in that part of the body where it is required the most. However, most of the time these systems fail to work efficiently because the particles of the drug are too large for the cells to absorb, or they are insoluble or they have the potential to cause tissue damage. On the other hand, due to their exceedingly small size, nanoparticles are easily taken up by the cell. Moreover, they are completely soluble and they do not also damage the tissues. Hence the efficiency of the drug delivery system can be increased several times by integrating Nanoparticles with them.

COUPLING OF NANOPARTICLES WITH BIOPHARMACEUTICALS

Biopharmaceuticals are peptides or protein molecules that trigger multiple reactions in the human body. They are widely used in the treatment of life – threatening diseases like cancer. The effectiveness of Biopharmaceuticals can be increased several times by coupling them with nano particles, which will proficiently deliver the peptides or proteins at the tumor site and in this manner cure cancer without causing extensive damage to the adjacent tissues and organs.

NANOTECHNOLOGY AND NEURO – ELECTRONIC DEVICES

Neuro–electronic devices are unique machines based on nanotechnology that connect the nervous system with the computer. These devices not just detect and interpret the signals from the nervous system, but also control and respond to them. They can be used in the treatment of diseases that slowly and steadily decay the nervous system like multiple sclerosis.

NANONEPHROLOGY

This is a sub–branch of Nanomedicine which is concerned with the detection and treatment of kidney diseases. Here various devices based on Nanotechnology are used for the studying the different kidney processes and detecting disorders. Thereafter, nanoparticles and drug delivery system are used for curing the disorder.

NANOTECHNOLOGY AND CELL REPAIR MACHINES

These cell repair machines use Nanotechnology to penetrate into the cell and rectify disorders like DNA damage or enzyme deficiency. These machines are no bigger than a bacteria or virus.

NANOROBOTS

The entry of Nanorobots will literally revolutionize the World of Medicine. These miniature devices are only be capable of entering into the body detecting the diseases and infection, but also they will be capable of repairing internal injuries and wounds.

Nanotechnology is the science of maneuvering the structure and properties of matter at an atomic and molecular scale. As a result of this maneuvering, the properties of matter change dramatically i.e. the inert elements start to function as catalyst and insoluble matter develop unique solubility capacity. Likewise, non colloids begin exhibiting excellent colloidal properties and electrical non-conductors start conducting electricity. Owing to their size and properties, nanomaterials are extensively used for the treatment of a number of diseases. Cancer is such a disease where Nanotechnology can play a significant role.

NANOPARTICLES AND NANOROBOTS

Cancer is a condition where changes occur in a small percentage of cells and they start replicating interminably. Problems come to the fore only when the condition becomes unmanageable. The size of nanoparticles and nanorobots is exceedingly small, and because of this property, they can easily enter into the blood vessels, organs, tissues and even the cells of the body. Additionally, they can also find out those cells that are growing abnormally. Thus they can play a decisive role in the detection of cancer at a very early stage.

Nanodevices can provide rapid and sensitive detection of cancer – related molecules by enabling scientists to detect molecular changes even when they occur only in a small percentage of cells. This would allow early detection of cancer a critical step in improving cancer treatment. Nanotechnology will allow the reduction of screening tools which means that many tests can be run on a single device. This makes cancer screening faster and more cost–efficient.

Nanoparticle contrast agents are being developed for tumor detection purposes. Labeled nanoparticles and non-labeled particles are being tested as imaging agents in diagnosis procedures such as Computed Tomography and Nuclear Magnetic Resonance Imaging[5].

Super paramagnetic nanoparticles are used for Magnetic Resonance Imaging (MRI)[6] .They consist of an inorganic core of iron oxide coated or not with polymers like dextran. There are two main groups of nanoparticles

(i) Superparamagnetic iron oxides whose diameter size is greater than 50 nm.

(ii) Ultrasmall superparamagnetic iron oxides whose nanoparticles are smaller than 50 nm.

Quantum dots are nanoscale crystals of a semiconductor material such as cadmium selenide whose colour properties depend on particle size. Quantum dots can be linked to antibodies and combined to create Assays that are capable of detecting multiple substances simultaneously. They can be used to measure levels of cancer markers such as breast cancer marker Her – 2, actin, microfibril proteins and nuclear antigens[4]. Quantum dots are robust and very stable light emitters. Their photochemical stability and the ability to tune broad wavelengths make quantum dots extremely useful for Biolabelling[7].

Nanoparticles can be used as tumor Biomarkers. They help the detection process by concentrating and protecting a marker from degradation so that the analysis is more sensitive. Streptavidin coated fluorescent polystyrene nanospheres used in Flow Cytometry to detect biological molecules, have shown greater sensitivity as compared to conventional dyes[5].

Nanoparticles can be in the form of nanospheres (matrix systems in which drugs are dispersed throughout the particle) and nanocapsules (drug is confined in an aqueous or oily cavity surrounded by a single polymeric membrane)[5].

Nanoparticles have the potential to overcome biological, biophysical and biomedical barriers currently faced by conventional administration of cancer drugs. Poly(isobutyl cyanoacrylate) has been used to make nanocapsules with an oily core for hydrophobic drugs. Some nanospheres are made of poly (isohexyl cyano acrylate), poly(methyl cyanoacrylate) and biodegradable poly(ethyl cyanoacrylate)[5].

Further improvements to these nanospheres are being made by coating the nanoparticles with hydrophilic polymers like poly(ethylene glycol), poloxamines, poloxamers and polysaccharides which provide a cloud of hydrophilic and neutral chains at the particle surface[8]. Molecules like poly(ethylene glycol) reduces nonspecific attachment and allows longer circulation without being taken up by the body's macrophages, so as to direct more specific targeting[8].

Some of synthetic materials were also used as nano carriers. Dendrimers, 1 to 10 nanometer spherical polymers of uniform molecular weight made from branched monomers have been proven to provide a multifunctional cancer agent[4]. It has been found experimentally that the dendrimer delivered the therapeutic drugs while simultaneously labeling the cells for fluorescent detection.

Nanoparticles have also been used to deliver a gene that forces blood vessels to self-destruct. This prevents angiogenesis, or the formation of blood vessels in a tumour[9].

NANOSIZED NON–INVASIVE PROBE TO SEE BLOOD VESSEL GROWTH IN TUMOURS

Using Nanotechnology, material science and the clinical imaging modality MRI, researchers have created a nanosized probe capable of non-invasively visualizing and quantifying the blood vessel growth in tumours in a preclinical model[10].

Imaging tumour angiogenesis is important in early detection, tumour stratification and post-therapy assessment of antiangiogenic drugs. Nano probes aim to image angiogenesis – specific tumour markers that are clearly expressed in the tumour vasculature during the early phase of angiogenesis[10].

ACCURATE DRUG DELIVERY

Once the cancer has been detected, it becomes essential to treat it as quickly as possible. Most of the cancer treatment methods cause widespread damage because while eliminating the cancerous cells they also start acting upon the normal cells. Drug delivery systems that use nanoparticles can effectively treat cancer without damaging the surrounding cells and tissues. These nanoparticles are smaller than the body cells and can easily carry

the drug to that part of the body where the cancerous cells are located.

Nanoscale devices have the potential to radically change cancer therapy by increasing the number of highly effective therapeutic agents. Nano particles can serve as customizable, targeted drug delivery vehicles capable of conveying chemotherapeutic agents or therapeutic genes into malignant cells while sparing healthy cells. This may allow for smaller doses of toxic substances as the drugs, which are delivered directly to the target tissue. Doctors may also be able to deliver toxin in a controlled and time-release manner.

Carbon nanotubes are hollow wires of carbon about 50,000 times narrower than a human hair. Carbon bucky balls and carbon nanotubes may be useful as drug delivery vehicles because their nanometer size enables them to move easily inside the body. The active compound might be inserted in a nanotube or bonded to a particle's surface. Nanoparticle delivery systems combine a drug with an artificial vector that can enter the body and move in like a virus. ABI-007, is a new nanoparticle delivery system for an established anticancer drug[11]. This ABI-007 is 130 nm long and consists of an engineered protein – stabilized nanoparticle that contains paclitaxel which is used to treat breast, bladder and more than a dozen other cancers[11].

BIOPHARMACEUTICALS AND CANCER

The effectiveness of these pharmaceuticals will increase several times if they are coupled with nanoparticles. The nanoparticles will carry the biopharmaceuticals directly to the tumour site without adversely affecting the cells and tissues that come in the way. In this manner, cancer would be cured and healthy cells will remain as such.

Currently, cancer fight drugs are toxic to both tumour and normal cells, thus the efficacy of chemotherapy is often limited by the side effects of the drug[5]. Some nanoscale delivery devices such as dendrimers (spherical, branched polymers), silica coated micelles, ceramic nanoparticles and cross linked liposomes can be targeted to cancer cells. This increase selectivity of drugs towards cancer cells and will reduce the toxicity to normal tissue[5].

Some cancer targeting molecules include high-affinity folate receptor, luteinizing harmone releasing harmone and integrin $\alpha_\gamma\beta_3$[12]. The folate nanoparticles improved the uptake of the encapsulated drug that it carried and showed higher specificity for cancerous human cells[12].

Barriers to cancer drugs can be in the form of the cell's plasma membrane or epithelial or endothelial layers of cells. The covalent attachment of peptidic Membrane – Translocation Sequences (MTS), peptides with the ability to pass through membrane, to nanoparticles have shown increased permeability through membranes[13]. With improved cell permeability, nanoparticles can become more therapeutically effective drug transport vehicles.

CELL REPAIR MACHINE AND CANCER TREATMENT

Cancer primarily occurs due to mutation; the genetic information stored in the DNA is changed. As the result the affected cells divide continuously and cause the formation of tumours. The cell repair machine that is as small as a nanoparticle can easily penetrate into the cancerous cell and repair the damaged DNA. As the technique is completely non-invasive, the normal cells remain unarmed.

Nanowires by nature have incredible properties of selectivity and specificity. Nanowires can be engineered to sense and pick up molecular markers of cancer cells. These nanowires can help to pinpoint the changes in the genetics of cancer. Each Nanowire bears a different antibody or oligonucleotide a short stretch of DNA that can be used to recognize specific RNA sequences[14]. Carbon nanotubes are also being used to make DNA biosensors. This uses self-assembled carbon nanotubes and probe DNA oligonucleotides immobilized by covalent binding to the nanotubes. These DNA biosensors

being developed are more efficient and more selective than current detection methods[15].

Nanoscale cantilevers are built using semiconductor lithographic techniques[4]. These can be coated with molecules like antibodies capable of binding to specific molecules that only cancer cells secrete. These are extremely sensitive and can detect single molecules of DNA or protein, thus providing fast and sensitive detection methods for cancer related molecules[4].

NANOSHELLS

Destruction of solid tumours using high heat has been in investigation for some time. Some thermal therapies include the use of laser light, focused ultrasound and microwaves[13]. the advantage of using thermal therapeutics is that most procedures are non-invasive, relatively simple and have the potential to treat tumors where surgery is not possible. However to reach underlying tumors, the energy sources has to penetrate healthy tissues, often destroying healthy tissue.

Nanoshell–Assisted Photo Thermal therapy (NAPT) is a simple, non invasive procedure for selective photo-thermal tumour removal. It makes use of nanoshells that absorb light in the Near InfraRed (NIR) region.

Nanoshells have a core of silica coated with an ultra-thin metallic layer, normally gold[16]. By adjusting the core and shell thickness, nanoshells can be designed to absorb and scatter light at a desired wavelength. Nanoshells for cancer therapeutic purposes have been designed to have a peak optical absorption in the NIR, as this is the wavelength that optimally penetrates tissue.

The metal shell converts the absorbed light into heat with great efficacy and stability[17]. Due to their small size, nanoshells are preferentially concentrated in cancer cells by EPR or enhanced permeation retention[17].

By supplying a NIR from a laser, the particle heats up and kills the tissue. It was found that the temperature within the nanoshell-treated tumours rose by about 40^{o}C compared to a rise in 10^{o}C in tissues that was treated with NIR light alone[18]. Thus using a NIR laser, cancer tissue can be destroyed by local thermal heating around the nanoshells[18,19].

CONCLUSION

Nanotechnology will radically change the way we diagnose, treat and prevent cancer to meet the goal of eliminating suffering and death from cancer. Nanotechnology can provide the technical power and tools that enables development of new diagnostics, therapeutics and preventives.

With Nanomedicine, we might be able to stop cancer even before it develops. Nanomedicine has the ability to improve health care by leaps and bounds. It has positive impact to people from all walks of life.

Nanotechnology improves cancer treatment in terms of efficiency and quality and also helps in the process of understanding cancer as a disease process. Nanomedicine is a powerful and revolutionary development that has significant impact on society, the economy and life in general.

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PHAGOCYTOSIS : THE DEFENSE MECHANISM IN ANIMALS AND BIRDS

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Phagocytosis is a cellular process of engulfing solid particles by the phagocytes. It is the major mechanism used to remove pathogens like bacteria, physiological dead cells, tissue and cell debris, small mineral particles etc. The phagocytic cells are macrophage, neutrophil, eosinophil, basophil in mammals and particularly heterophil in birds. The process of phagocytosis consists of chemotaxis, adhesion, ingestion and destruction similar to human. Any accidental leakage of lysozyme causes damage of adjacent tissue with inflammation.

INTRODUCTION

Animal body defends itself in many different ways like physical barriers where the skin excludes many organisms. Always the physical barriers are not sufficient to protect the body, so the animals also require a reactive defense system where they are able to mobilize and to focus the organism at invasion site. Initially, any invading organism that manages to enter into tissues, will be promptly trapped, processed, digested and destroyed by various cells. The process where the cells bind and digest the foreign materials or organisms is known as Phagocytosis (Phagocytosis is a Greek word and means eating by cells).

The cells having the phagocytic property are called phagocytic cells. The phagocytic cells of mammals are of two types like the myeloid system which consists of the polymorpho (poly means many, morpho means appearance) nuclear leukocytes including neutrophil, heterophil (in poultry), eosinophil and basophil. The cells are granular in nature, and acts rapidly so they are incapable of sustained effort and are regarded as first line of defense. Another one type is present the mononuclear phagocytic system which consists of macrophage and lymphocyte. The cells are agranular in nature, act more slowly but are capable of repeated phagocytosis and regarded as second line of defense.

Nevertheless, the phagocytosis in other animals is performed by two types of cells. Haemocytes (leukocytes) are found in protosomes (mollusks, annelids, arthropod) and the coelomocytes (body cavity cells) are found both in protosomes and deuterosomes (chordate and echinoderm). All types of the phagocytic cells pass through chemotaxis, adhesion, ingestion and destruction similar to mammalian phagocytosis.

HISTORY OF PHAGOCYTOSIS

Before the discovery of phagocytosis, it was suggested that the foreign bodies are only digested by the antigen antibody reaction, but the destruction of foreign particle by phagocytic cells was overlooked.

The Russian scientist Elie Metchnikoff born in the year 1845 was a Zoologist. During his research in 1882, he inserted a rose thorn (as foreign body)

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in a star fish larva. Subsequently, he found that many mobile cells moved towards the injured area produced by the thorn and surrounded the area. Later he opined that these mobile cells had a defense function and acted to protect the body against invasion. He showed that mammalian white blood cells are phagocytic in nature.

Simultaneously, a debate arose and continued concerning the significance of phagocytosis and destruction of foreign body by antibodies. Ultimately, Almroth Wright identified the opsonin and firmly established the process, phagocytosis by experiments. Afterwards, the debate died down and both the processes like phagocytosis and destruction by antibodies for elimination of foreign body were strongly established.

The Russian scientist Elie Metchnikoff coined the term phagocyte. He devoted the rest of his life to develop and to shape the theory Phagocytosis. For the great discovery, he was honoured with Nobel Prize in 1908 and the prize was also shared with Paul Ehrlich (coined the term complement) for contribution in immunity. The great scientist breathed his last in 1916.

CELLS INVOLVED IN PHAGOCYTOSIS

Neutrophil

Sometimes also called as polymorphonuclear neutrophil granulocyte. Its main function is Phagocytosis. Very limited reserve of energy (glycogen) found in neutrophil and the cells survive even for less than a day. The dying neutrophil is recognized due to change in lipid cell membrane, ingested and destroyed by macrophage before the release of lysosomal enzyme. This process of killing of dying neutrophil known as Apoptosis. Apoptosis is a Greek word and means falling away of petals from flowers or the leaves from trees.

Heterophil

These cells are found in avian (birds). Chicken heterophils are highly phagocytic for a broad spectrum of microbes. The potent myeloperoxidase enzyme is lacking in chicken heterophil. For antimicrobial action, the heterophil depends on non-oxidative mechanism where the beta-defensin is the ultimate product having antimicrobial action. Heterophils form the first line cellular defense against invading microbial pathogen in lungs and air sacs in particular.

Eosinophil

The granules of cytoplasm stains intensely red dye (Eosin colour) so called Eosinophil (phil means affinity). All eosinophils leave the bone marrow in a relatively immature state and reach to spleen to mature there and thereafter released in circulation. The half life in circulation is only about 30 minutes. Subsequently, Eosinophils migrate into the tissue with a half life of 12 days. As a result, for one eosinophil seen in blood, there are about 500 eosinophil stored in tissues. The peroxide in these cells uses bromide ion rather than chloride so that the Eosinophil kills pathogen (disease producing agents) more efficiently than chloride metabolites. Each Eosinophil granules contain in its crystalline core, a protein called major basic protein (MBP) which is highly toxic for invading parasites.

In the damaged area produced by parasite, several specific and non-specific chemotactic (chemicals having cell attracting power) factors like histamine, C5a (complement) etc are released from mast cell. The eosinophils run in a unidirectional movement towards the releasing site of different chemotactic factors. After reaching to nearby parasite, the Eosinophil stick with previously antibody coated (opsonized) parasite, MBP and other toxic protein are inserted in parasite and ultimately the parasite is destroyed.

Basophil

In mammals, the basophils are not phagocytic but in contrast, avian basophils may share a phagocytic property.

Macrophage

Macrophages (macro means large, phage means eat) are large cells of 14-20 micron diameter (In contrast, diameter of neutrophil is 10-12 micron). Monocytes are immature macrophages and ultimately transformed into (mature) macrophages. The cells have single (mono) nucleus, abundant cytoplasm with avid phagocytic activity so called mononuclear phagocytes. All macrophages originate from bone marrow as monoblast, transform into promonocyte and ultimately into monocyte under the influence of Colony Stimulating Factor (CSF) protein. Then monocytes enter into blood stream, then into tissue as macrophage. Macrophages are various types like histiocyte (in connective tissue), Kupffer cell (in sinusoids of liver), microglia (brain) and alveolar macrophages (in lungs). Sometimes seen as Giant cell, after fusion of many macrophages when attempting to enclose and to digest too large particle by a single cell. Like in tuberculosis, abundant numbers of macrophages are found in lung and are of diagnostic importance. When foreign body exists in body for a long time, macrophages accumulate in large numbers around the persistent organism and looks like epithelium under histological section. These cells are called epitheloid (loid means like, the cells are not epithelium but like the epithelial cells) cells. These epitheloid cells are usually packed closely together with abundant cytoplasm containing lysosome in tuberculosis.

The main functions of macrophages are phagocytosis, secretion of cytokines (regulatory proteins in cells) like Interleukin-1, 6, 8, 12, tumour necrotic factor-alpha etc., enzymes like lysozyme, acid hydrolases, arginase, lipase, collagenase, elastase etc. with release of other factors like prothrombin, coagulation factors.

Lymphocyte

It acts by cell-mediated and humoral (Immunoglobulin) mechanism to destroy foreign body.

MECHANISM OF PHAGOCYTOSIS

The entire phagocytic system is divided into chemotaxis, adhesion, ingestion and destruction.

Chemotaxis

It is the unidirectional movement of neutrophil/ phagocytic cells towards the foreign body under the influence of external chemical gradients. During the foreign body invasion and tissue damage of host, several chemotactic factors like histamine, C5a (complement), Interleukin- 8 are released and attracts phagocytic cells. The invading bacteria sometimes release peptide, containing formylated methionine which also a potent chemotactic factor. During the movement, neutrophil can crawl but cannot swim. So, to crawl, neutrophil attaches with the surface of endothelium of vascular wall by surface adhesive proteins like integrin, selectin. The chemoattractants trigger a change in cell surface electrical potential, increasing the plasma membrane fluidity with a rapid intracellular calcium level enhancement. As a result, the phagocytic cells align themselves along with the concentration gradient and crawl toward the source of chemotactic materials.

Adhesion

Adhesion in between phagocytic cell and foreign body does not happen spontaneously as because both the phagocytic cell and foreign body are negatively charged due to zeta protein and repels each other. Negative charge of bacteria is neutralized by coating with a positively charged protein like (complement). The molecules coat the bacteria and represent the bacteria tastier for neutrophil, ultimately promote the phagocytosis are called opsonin and the process is called opsonization. Afterwards, the opsonized bacteria become positive-charged. The bacteria now combine with negatively charged macrophage and adhered each other. Different receptors of neutrophil like antibody receptor (CD32), complement receptor (CD35) also triggers the process of adhesion with opsonized bacteria.

Ingestion

The cytoplasm of neutrophil forms pseudopod containing a filamentous network of protein, actin and myosin. Pseudopod of neutrophil runs first, followed by main body portion. Then the pseudopod flows over and around the bacteria, drawn into the cell, engulfed by the cytoplasm and ultimately it is enclosed in a vacuole called phagosome (vacuole of active phagocytic cell). Lysosome of neutrophil migrates through the cytoplasm, fuses with phagosome with release of lysozyme and other enzymes into the vacuoles. Then the vacuole is known as phagolysosome.

Destructions

After the bond in between foreign body and neutrophil, neutrophil starts oxygen consumption nearly 100-folds more for rapid assemble and activation of various cell surface enzymes. The activated enzymes like oxidase, superoxide dismutase, myeloperoxidase ultimately release superoxide, hydrogen peroxide and hypochloride ion respectively. This enzymatic process is known as respiratory burst. All released ions are very much toxic, hampers normal metabolic pathway by destroying the cell wall and ultimately bacteria are killed. Side by side, the lactoferrin an iron containing molecule, competes with bacteria for iron takeup in the phagolysosome, causes poor growth of bacteria with bacteriostatic environment due to less availability of iron.

ADVERSE EFFECT OF PHAGOCYTOSIS

Normally lysozyme is enclosed and acts within phagolysosome. But the problem arises when the lysozyme escapes from the vacuole and produces adverse conditions like inflammation, damage of surrounding tissues etc. Sometimes powerful inflammatory mediators like prostaglandin, leukotriences of arachidonic acid metabolites also leaks with lysozyme and causes acute to chronic inflammation, Lysozyme may be leaked by regurgitation when the phagosome boundary is incomplete or digested.

Frustrated Phagocytosis

This is an incomplete phagocytosis by neutrophil to an indigestible material like immune complex on flat surface. Due to flat surface like in capillary endothelium, lysozyme is leaked due to incomplete boundary and neutrophil cannot complete phagocytosis. This type of phagocytosis is called Frustrated Phagocytosis.

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ECONOMIC ACTIVITIES OF THE HILL PEOPLE AND ITS IMPACT ON THE NATURAL ENVIRONMENT

(An Anthropo-Ecological Perspective of Manipur)

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The Anthropo-ecological conflict resulting into rapid exploitation of natural resources is one of the most striking reasons of the environmental degradation. The economic activities of the hill people of Manipur do not favour the environmental growth in the region. To protect and conserve the forest resources of Manipur, some alternative arrangements for the economic needs of the hill people should be implemented so that they could change their age old economic activities. As the United Nations Assembly declared 2010 the International Year of Bio-diversity, it is right time to take necessary arrangements to conserve the natural environment of Manipur.

INTRODUCTION

The life of mankind is being so rapidly adversely affected by environmental degradation caused by man himself. The most striking reason of the environmental degradation and hence global environmental crisis is the fast deteriorating relationship between man and environment because of the rapid rate of exploitation of natural resources. The present paper attemps to highlight the rich biodiversity of Manipur, its degrading situation mainly caused by anthropogenic activities of the hill people to meet their economic needs and its impact on the natural environment which again gives harmful effect to mankind.

HUMAN OCCUPANCY OF LAND

Man occupies directly only a part of the Earth and his occupancy is restricted mainly to the land part of it. Land under human occupancy is used for a variety of purposes ranging from residential and agricultural to industrial and transportation. Although productive usage of land has been continuing since time immemorial, the nature of these uses has been changing with the passage of time. Development of technology, a growing population and increasing needs of humanity with evolving cultures have led to most of the changes in the nature and types of uses of land[7].

OUR DEGRADING BIO-DIVERSITY

Bio-diversity provides a variety of environmental services from its species and ecosystems that are essential of the global, regional and local levels. The production of oxygen, reduction of carbon dioxide, maintaining the water cycle and protecting soil are some important services. Forests are the main mechanism for the conversion of carbon dioxide into carbon and oxygen. Thus, lost of forest cover automatically leads to increasing release of carbon dioxide and also causing major atmospheric changes, leading to increased

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temperature, serious drought in some areas and unexpected floods in other areas. Bio-diversity is also essential for preserving ecological process, such as fixing and recycling of nutrients, soil formation, circulation and cleansing of air and water, maintaining stream and river flows throughout the year, erosion control and local flood reduction. India is one of the most disaster prone countries in the south Asian region. Drought, flood, earthquakes and cyclones occur with grim regularity. It is also a well known fact that more than ten percent of India's recorded wild flora and fauna are threatened and many are on the verge of extinction[5].

MANIPUR- A PROFILE

Manipur, one of the border states in the north east region of India is situated between latitudes 23°80′ to 25°68′ N and longitudes 93°03′ to 94°78′ E. The state occupies a total geographical area of 22,327 Sq. km. and is bounded by Nagaland on the north, Assam on the west and Mizoram on the south. Along the east, it shares a 352 km long international boundary with Myanmar. Of the total geographical area, about nine-tenth constitute hills and the remaining one-tenth valley. The state is dominated by three major ethnic groups; the Meiteis in the valley, the Nagas and the Kuki-chin tribes in the hills. The Meitei Pangals (Muslims) form a minority community. Besides this, other communities from other states of the country have also settled in the state.

BIO-DIVERSITY

The globally accepted national 'Hotspots' are in the forests of the North- east and the Western Ghats, which are also included in the most bio-rich areas of the world. Out of 135 genera of land mammals in India, 85 (63%) are found in the North eastern states of this country. This region also have 1500 endemic plant species. Manipur contributes 116 avifaunal species, 100 species of mammals, 265 species of flora and 425 species of fauna[3].

DEGRADING FOREST

According to forest survey of India (1997), the total forest area of Manipur is 17,558 Sq.km, of which the recorded forest area is about 15,154 Sq.km. In 1995, the dense forest area was 5,318 Sq.km. and in 1997 it was reduced to 4,937 Sq.km. while the open forest increased from 12,240 Sq.km. in 1995 to 12,481 Sq.km. in 1997 which brings a net loss of 140 Sq.km. In short, approximately the forest area is degrading at the rate of 20 Hac/ day[3].

ECONOMIC ACTIVITIES OF THE HILL PEOPLE OF MANIPUR

As the present paper is based on economic activities of the hill people, due consideration would be on the economic activities of different tribal communities inhabited in five hill districts of Manipur viz. Chandel, Churachanpur, Senapati, Tamenglong and Ukhrul; which are locally known as Ching-mee or hill- people. Their economic activities are mainly confined to the forest resources and subsist on it through primary activities. A year round calendric activities will clearly show how these people are surviving depending on the forest resources.

SHIFTING CULTIVATION

Shifting cultivation, an age old farming system is still in practice as the principal mode of subsistence in the hills of Manipur. It is locally called 'Jhum' or 'Pamlou'. The pattern of shifting cultivation is known with different people; for example, it is known as Jhum by the Nagas (in a larger Indian context), Penda by the Marias, Bewar by the Baigas, Chhimata by the Bhils, Kumri by the Mudugas, Ladang in Malayasia and Indonesia, Milpa in Mexico, Masole in Congo, Conuco in Venezuela, Roca in Brazil and so on. This system of cultivation has come under severe criticism from nearly all quarters as an uneconomic, wasteful and inefficient system and thus felt the need to

Table 1 : A year round Economic activities of the hill people of Manipur

January	Cutting and clearing of forest for cultivation.
February	Production of timber, firewood, charcoal, hunting, fishing etc.
March	Burning of the debris and preparation of Jhum fields.
	Hunting and fishing continued.
April May	Plantation of case crops like ginger, sweet potato, arum etc.
June	Showing of paddy seeds, maize in the Jhum field followed by weeding.
July August	Collection of bamboo shoots.
September	Hunting, fishing and collection of forest produces like honey, variety of fruits etc.
October	Harvesting of Jhum fields.
November	Cutting and clearing of forest for timber production, charcoal, firewood
December	etc.

check it without further delay[2]. It is observed by Dr. N.L. Bor, Batanist of all the Forest Research Institute, Dehradun that 'of all the practices intimated by men, the most anxious is that of shifting'. The system essentially consist of removal of forest by slash and burn techniques followed by mixed cropping for a short period before abandoning the site for recovery through forest development. The land is usually abandoned after two years of cropping as it losses the fertility by then and the jhumia family shifted to another site to repeat the similar process. The time gap called jhum cycle between two consecutive slash and burn events has shrunk with phenomenal increase in tribal population and has now reduced from 15-20 years in the past to about 5 years at present. During the period of ripening, the crop has to be protected from birds and animals which enhance hunting activities of the tribal people.

FORESTRY

The term forestry refers to obtaining of various types of products from forest. It includes not only the production of timber but also the activities of gathering of products from plants and trees. Gathering of forest products is generally the way of life of people with a low level of cultural and economic development[4]. Forest constitutes a major economic resource for the hill people of Manipur. Forest produce can broadly be classified into wood and non-wood forest produces. Wood products include timber, firewood and charcoal. Non wood products include variety of fruits, medicinal plants, bamboos and canes. The above mentioned forest produces assured supplementary income to about 87 percent of the tribal farmers of Manipur.

IMPACT OF DEFORESTATION

In Manipur deforestation give birth to several severe problems encompassing environmental degradation through accelerated rate of soil erosion, increase in sediment load of the rivers, siltation of reservoirs and river beds, reduces the water retaining capacity of soil, economic loss through damages of agricultural crops due to increase incidence of floods and droughts. Shifting cultivation is a major cause of forest loss in the hills of Manipur and the loss of virgin forest cover due to shifting cultivation is increasing every year to meet the economic needs of the growing tribal population. It is evident from the report of forest survey of India that about 500 sq. km. of forest is lost annually due to shifting cultivation and population dependent on it is estimated as three Lakhs. Lumbering for domestic and commercial purposes is also a real cause of large scale destruction of forest covers in the state. The reckless felling of trees for various purposes due to urban growth and rapidly increasing population has done great damage to natural forest

covers of Manipur. Collection of immature woods for firewood and charcoal production from the depleted and poor forest covers has further degenerated already impoverished forest covers. Deforestation and forest fire results in the increase of the concentration of carbon dioxide in the atmosphere. It obviously increases the green house effect which raised the temperature and promotes climate fluctuation particularly in the state. The reduction of jhum cycle and continuous exploitation of forest for timber and other purposes has converted the lush evergreen forest into barren rocky lands or degraded secondary vegetation. It promotes growth and development of certain exotic weeds which have now become a real menace in the hills of Manipur.

THE DEGRADING LOKTAK LAKE

The Loktak lake is the largest fresh water lake in the North east region of India. It is important from the point of view of the economic and ecological security of the state. This lake has been identified as one of the conservation sites under the Ramsar Convention. The lake and its surrounding marshes support to four hundred and twenty five types of wild animals and twenty one types of water fowls. The lake is also important because the 'Keibul Lamjao National Park', the home of the 'Sangai'(Brow antlered Deer) is located within the catchment area. However, it has been well documented that deforestation has led to the siltation of the lake. A total of 50 percent of the soil loss carried down by different rivers is retained in the lake every year which results to an annual siltation of 4.50 hectare meters per 100 sq. km[8].

NECESSARY REMEDIES

The protection and conservation of forest resources are not only desirable but are also necessary for the economic development of a nation and maintenance of environmental and ecological balance from local through regional to global level[7]. To protect and conserve the forest resources of Manipur, some alternative arrangements for the economic needs of the hill people should be implemented so that they could change their age old economic activities. The Following suggestions may be discussed in this regard :

1. There is an urgent need for the development of a comprehensive state forest policy, which should be expedited by setting up a state enquiry commission on forest and land management. The New Land Use Policy and Jhum Control Project of Mizoram state may be recommended in this regard[6].

2. There is a need for more plantations. This would promote trees and species useful for timber and also cover a strategy of agro-forestry with local species that can support a diversity of occupations.

3. Some important multipurpose species viz. Cinnamon, Alder, Pineapple, Passion fruit, Brazil nut, Jack fruit, Orange, Lemon, Mango etc. are to be promoted which are much suitable to the hills of Manipur.

4. To prevent soil erosion and siltation on the water bodies, wet rice cultivation with horticultural and medicinal plants may be implemented around the catchment areas.

5. In Manipur, there is an enormous potential to develop system of value addition in forest produce.

6. Horticultural processing units and essential oil units may be established with sufficient market facilities.

7. Research and developmental activities with a focus on medicinal plants should also be strengthened so as to promote plantation of important and useful medicinal plants and herbs in the region.

8. Government agencies and NGO's may organize awareness campaign to highlight the importance of forests and its role in the human survival.

CONCLUSION

It is apparent from the above discussion that the economic activities of the hill people of Manipur do not favour the environmental growth in the region. It is also evident that there has been a gradual decline in the forest cover in the state. It is a matter of serious concern that the hill people of Manipur ignored the environmental and ecological significance of natural vegetations and may be due to the immediate economic needs. It has destroyed the forest so rapidly and alarmingly that the forest areas have so markedly decreased that several serious environmental problems such as accelerated rate of soil loss through rain splash, sheet wash, rill and gully erosion; increase in the frequency and dimension of floods, greater incidence of drought due to decrease in precipitation have plagued the state. As the United Nations Assembly declared 2010 the International Year of Biodiversity, it is right time to take necessary arrangement to conserve the natural environment of Manipur.

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SHORT COMMUNICATION

ENERGY SAVING OPPORTUNITIES IN SOME TYPICAL HOME APPLIANCES

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Residential appliances and equipments use 30% of all electricity generated in Organization for Economic Co-operation & Development (OECD) countries, producing 12% of all Energy-related carbon dioxide emissions which is a primary contributor to global warming. Since 1973, primary energy demand in the residential sector in OECD countries has grown more than all other sectors apart from transport. There are many simple ways to use energy more efficiently that will save fuel as well as money, make the home more comfortable and benefit the environment. 20% of the energy bills can be saved every year by taking some simple actions. Calculating energy use based on a description of the house and appliances can help identify the best opportunities for energy savings. Knowing how much electricity each of appliances uses will also give a clearer picture of where the energy cost is going. Powered with this knowledge, one can use energy more efficiently and trim the energy budget.

ENERGY USE CALCULATION

To estimate how much electricity the home appliances consume, one can generally find the wattage stamped on the bottom or back of the appliances or on its "nameplate."

The wattage listed is the maximum power drawn by the appliance. Since many appliances have a range of settings (for example, the volume on a radio), the actual amount of power consumed depends on the setting used at any one time.

If the wattage is not listed on the appliance, it is estimated by finding the current drawn (in amperes) and multiplying that by the voltage used by the appliance. The amperes might be stamped on the unit in place of the wattage. If not, find a clamp-on ammeter, an electrician's tool that clamps around one of the two wires on the appliance to measure the current flowing through it. The reading, while the device is running, is the acutal amount of current being used at that instant.

To estimate the amount of energy a specific appliance consumes the following formula can be used :

Wattage × Hours Used per Day × No. of Days used in a year = Annual watt hour (Wh) consumption.

1 Kilowatt hour (k Wh) = 1000 Watts hour = 1 unit power consumption.

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Table –1 : Energy Consumption of Some Typical Home Appliances.

Device (capacity & size)	Wattage	Deivce (capacity & size)	Wattage
Incandescent lamp (Bulb)	25/40/60/100	Vacuum Cleaner	1000-1400
Compact Fluorescent Lamp (CFL)	7/11/12/27	Electric Kettle	1000/2000
Fluorescent Tube Light With Copper choke With Electronic choke	 55 35	Washing Machine Automatic Semi-Automatic	 325/1000 200
VCR/DVD	17-21/20-25	Mixture Juice (big)	450
Ceiling Fan 36/48 (inch) 56 (inch) 60 (inch)	 50 60 70	Water Purifier Radio Tape Recorder	25 15 20
Table Fan (12/16 inch)	40	Night Lamp	15
Immersion Rod	1000/1500	Television	100
Air Conditioner 1.0 ton 1.5 ton	 1400 1800	Personal Computer CPU - awake/asleep Monitor - awake/ asleep	 120/30 or less 150/30 or less
Air cooler	170	Electric Heater	1500/2000
Refrigerator Small Big	 225 300	Electric Iron Domestic Dhobi	 450/700 1000

Table–2 : Example of Energy Bill for Some Home Appliances.

Appliances	Watts	×	Hours per Day	×	Days per Year	÷	Convert to k Wh	×	k Wh Rate (Rs.)	=	Cost per Year (Rs.)
Bulb	100	×	6	×	340	÷	1000	×	4	=	816
Compact Fluorescent Lamp (CFL)	20	×	6	×	340	÷	1000	×	4	=	163
Electric Heater	1500	×	4	×	340	÷	1000	×	4	=	8160
Air Conditioner (1 ton)	1400	×	14	×	140	÷	1000	×	4	=	10976

SOME TIPS AND GUIDANCE FOR SAVING ENERGY COST

Lifecycle Cost

The sum of the purchase price and the energy cost of running an appliance over its lifetime are called its lifecycle cost. Over the life-span of an appliance the energy cost can be many times greater than the initial cost. The lifecycle cost of an energy-efficient appliance is typically lower than the lifecycle cost of an average model. For example Compact Fluorescent Lamps (CFLs) are the highly efficient alternative to standard incandescent bulbs. A single 20-watt CFL will provide the same amount of light as a 100-watt incandescent bulb and last up to seven times longer. Because CFLs use less energy and last longer, the life cycle cost of CFL is less than the Bulb (Table-2), and may save up to several times their purchase price each year through reduced electricity bills and fewer replacement of bulbs.

Loss of Phantom Power

Many appliances continue to draw a small amount of power when they are switched "off". These "phantom loads" occur in most appliances that use electricity, such as VCRs, Televisions, Stereos, Computers, and Kitchen appliances. Most phantom loads will increase the appliance's energy consumption a few watts per hour. These loads can be avoided by unplugging the appliance or using a power strip and using the switch on the power strip to cut all power to the appliance.

Lighting

- Use Energy Efficient Bulbs (CFLs) instead of traditional Bulbs-they use 1/5th the energy and last upto 7 times as long.
- Turn off lights in empty rooms and corridors. This can save up to 15% of the lighting bill.
- Use just the light in need.
- Use daylight freely, so keep windows and skylight clean and clear and adjust the curtains or blinds to let in as much light as possible during the day.
- Clean light fittings annually, dirt reduces light efficiency.

Refrigerators and Freezers

Refrigerators, although turned "on" all the time, actually cycle on and off at a rate that depends on a number of factors. These factors include how well it is insulated, room temperature, freezer temperature, how often the door is opened, if the coils are clean, if it is defrosted regularly, and the condition of the door seals. To get an approximate figure for the number of hours that a refrigerator actually operates at its maximum wattage, divide the total time the refrigerator is plugged in by three. However,

- Don't leave the door open for longer than necessary, cold air escapes.
- Avoid putting hot or arm food straight into the freeze by allowing it to cool down first.
- Defrost the freezer regularly to keep it running efficiently and cheaply. If it tends to frost up quickly, check the door seal.
- Place your refrigerator or freezer away from heat sources such as the oven, dishwasher, heating vent or direct sunlight.

Other Appliances

- Only boil as much water as needed.
- Use a Microwave instead of the Oven and the Toaster instead of the Grill when ever possible.
- Televisions, Videos, Stereos and Computers : cut down on wasted energy, by switching appliances off completely rather than leaving them on standby.

CONCLUSION

Reducing energy bill reduces the Environmental pollution associated with energy production and has a positive effect on National security and the Economy. So, it is required to save Energy for benefit of self and Nation.

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2. Bureau of Energy Efficiency website.
3. U.S Department of Energy website.

KNOW THY INSTITUTIONS

BOSE INSTITUTE, KOLKATA

Founded by Acharya Sir Jagadis Chandra Bose in 1917 for the advancement of science and dissemination of knowledge, the Bose Institute has served the nation for the past 93 years through its pursuit of advancement of knowledge in science and technology and by developing highly competent and able scientific manpower for the country. The Institute has on its staff highly qualified and experienced scientists devoted to original and path breaking research in the fields of Plant Sciences, Structural Biology, Molecular Biology, Biomedical Sciences, Biotechnology, Quantum Mechanics, Astrophysics and Condensed Matter Physics.

Bose Institute started originally with three departments, Botany, Chemistry and Physics. With time more departments like the Animal Physiology Section (1930), Department of Microbiology (1942), Department of Biochemistry (1974), the Plant Tissue Culture Section (1976, subsequently renamed Plant Molecular & Cellular Genetics Section in 1989), Department of Biophysics (1985), the Environmental Science Section (1992) and the Immunotechnology Section (1992) were added. Very recently, a division of Molecular Medicine has been established, encompassing the sections of Animal Physiology and Immunotechnology, along with the induction of a few scientists from the Departments of Chemistry and Microbiology. In addition, the institute hosts support and service centres like the Central Instruments Facility, the Distributed Information Centre, Library, Workshop, J.C. Bose Centre comprising the Museum and the Publication sections. The wide-ranging and comprehensive base of available scientific infrastructure at Bose Institute also comprises the Acharya J.C. Bose High Altitude Research Centre

at Darjeeling and the experimental field stations at Falta, Madhyamgram and Shyamnagar respectively. Recent augmentations include the establishment of a National Facility on Proteomics and Genomics, a National Facility on Astroparticle Physics and Space Sciences, a Centre of Excellence in Bioinformatics, a Rural Biotechnology Training Centre at Falta and the J.C. Bose Biotechnology Innovation Centre based at the Madhyamgram campus. The facilities available in the institute for scientific enquiry and its applications also cater regularly to the scientists from several universities and research centres in the country. Special efforts have been undertaken to upgrade and modernize the library of The Bose Institute during the recent years.

The eminence of Bose Institute scientific research spanning a wide range of disciplines is evident from the large number of research publications in the most competitive peer reviewed international and national journals, the recognition received by the scientists in the form of S.S. Bhatnagar Prize, INSA young scientist award, fellowship of the National Science Academies, fellowship of the Third World Academy of Science, Nehru Fellowship, K.S. Krishnan Fellowship, Rockefeller Foundation fellowship and Homi Bhabha fellowship. The institute has over the years provided yeoman service in manpower development, having trained a large number of Ph.D. students many of whom are now reputed experts in their fields in India and abroad. On an average, 30-40 scholars are awarded Ph.D. degree every year. Over the past decade, scientists of Bose Institute have maintained an enviable record of publication in peer reviewed journals. A number of its scientists and research scholars participate every year in numerous academic activities (seminars, conferences, workshops) in India and abroad as invited speakers, chairpersons and resource persons. A large number of extramural research projects, with support from various government agencies as well as international funding agencies, are carried out at Bose Institute.

RESEARCH ACTIVITIES

At the time of founding Bose Institute, the illustrious founder, Sir J. C. Bose had unequivocally declared that the objective of this Institute would be to practice seamless science, without compartmentalisation on the basis of specialisation. Bose Institute strives to achieve this ideal, encouraging inter-disciplinary research to the fullest. Broadly, the current research activities of our scientists cover the following areas :

Improvement of Plants

Biotechnological, Genomic and Proteomic Approaches : Focus of this Institutional programme is to identify the components responsible for desirable phenotypes and to characterize them extensively through cellular, molecular, genomic and proteomic approaches for their further expression in target plants for quality improvement.

Protein Structure, Function and Engineering

Resolution of Protein structure is the key criteria to determine functional organization of a protein. Study on the structure function relation coupled with expression analyses have been undertaken to design therapeutically and other economically important protein molecules.

Bioinformatics & Computational Biology

Bioinformatics Centre was incepted in 1988 as one of the nine nodal centres under the programme, Biotechnology Information System of the DBT with genetic engineering and molecular modelling as the two major thrust areas. Since then the centre is functioning as a repertoire of information related to bio-informatics and its dissemination in Eastern India. It provides computational facilities to carry out research in genome analysis, molecular modelling, plant genomics and proteomics, biomolecular structure determination (through NMR and X-ray crystallography), protein structure analysis, protein-protein interaction, docking and molecular recognition, protein folding and threading

etc. The Bioinformatics Centre has the distinction of being designated as Centre of Excellence of the Department of Biotechnology, Government of India.

Molecular Medicine

Participants have taken initiatives in identifying and characterizing the active principles of biomolecules useful in pathophysiology. Development of novel peptides/ biomolecules is also another target.

Microbial Genomics and Infection Biology

Genomic approaches have been taken to study the basic biology of microbes leading to useful insights into the mechanisms of their growth, proliferation and cell-cycle regulation. Molecular mechanisms underlying the processes by which some of these microbes cause infectious diseases are being elucidated. Identification of microorganisms with a potential for bioremediation is also under study.

Development of Systems Biology

Scientists have taken system level approaches combining mathematical modeling with cell biological experiments to dissect the functional organization of various genes, proteins and transcription factors in relation to development of cancer, tuberculosis and other diseases and the biology of pathogens.

Basic and Applied Problems in Physical and Environmental sciences

The Department of Physics contributes both to fundamental knowledge as well as applications relevant to industry and society in general. The Department's current research activities are in the areas of Radiation Physics; Statistical Mechanics; Foundations of Quantum Mechanics and Quantum Entanglement; Astrophysics of Strongly Interacting Matter; Characterization of Detector Materials for Heavy Ions; Preparation and Characterization of Dielectric Materials, Condensed Matter Physics, Nuclear and High Energy Physics, Astroparticle Physics and Cosmology. Recently, intense activities have also been initiated in Millimeter Wave and Microwaves as well as atmospheric sciences. In other experimental stations attempts are being put forward to translate the knowledge acquired at plant molecular biological laboratories to the field.

Human Resource Development

Bose Institute has recently started a new chapter in the realm of manpower development. In collaboration with the University of Calcutta, an integrated M.Sc.-Ph.D. course in Plant Molecular Biology & Technology has been initiated in September 2007. This is the first time in India that a national institute and a university are awarding joint degrees; rather than depleting the resources of a university, this may serve as a model for cooperation and collaboration for the overall growth in the academic sphere. Also in September 2007, a four semester M.Sc. course in Physics, with specialisation in Astrophysics & Space Sciences has been started in collaboration with St. Xavier's College, Kolkata.

Science and Society

A Rural Biotechnology Centre has been developed to provide the knowhow of basic biotechnology to the rural people to improve the socioeconomic status. Although the beginning is modest, the response of the local people, the primary beneficiaries of the project, has been one of tremendous enthusiasm and efforts are now on not only to sustain it but also to substantially expand its scope.

Contact : Director, Bose Institute, 93/1 A. P. C. Road, Kolkata-700 009

Conferences / Meetings / Symposia / Seminars

2012 International Conference on Life Science and Technology (ICLST 2012), Hong Kong, 5-7 January, 2012

Sponsored by the Asia-Pacific Chemical, Biological & Environmental Engineering Society (APCBEES).

ICLST 2012 is the premier forum for the presentation of new advances and research results in the fields of theoretical, experimental, and applied Life Science and Technology. Topics of interest for submission include, but are not limited to :

Biological and Life Sciences
Medical and Veterinary Sciences
Biological and Biomedical Sciences
Agriculture, Borestry and Life Sciences
Biology and neuroscience
Biological Science (Botany, Forestry, Cell Biology, Marine Biology, Zoology)
Genetics and Human Genetics
Biochemistry and Molecular Biology
Biology and Medical Physics, Biomedical Engineering
Anatomy
Biochemistry
Computational Biology
Biology
Systems Biology
Bioscience Engineering
Genetics and Human Genetics
Microbiology
Food Engineering
Nutritional Sciences
Pharmacology
Physiology and Biology
Health Sciences
Pharmaceutical Science

All papers for the conference will be published in the proceeding of the ICLST 2012, and will be listed in the Science & Technology Digital Library, and Indexed by the Thomson ISI. About 10 selected papers will be published in the International Journal of Bioscience, Biochemistry and Bioinformatics (IJBBB, ISSN : 2010-3638) free of charge, Paper Submission (Full Paper) Before *September 15, 2011*

Contact : BEES Senior Editors, Ms. Yang, Asia-Pacific Chemical, Biological & Environmental Engineering Society, ICLST 2012 Website: http://www.iclst.org/; ICLST 2012 E-mail iclst@cbees.org

S & T ACROSS THE WORLD

HUMAN BRAINS 'SHRINKING OVER LAST 20,000 YEARS'

Admit it or not, people may be becoming increasingly dumb, says a new study which has found that the human brain has been gradually shrinking over the last 20,000 years.

According to the study, this decrease in size follows two million years during which the human cranium steadily grew in size, and it has happened all over the world, to both sexes and every race.

"Over the past 20,000 years, the average volume of the human male brain has decreased from 1,500 cubic centimetres to 1,350 cubic centimetres, losing a chunk the size of a tennis ball. The female brain has shrunk by the same proportion," the *'Daily Mail'* quoted as saying a report in 'Discover[1] magazine.

In the magazine, author Kathleen McAuliffe reported on the comments made by DrJohn Hawks, an anthropologist from the University of Wisconsin,

Who argues that the fact the size of human brain is decreasing doesn't necessarily mean people's intelligence are in decline as well.

Some paleontologists agree with this diagnosis, that human brains may have become smaller in size, but increasingly efficient. But others believe man has indeed become steadily more stupid as he has evolved.

Several theories have been advanced to explain the mystery of the shrinking brain. One is that big heads were necessary to survive Upper Paleolithic life, which involved cold, outdoor activities.

A second theory is that skulls developed to cope with a chewy diet of rabbits, reindeer, foxes and horses. As our food has become easier to eat, so human heads have stopped growing, according to supporters of this theory.

Other experts say that with high infant mortality, only the toughest survived - and the toughest tended to have big heads. Therefore a gradually decreasing infant mortality rate led to proportionate decrease in the human brain size.

A recent study conducted by David Geary and Drew Bailey, cognitive scientists at the University of Missouri, explored how cranial size changed as humans adapted to an increasingly complex social environment between 1.9 million and 10,000 years ago.

They found that when population density was low, such as during the majority of human evolution, the cranium increased in size. But when a certain area's population changed from sparse to dense, human cranium size decreased.

They concluded that as increasingly complex societies emerged, the brain grew smaller because people didn't have to be as smart to stay alive.

SCIENTISTS 'CREATE GENETICALLY MODIFIED PIGS'

In a world's first, scientists claim to have created a new generation of genetically modified pigs which they say are greener and fit for human consumption.

According to its creators, the Enviropigs look, sound and taste like normal pigs, but are designed to be greener — each contains genes from mice and *E.coli* bacteria which have been inserted into their DNA with absolute precision.

Those genes make a small but important difference to the way these pigs process their food and so, their manure contains less phosphorus than normal slurry and poses less risk to rivers, streams and lakes, say the scientists.

Unlike normal pigs, Enviropigs have been designed to produce their own phytase, say the creators.

In tests, the Enviropigs were able to absorb more phosphorous from its feed. Their wastes contained less of the potentially toxic substance and their meat also appears to be identical to cuts from a traditional Yorkshire pig.

Professor Rich Moccia of the University of Guelph in Canada, whaled a team, is proud of what has been achieved.

"It's the forefront of discovery in the scientific community. It's one of only two animals right now using this kind of technology. It really is mind-boggling when you think of it," the lead scientist told the 'BBC'.

Prof Moccia added: "They are pretty friendly and pretty gregarious. These pigs are almost

identical to a normal Yorkshire pig. They look normal, they grow normally and they behave normally.[11]

But critics of GM food said the animals are "anything but environmentally friendly" and could lead to more intensive pig farms.

Anti-GM campaigner Lucy Sharratt said the very notion of transgenic animals is a nightmare. "This is an absolutely critical time when North America is at the very centre of the global conflict over genetically engineered animals - to break open a whole new area of application of this technology, which we had never imagined would be possible.

"I am very worried and I think people around the world should be worried about what is happening in North America," she was quoted as saying.

MYSTERY OF SUN'S HOT OUTER ATMOSPHERE 'SOLVED'

One of the longstanding mysteries in solar physics is why the Sun's outer atmosphere, or corona, is millions of degrees hotter than its surface.

Now, scientists claim to have finally solved the mystery after they discovered a major source of hot gas that replenishes the corona - jets of plasma shooting up from just above the Sun's surface, the '*Science*' journal reported.

Scott Mclntosh of the National Center for Atmospheric Research in Colorado, a member of an International team which carried out the NASA-supported research, said: "It's always been quite a puzzle to figure out why the Sun's atmosphere is hotter than its surface.

"By identifying that these jets insert heated plasma into the Sun's outer atmosphere, we can gain a much greater understanding of that region and possibly improve our knowledge of the Sun's subtle influence on the Earth's upper atmosphere."

Team member Rich Behnke of the National Science Foundation, which funded the research, said: "These observations are a significant step in understanding observed temperatures in the solar corona.

"They provide new insight about the energy output of the Sun and other stars. The results are also a great example of the power of collaboration among university, private industry and government scientists and organisations."

In fact, for its research, the team focused on jets of plasma known as spicules, which are fountains of plasma propelled upward from near the surface of the Sun into the outer atmosphere.

For decades, researchers believed spicules could send heat into the corona. However, following observational research in the 1980s, it was found that spicule plasma did not reach coronal temperatures, and so the theory largely fell out of vogue.

"Heating of spicules to millions of degrees has never been directly observed, so their role in coronal heating had been dismissed as unlikely," said Bart De Pontieu, the lead scientist and a solar physicist at Lockheed Martin's Solar and Astrophysics Laboratory.

In 2007, De Pontieu, Mclntosh, and their colleagues identified a new class of spicules that moved much faster and were shorter-lived than the traditional spicules. These "Type II" spicules shoot upward at high speeds, often in excess of 100 kilometers per second, before disappearing.

The rapid disappearance of these jets suggested that the plasma they carried might get very hot, but direct observational evidence of this process was missing.

In its latest research, the team used new observations from the Atmospheric Imaging Assembly on NASA's recently launched Solar Dynamics Observatory and NASA's Focal Plane Package for the Solar Optical Telescope on the Japanese Hinode satellite to test their hypothesis.

"The high spatial and temporal resolution of the newer instruments was crucial in revealing this previously hidden coronal mass supply.

"Our observations reveal, for the first time, the one-to-one connection between plasma that is heated to millions of degrees and the spicules that insert this plasma into the corona," Mclntosh said, recently launched Solar Dynamics Observatory and NASA's Focal Plane Package for the Solar Optical Telescope on the Japanese Hinode satellite to test their hypothesis. "The high spatial and temporal resolution of the newer instruments was crucial in revealing this previously hidden coronal mass supply.

Cth;eg ÂJÒttl fltdm mô:t

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m=ôg;t fle N; yth m=ôgt fle ÂJNMtÂ"fith/Terms of Membership and Privileges of Members

mô:t fle m=ôg;t Wl mCe jtdt fl ÂjY Fje n, st ôlt;fl gt Wmfl mbtl ô;h vh NGÂKfl gtÉg;t ysl flh afl n yth Âsàn Cth; b ÂJÒttl fle ;h¢fle b ÁÂa n›

Membership of the Association is open to person with *Graduate or equivalent Academic Qualifications* and interested in the advancement of science in India.

1. **JtÂMfl m=ôg** & st ÔgÂÿl lg Áv m JtÂMfl m=ôg;t dnK flhlt atn;t n Wm JtÂMfl m=ôg;t NÖf ₹ 200/- fl mt: C;e NÖf ₹ 50/-* (ÂJ=ÂNgt fl ÂjY** U.S.$ 70) btºt =l vzd› JtÂMfl m=ôg;t NÖf ŒÀgfl JM fl 01 yŒj flt =g nt stYdt› st Ce 15 sjtR fl Ce;h yvle m=ôg;t NÖf lne y=t flh vtYdt Jn Wm mtj fl ÂjY yvle Jtx =l fle Gb;t m JÂa; nt stYdt yth/gt Jn Wm JM fl ÂjY mô:t fl fltgtjg flt Ce ÂlgºtK lné flh vtYdt› m=ôgdK yvlt vvh fltdm mºt fl mbg vN flh mfl; n› Wàn JtÂMfl ÂJÒttl fltdm mºt fle fltgÂJJhK fle Yfl ŒÂ; Âclt bÖg b ŒtË; nt mfl;e n› Rmfl mt: J mô:t fl htsltbat llYJhebàm mtRm00 fle ŒÂ; Ce Âclt bÖg ŒtË; flh mfl; n›

1. **Annual Member :** A person willing to be enrolled as new Annual Member has to pay an annual subscription of ₹ 200/- along with an admission fee of ₹ 50/-* (for foreign** U.S.$ 70) only. The annual subscription of a Member shall become due on the 1st April of each year. Anyone who fails to pay the subcription on or before the *15th July* in any year shall lose the right of voting and/ or holding any office of the Association for that year. A member failing to pay the annual subscription by the end of March of the following year shall cease to be as Member.

   Members may contribute papers for presentation at the Science Congress. They will receive, free of cost, reprints of the Proceedings of the Session of any one section of their interest and also the bi-monthly journal of the Association "Everyman's Science".

2. **mºt m=ôg** & gÂ= f‖A f‖thKt m JtÂMf‖ m=ôg yvle m=ôg;t Wm JM f‖ 15 sjtR f‖ y=h =tnhtlt Cj stY, ;t Wlf‖e m=ôg;t, mºt m=ôg;t f‖ Áv b Âclt Jtx ztjl f‖e Gb;t b meÂb; f‖h Â=gt stYdt› mºt m=ôg f‖t ₹ 200/- (ÂJ=ÂNgtf‖Âj Y $50) y=t f‖hlt vzdt› JtÂMf‖ m=ôg yvle m=ôg;t =tctht ydj mtj 15 sjtR f‖ Ce;h Âclt C;e NÖf Â=Y vl& yvle m=ôg;t Œtë; f‖h mf‖;t n› Yf‖ mºt m=ôg f‖t jF/vtôxh Œô;Â;f‖hK f‖t yÂ"f‖th Œtë; ntdt Âsm f‖tdm mºt f‖t Jn m=ôg n› Yf‖ mºt m=ôg Jtx ŒÂf‖gt b Ctd jl f‖ gtÉg lne n›

2. **Sessional Member :** If for some reasons, Annual Members fail to renew their Membership by remitting subscription prior to 15th July each year, their Membership for the year would be restricted to Sessional Membership without voting rights. Sessional Member has to pay ₹ 200/- (for foreign $50). Annual members can renew their Membership without paying the admission fee in the next year by remitting subscriptions in time. i.e. within 15th July A Sessional Member shall have the right to present paper/poster at the Session of the Congress of which he/she is a members. A sessional member shall not be eligible to participate in the voting process.

3. **Atºt m=ôg** & st ôgÂÿ‖ ôlt;f‖ ô;h f‖ lea vZtR f‖h hnt n Jn JtÂMf‖ m=ôg;t NÖf ₹ 100/- btºt =l vzd› yvlt ltb Atºt m=ôg f‖ Áv b ÂjFJt mf‖;t n cN; Wmf‖ ytJ=l vºt vh Wmf‖ Œtatg/ ÂJCtdtÉgG/mô:tl f‖ Œ"tl f‖ nô;tGh nt› Yf‖ Atºt m=ôg f‖t gn yÂ"f‖th Â=gt stYdt Âf‖ Jn yvlt vvh f‖tdm mºt f‖ mbg vN f‖h mf‖, cN; Jn vvh Jn Âf‖me JtÂMf‖ m=ôg gt mô:t f‖ f‖tR yJ;Âlf‖ m=ôg f‖ mt: vN f‖h› Wm Jtx f‖hl f‖t gt f‖tgtjg f‖t ÂlgºtK f‖hl f‖t yÂ"f‖th Œtë; lné ntdt› Atºt m=ôg f‖t ÂJCtdt f‖ ôgJmtg cXf‖t yth mt"thK cXf‖t b Ctd jl f‖e gtÉg;t Œtë; lné n›

3. **Student Member :** A person studying at the under-graduate level may be enrolled as a Student Member by paying an annual subscription of ₹ 100/- only provided his/her application duly certified by the Principal/Head of the Institution/Department. A student member shall have the right to submit papers for presentation at the Session of the Congress of which he/she is a member, provided such papers be communicated through a Member, or an Honorary Member of the Association. He/she shall not have the right to vote or to hold any office. A student member shall not be eligible to participate in the Business meetings of the Sections and the General Body.

4. **ytseJl m=ôg** & Yf‖ m=ôg yvl CÂJíg f‖e mthe JtÂMf‖ m=ôg;t NÖf Yf‖ cth b ₹ 2000/- (ÂJ=ÂNgt f‖ Âj Y U.S.$ 500) btºt y=t f‖hf‖ vt mf‖;t n› Yf‖ ôgÂÿ‖ st 10 mtj gt Wmm yÂ"f‖ ÂlgÂb; Áv m m=ôg;t Œtë; f‖h af‖t n, Wm Wmf‖e mgÿ‖ m=ôg;t NÖf f‖ W¥vh ŒÂ;JM Á 50/- f‖e Ax =e stYde, cN; Âf‖ Wmf‖e mgÿ‖ NÖf ₹ 1,200/- m lea l nt (ÂJ=ÂNgt f‖ Âj Y U.S.$ 12.50 yth U.S.$ 300 f‖bN&)› Yf‖ ytseJl m=ôg f‖t Wmf‖ vh seJl f‖tj b m=ôg;t f‖ mth ÂJNMtÂ"f‖th Œtë; ntd›

4. **Life Member :** A Member may compound all future annual subscriptions by paying a single sum of ₹ 2000/- (for foreign** U.S.$ 500) only. Any person who has been continuously a member for 10 years or more, shall be allowed a reduction in the compounding fee of ₹ 50/- for every year of such membership, provided that the compounding fee shall not be less than ₹ 1,200/- (for

foreign** U.S.$ 12.50 and U.S.$. 300 respectively). A life Member shall have all the privileges of a member during his/her lifetime.

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* C;e NÖf ₹ 50/- ÂmVl Yfl lg JtÂMfl m=ôg fl Âj Y sÁhe n› gn mºt m=ôg/ytseJl m=ôg/ mô:tl m=ôg/Atºt m=ôg/=t;t fl Âj Y sÁhe lné n›

* Admission fee of ₹ 50/- is needed only for becoming a new Annual Member and not for Sessional Member/Life Member/Institutional Member/Student Member/Donor.

** (Yfl ÂJ=Ne m=ôg flt y: n, st Cth;JM fl ctnh flt ltdÂhfl nt›)

** (A Foreign Member means one who is Normally Resident outside India).

5. **mô:tl m=ôg** & Yf mô:tl st ₹ 5,000/- m=ôg;t NÖf fl Áv b = Jne mô:t fl mô:tl m=ôg cl mfl; n, (ÂJ=ÂNgt fl Âj Y U.S.$ 2,500)› Rmb Jn ÂJÒttl fltdm fl JtÂMfl mºt b yvl Yfl ÔgÂÿl flt ltb ltbtÂfl; flh mfl;t n, st Wlflt ŒÂ;ÂlÂ" nt› Yfl mô:tl m=ôg flt JtÂMfl ÂJÒttl fltdm mºt fle fltgÂJJhK fle Yfl vK ŒÂ; Âclt bÖg b ŒtË; nt mfl;e n› Rmfl mt: J mô:t fl htsltbat llYJhebàm mtRm00 fle ŒÂ; Ce Âclt bÖg ŒtË; flh mfl; n›

5. **Institutional Member :** An Institution paying a subscription of ₹ 5,000/- (for foreign** U.S.$2,500) only, can become an Institutional Member of the Association. It shall be eligible to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional Member shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also a copy each of the Association's journal "Everyman's Science".

6. **=t;t** & fltR Ce ÔgÂÿl, st Yflmt: ₹ 10,000/- (ÂJ=ÂNgt fl Âj Y U.S.$ 5000) btºt =, Jn mô:t fl =t;t cl mfl; n› Yfl ÔgÂÿld; =t;t flt Jn mth yÂ"flth yth ÂJNMtÂ"flth Âbjd, st Yfl m=ôg flt Wmfl vK seJl fltj b ŒtË; nt; n› Yfl mô:tl st Yflmt: ₹ 50,000/- (ÂJ=ÂNgt fl Âj Y U.S.$ 25,000) btºt =, Jn mô:t fl mô:tl =t;t cl mfl; n, Âsm Jn Yfl ÔgÂÿl flt ltbtÂfl; flhfl Wm yvl mô:tl fl ŒÂ;ÂlÂ" fl Áv b ÂJÒttl fltdm fl JtÂMfl mºt b Cs mfl; n› Yfl mô:tl/ÔgÂÿld; =t;t JtÂMfl ÂJÒttl fltdm fl fltgÂJJhK yth mô:t fl htsltbat llYJhebàm mtRm00 fle ŒÂ; Ce Âclt bÖg ŒtË; flh mfl; n›

6. **Donor :** Any person paying a lump sum of ₹ 10,000/- (for foreign **U.S. $ 5000) only, can become a Donor of the Association. An ***INDIVIDUAL DONOR*** shall have all the rights and privileges of a member during his/her lifetime. An Institution paying a lump of ₹ 50,000/- (for foreign U.S. $ 25,000) only, can become an ***INSTITUTIONAL DONOR*** of the Association, which shall have the right to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional/Individual Donor shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also the Association's journal "Everyman's Science".

(y) **vh vN fhlt** & Yf vK vvh fle ŒÂ; Wmf mt: ;el mthtN fle ŒÂ; st 100 Nç=t m ßgt=t l nt yth Âsmb fltR ythF gt Vltbjt l nt, Jn ŒÀgf JM 15 Âm;öch f y=h bntmÂaJ (m=ôg;t fltg) ;f vna stlt atÂnY›

(A) **Presentation of Papers :** A copy of complete paper accompanied by an abstract in triplicate not exceeding one hundred words and not containing any diagram or formula, must reach the General Secretary (Membership Affairs) latest by September 15, each year.

(c) mCe Jdt f m=ôg st ÂJÒttl fltdm mºt b Ctd jl f vëat; jtx; mbg f Âxflx b Âhytg; ŒtË; flh mf;t n, cN; Âf Wlfle gtºtt f Fa flt :tzt Ce Ctd mhflth (fŠeg gt htßg), fltR fltlle mútt gt fltR ÂJëJÂJ'tjg gt fltR ldhvtÂjflt l WXtY›

(B) Members of all categories are entitled to Railway Concession of return ticket by the same route with such conditions as may be laid down by the Railway Board for travel to attend the Science Congress Session provided that their travelling expenses are not borne, even partly, by the Government (Central or State), Statutory Authority or an University or a City Corporation.

(m) mô:t f vô;fltjg b mCe Jdt f m=ôg flt vZl fle mÂJ"t mcn 10.00 cs m Ntb flt 5.30 cs ;f mCe fltb f Â=lt b (NÂlJth yth hÂJJth) flt Atzflh ŒtË; ntde›

(C) Members of all categories are entitled to reading facilities between 10.00 a.m. to 5.30 p.m. on all weekdays (except Saturdays & Sundays) in the library of the Association.

(z) mbg mbg vh mô:t Ãtht ;g fle dR bÖg =ht vh ÂJ¶tbdn, mCtdth ytÂ= fle mÂJ"tyt fle ŒtÂË; Ce mCe Jdt f m=ôg flh mf; n›

(D) Members of all categories may use Guest House facilities, Lecture Hall hiring at the rates fixed by the Association from time to time.

(R) CÂJíg b Cth;eg ÂJÒttl fltdm mô:t Ãtht ytgtÂs; vÂhmJt=, möbjl yth JtÂMf fltdm b mCe Jdt f m=ôgt Ãtht Ctd jl f ÂjY yvle-yvle m=ôg;t vºt flt jtlt sÁhe ntdt›

(E) Members of all categories should bring the Membership Card always for attending any Seminar, Conference and Annual Congress organized by ISCA in future.

Ægtl = & mCe cf ztÜx "Treasurer, The Indian Science Congress Association" f ltb m ne ÂjFt stY, yth st fltjflt;t f Âflme Ce NtFt b =g nt› m=ôgt m gn ÂlJ=l Âflgt st hnt n, Âf J yvle m=ôg;t mÏgt flt W¨F Cth;eg ÂJÒttl fltdm mô:t f fltgtjg f mt: vºttath f Jf; yJëg flh›

Note : All Bank Drafts should be drawn in favour of "Treasurer, The Indian Science Congress Association" Payable at any branch in Kolkata. Members are requested to mention their Membership No. while making any correspondence to ISCA office.

Cth;eg ÂJÒttl f\tdm mô:t

14, ztO ÂchN dnt ôxex, f\tj f\t;t - 700 017, Cth;

THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

;th/Telegram : SCICONG : CALCUTTA
V\¢m/Fax : 91-33-2287-2551
=hCtM/Telephone : (033) 2287-4530, 2281-5323
R-bj/E-mail : iscacal@vsnl.net
JcmtRx/Website : http://sciencecongress.nic.in
iscacal_2004@yahoo.com

m=ôg;t f\ ÂjY ytJ=l - v°t/ Application Form For Membership

mJt b/To
bntmÂaJ (m=ôg;t f\tg)/ The General Secretary (Membership Affairs)
Cth;eg ÂJÒttl f\tdm mô:t/The Indian Science Congress Association
14, ztO ÂchN dnt ôxex/14, Dr. Biresh Guha Street,
f\tj f\t;t - 700 017/Kolkata - 700 017

bnt=g/Dear Sir,

b, Cth;eg ÂJÒttl f\tdm mô:t f\t ytseJl m=ôg/JtÂMf\ m=ôg/m°t m=ôg/At°t m=ôg/mô:tl m=ôg/ =t;t/ yvlt ltb ÂjFJtlt atn;t / atn;e n›

I like to be enrolled as a Life Member/Annual Member/Sessional Member/Student Member/Institutional Member/Donor/of The Indian Science Congress Association.

b Rmf\ mt: ₹ _____ m=ôg;t NÖf f\ Áv b lf\=/cf\ ztÜx mÏgt _____ Â=ltÂf\; _____ Œatjf\ cf\ _____ 01 yŒj —— m 31 bta —— ;f\ Cs hnt/hne n›

I am sending herewith an amount of ₹ ———— in payment of my subscription by Cash/Bank Draft No. ———— dated ———— issuing bank from the year 1st April —— to 31st March ——.

b ÂlölÂjÂF; ÂJCtd b ÁÂa hF;t/hF;e n (f\vgt Âf\me Yf\ b ÂlNtl jdtY)/ I am interested in the following section (Please tick any one).

ÂJCtd/Section

1. f\ÂM yth JtÂlf\e ÂJÒttl/Agriculture and Forestry Sciences
2. vN, vNÂaÂf\Àmt yth bÀôg ÂJÒttl/Animal, Veterinary and Fishery Sciences
3. btlJNtô°teg yth ytahK ÂJÒttl (Âsmb mÂöbÂj; n, vht;ÀJ-ÂJÒttl yth bltÂJÒttl yth NÂGf\ ÂJÔttl yth mlt ÂJÒttl)/Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences & Military Sciences)
4. hmtgl ÂJÒttl/Chemical Sciences

5. C-võÂ; ÂJÒttl/Earth System Sciences
6. yÂCgà;t ÂJÒttl/Engineering Sciences
7. vgtJhK ÂJÒttl/Environmental Sciences
8. malt yth mathK ÂJÒttl yth Œt'tÂdfle (Âsmb flÖËgxh ÂJÒttl Ce mÂöbÂj; n)/Information and Communication Science & Technology (including Computer Sciences)
9. CtÂ;fl ÂJÒttl/Materials Science
10. dÂK; ÂJÒttl (Âsmb mtÂÏgfleg Ce mÂöbÂj; n)/Mathematical Science (including Statistics)
11. ÂaÂflÀmt Ntô°t (Âsmb Nheh ÂJÒttl Ce mÂöbÂj; n)/Medical Sciences (including Physiology)
12. lgt seJÂJÒttl (Âsmb seJ-hmtgl, seJ CtÂ;fle yth ytKÂJfl seJÂJÒttl yth seJ-Œt'tÂdfle Ce mÃöbÂj; n)/New Biology (including Bio-Chemistry, Biophysics & Molecular Biology and Biotechnology)
13. CtÂ;fleg ÂJÒttl/Physical Sciences
14. Jlôv Â; ÂJÒttl/Plant Sciences

(flvgt xÂfl; flh gt çjtfl yGht b Ch/Please type or fill up in Block Letters)

ltb/Name (çjtfl yGht b/in Block Letters) : _____ _____

fljltb/Surname Œ:b ltb/First Name

_____

bÆg ltb/Middle Name

NGÅKfl gtÉg;t/Academic Qualifications :
(ŒbtK sbt flhlt n/Evidence to be submitted)

v=ltb/Designation :

mövfl flt v;t/Address for communication :
(htßg, Nnh/ldh yth Âvl fltz mÂn;/including State, city/town and pin code)

=hCtM mÏgt yth R-bj/Phone No. & E-mail :
(ydh fltR/if any)

ô:tge v;t/Permanent Address :

ÂxËvKe (ydh fltR)/Comments (if any)

CJ=eg/Yours Faithfully

Â=ltfl/Date : nô;tGh/Signature

Agtl =& (i) mCe cf\ ztÜx "Treasurer, The Indian Science Congress Association" f\ ltb m ne Âj Ft stY yth f\tj f\t;t f\ Âf\me Ce NtFt b =g nt›

Note : (i) All Bank Drafts should be drawn in favour of "Treasurer, The Indian Science Congress Association" Payable at any branch in Kolkata.

(ii) *10 yÿ\ch, 2004 f\ f\tgf\tÂhKe mÂbÂ; f\ Œô;tJ f\ yl mth Cth;eg ÂJòttl f\tdm mô:t f\e m=ôg;t f\ Âj Y ytJ=l b Âf\me yàg ôgÂÿ\ f\ lbtV\;0 f\t mtbtàg;& n;tÀmtÂn; Âf\gt dgt n› vh; ÂV\h Ce gÂ= ytJ=lv°t b lbtV\;0 f\t v;t Â=gt hndt, ;t Wmb Âsm ôgÂÿ\ f\t ltb Â=gt hndt, Wmf\ nô;tGh Ce sÁhe n›

(ii) *As per resolution of Executive Committee in its meeting held on October 10, 2004 Application for membership of ISCA in 'Care of' of some other person is generally discouraged. However, if in the Application form "care of" address is given then there should be also signature of the person in whose name "care of" is given.

(iii) *C;e NÖf ₹ 50/- ÂmV\ Yf\ lg JtÂMf\ m=ôg f\ Âj Y sÁhe n› gn m°t m=ôg/ytseJl m=ôg/mô:tl m=ôg/At°t m=ôg/=t;t f\ Âj Y sh¥he lné n›

(iii) *Admission fee of ₹ 50/- is needed only for becoming a new Annual Member and not for Sessional Member/Life Member/Institutional Member/Student Member/Donor.

(iv) m=ôgt m gn ÂlJ=l Âf\gt st hnt n, Âf\ J yvle m=ôg;t mÏgt f\t W¨F Cth;eg ÂJòttl f\tdm mô:t f\ f\tgtjg f\ mt: v°ttath f\ mbg yJëg f\h›

(iv) Members are requested to mention their Membership No. while making any correspondence to ISCA office.