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EDITORIAL

METHODS OF INCORRECT EVALUATION

Various institutions of any modern society rest on reliable methods of testing and evaluation that have scientific basis. Assessment of quality and quantity relates to a variety of things such as awarding of marks to answer scripts, selection of people for rcruitment and promotion by interviews and other kinds of oral tests, research and development, publications and project proposals, measurements of various properties of materials, criteria for evaluation of mental and physical conditions of patients, athletics, games, performing arts, states of environment and economy in the country, law and order, cinema and theatre and others. Correct evaluation is a corner-stone of science whose goal is truth. In institutions, the main goal is the overall interest of the institution. Assessment of team performance is always more difficult.

Scientific evaluation of quality and/or quantity must be based only on rational, objective and transparent criteria to help generate correct conclusions and decisions. In this sense, the approach is different from those used for decision-making in politics, judical proceedings, military campaigns and financial affairs where often 'winning' is the main motivating force and short term goal. Evaluation can be formal, informal, statutory or optional. Random criticisms of individuals are often examples of unnecessary and uncalled for haphazard evaluation. Bitterness about apparently faulty assessment and subjective bias is commonplace in all institutions. A major demotivating force, this is a matter of concern and unhappy employees often outnumber the happy ones. Obviously, incorrect evaluations are not rare and the subject merits a serious discussion. Origins of some methods of incorrect evaluation are discussed here. Some of the ideas presented are based on published literature on related topics.

EVALUATION OF ILL-DEFINED PARAMETERS

It should be noted that in many instances, circumstances require evaluation of some apparently vague criteria also e.g. style, personality, sense of aesthetics, humour, smartness, reflexes, etc. Necessarily there is subjectivity but even then these can also be measured using trained evaluators as meters if proper guidelines, methods and training are set. Thus, there is routine grading of gymnasts, divers, ice skaters in various competitions although there are no readily measurable parameters such as weight, height, distance, length, time, etc. In these sports, the main criteria are style, grace, degree of difficulty or risk taken i.e. daring, speed, reflex, innovation, etc. A panel of trained experts declares its verdict simultaneously by pressing buttons to give out scores and an average taken. There are routine evaluations in the field of performing arts, painting and sculpture, architecture, tastes of coffee, tea and alcoholic drinks, perfumery and cooking. Experts award numerical grades even for various countries in terms of indices of civilization including 'happiness'. In happiness

scale, India ranks around 150 (almost the same as FIFA ranking in soccer) whereas in corruption scale, it does better–being ranked 83. Some developed countries obsessed with grading everything evaluate hotels and restaurants, dresses, ladies' eyes, legs, hairstyles and hats, intelligence and even degree of marital bliss (e.g. 'Marriage 66 percent successful'–they can conclude after elaborate tests). Now all countries, developed and under developed, have 'beauty contests' too !

DEFINITION OF PARAMETERS

The reader may be familiar with the saying that if one can define then one can measure ; if one can measure then one can go on to analyze, control and improve. One cannot evaluate unless there is a proper test method made available. However, there are other important aspects also.

Somebody or something is being evaluated somewhere, somehow by someone all the time. Teachers evaluate students and vice–versa, juniors and seniors in any organization evaluate each other, doctors test the patients and get tested too and the same is valid for interviewers and the poor soul on the other side of the table. All evaluations are subject to errors and methods that lead to wrong conclusions are discussed.

A DOZEN METHODS OF INCORRECT EVALUATION

There are many time-tested methods of incorrect assessment of which a dozen are now discussed :

a. *Abdication* : The evaluator may abdicate the responsibility of doing a fair job because of inexperience, lack of training or time or plain callousness. The test done may be crude and may be haphazard.

b. *Default* : In some instances, the evaluator may have the necessary competence but he/she may be too busy doing other more important things or too busy worrying about other meetings to follow. The job at hand does not get the time and care it deserves and results go haywire by default.

c. *Reward and Punishment System :* A common source of error is mix-up of behavioural aspects with non-behavioural ones. "If you behave well in class, then I will give you more marks in mathematics", is an example. No wonder juniors often become obedient and supportive just prior to any selection and / or promotion issue. Many seniors appreciate this also. One can, of course write pages on this.

d. *Zealous Testing* : One can test "hell out of a person" by continuous or far too frequent evaluation tests that leave both the person and evaluator exhausted. In an organization, this can go either way, juniors evaluating seniors and vice versa. Many testing zealots forget altogether the main goal and get entangled in the octopus grip of test procedures.

When an assessment or evaluation is made far too complicated, then invariably the more deserving stands to lose. The Indian penal code, which is the vehicle for testing innocence or guilt, is thus heavily tilted towards culprits.

e. *Mid-game Rule Change* : Any evaluation procedure must rest on a set of regulations made clear to both the evaluators and the ones to be evaluated. If the regulations are arbitrarily changed midway then both are

left confused. This applies equally well for scientific experiments also where standardization of the procedure is a must.

Frequent changes are often introduced by vested interest groups to arrive at particular conclusions through suitable modification of the procedure or criteria midway.

f. *Confusing Criteria* : There are many instances of selection of the so-called best without anybody being fully aware of the criteria. The 'best' representatives are chosen to go to the Parliament after being declared winners in the 'free and fair' election which is also a kind of test. Now many elected representatives claim immunity from whatever criminal charges that exist against them because the highest court has cleared them ! Popularity certainly has its merits but few are clear about its rationality and what voting actually tests.

Consider another example. An industry is to be set up for which suitability of various alternative sites are being evaluated. There are some well-accepted criteria e. g. availability of land, power, water, railway lines, labour, etc., proximity to raw materials sources and centres for product outlet and others. It is, however, also well accepted that the constituency of the Minister, who takes the final decision, is likely to be the most suitable site.

In many tests today, written or oral, the goal is not to select but to eliminate. Thus the focus is on the negative aspects. In some interviews, one or two interviewers begin to teach and the 'apparent learning ability' becomes the important criterion.

g. *Psychic Grading* : Some super-persons make rapid assessments by using psychic power. No elaborate test is necessary for them because they go by their intuition for which a few utterances, the body language or just the look may be enough–with perhaps some help of the biodata. The test is cursory. Now, it is true there are some who are good at this–and there are legends in many organizations. However, too many mediocres falsely claim to be so special and in the process ruin persons as well as positions they hold.

h. *Unrealistic Standards* : All test scores use some standards for reference. 'No matter how brilliant you are, you cannot get more than 65% in English in Calcutta University', used to be a common saying. Even in science subjects, including mathematics, scores beyond 90% were for the real extraordinary. Contrast this with the cut-off of 90% in physics, chemistry, mathematics now routinely demanded for admission in many colleges. Obviously, standards of 'perfection' have changed.

The Americans expect their President to be a war hero, handsome and virile (but no extra marital affairs), rich (but no proven scandal), trim, wise, learned, child loving and of course, a good talker. A pretty wife also helps get him a better scope. In India, every employee in every organization wants their chief exective to be generous, strict for everybody (except for himself), a powerhouse of initiative, action, wisdom, compassion and efficiency. In addition, he should have qualities of a statesman, a Chief

Justice and also DIG police and be well connected so that he can bend rules to favour rule to meet demands.

These are unrealistic standards that make proper evaluation impossible.

i. *Relative Grading* : Some institutions evaluate individuals in a group by relative grading. Thus, if a specific individual is a part of group with a big number of brilliant fellows then he scores low, whereas, in a group of mediocres he will score high. Such a grading can motivate an individual to try harder but it can also destroy him or her.

j. *Lopsided Evaluation* : In any test there are often several parameters which are to be given due weightages. The principle of assigning the specific weightages can be debatable. In some four-year degree colleges, the final evaluation gives equal weightages to score for every year. Will it not be fair to give more weightage to later years to reward those who try to improve ? In written tests, often large sections of the syllabus go uncovered and some sections get undue weightage.

On a philosophical plane, the tests in the academic world are mostly faulty anyway as they give too much weightage to short term memory and special coaching, intelligence based on mathematical and logical abilities and, of course, knowing the rules of the game well. There is no test of knowledge, accomplishment, character, health, motivation, creativity, emotional intelligence, readiness to work hard, daring, co-curricular interests, etc.–qualities those are prerequisite to success. Moreover, there is no levelling of playing fields–the daughter of bonded labour is pitted against the son of a millionaire against the same criteria. I know of a student being unable to draw a telephone set because he had never seen any. Fortunately, he could choose an option to draw a bird in a cage. It was a beautiful drawing–far better than those of many others where the drawer often failed to insert the bird into the cage–the drawing kept the bird out !

k. *Objective Type Questions* : The yes/no or 'mark the correct answer' type questions can be very misleading. Many years ago, the author and some of his friends had given such a question paper of a premier institution to an illiterate, who was asked to mark at random. He happened to score rather high. Mercifully, things have now improved and in multiple-choice answers, the examinee is often required to mark more than a single choice.

l. *Plain Cheating* : as the reader is aware, there are times when the evaluation is totally devoid of an honest effort because there is a predetermined result. This is pure cheating. And if a serious matter such as a test comes to that, then we should stop discussing the subject.

Hem Shanker Ray

'The most solid stone in the structure is the lowest one in the foundation.'

–Kahlil Gibran

PRESIDENTIAL ADDRESS

SOME ASPECTS OF THE ALPINE VEGETATION OF THE HIMALAYA AND TIBET

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The Himalayan range, on account of its great diversity of climate at various altitudes and even in the various parts of its great length from east to west, offers a very favourable opportunity for the study of vegetation under different climatic conditions. Rising as it does from very near the level of the sea going up far beyond the snow line where the peaks are practically wholly covered with perpetual snow, thus placing a limit on the occurrence of vegetation, and extending as it does from the east where the climate is sub-tropical to the north-west it becomes markedly temperate and in places very dry, it presents a great variety of vegetation at different parts of its course from the magnificent sub-tropical rain forest to the scanty vegetation of Alpine desert. On the contrary beyond the lofty wall of the Himalaya is the highly elevated Tibetan plateau[1] with its scanty precipitation, strong dry winds, intense isolation and severe cold, presenting a very uniform set of climatic factors, with the result that vegetation is very similar over very large areas in that region.

Although the rich flora of the Himalaya has been more or less fully studied generally from the systematic point of view yet the study of the vegetation in its various aspects has not received the attention it deserves. Even from a purely systematic point of view the intensive study of the vegetation of limited areas is sure to lead to the discovery of new forms, and a study of the flora from the ecological point of view is bound to give results of the highest importance. Not only, therefore, is there room for field work by way of observation alone but experimental investigation on the lines of the work of Bonnier in the European Alps in connection with the effect of altitude on the growth of plants would no doubt be rewarded by similar interesting results.

I wish to put before you some very general observations on the Alpine vegetation of the Himalaya and Tibet as a result of my travels during the last 12 years or so. During this period I have had opportunities of visiting various parts of the Himalaya and have crossed the

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1. The Tibetan plateau near the Manasarowar Lake in Western Tibet is 15,000′ above the sea level and of course higher as we approach the neighbouring hills. It gradually falls down to the West until it is about 14,820′ at Tirthapuri and about 12,200′ at Tholing, both on the banks of the Sutlej. Beyond the Manasarowar Lake the level of the country again gradually falls towards the East. The plateau beyond the Tangla Pass is about 15,000′ and at Gyantse the level is 13,000′ above the sea.

range at nine different places from the Zojila in Kashmir in the west to the Tangla at the head of the Chhumbi Valley in the east.[2]

BOUNDARY BETWEEN INDIA AND TIBET

Although the Himalayan wall separates the southern region with its luxuriant vegetation at lower levels from the Tibetan plateau which may be termed generally a desert, yet there is no hard and fast line between the two regions so far as the vegetation is concerned in many places. Although some of the valleys like the Chhumbi Valley and the Alaknanda Valley are very rich in their flora, others like the Vishnuganga Valley in Garhwal, Chandra Valley in Lahul even the Sutlej Valley near Shipki, and the isolated tract of Spiti, possess a type of vegetation which is essentially Tibetan. The reason is, no doubt, the scanty precipitation and the low temperature in some cases due merely to the high altitude and in others to the nearness of high peaks with large glaciers. This difference is sometimes very marked even in neighbouring valleys where one would not expect it on account of their geographical contiguity. A good example is afforded by the Alaknanda Valley and the Vishnuganga Valley in Garhwal lying side by side and separated only by a ridge which were visited by me last August. The former possesses a rich herbaceous vegetation above 10,000 feet above the sea and was full of flowers occurring in large brilliantly coloured beds, whereas the vegetation in the latter was very scanty and presented a marked contrast on account of the absence of the colour present in the former.

FLORA OF TIBET

Collections in Tibet have been made by many travellers during the last 80 years or so and in 1902 Hemsley gave a very comprehensive account of the flora of Tibet or High Asia based on these collections (*Journ. Lin. Soc.* Vol. XXXV, 1902). Since then Marquand has added a considerable number to the list from Eastern Tibet from the collections made by Kingdon Ward (*Journ. Lin. Soc.* Vol. XLVIII, 1928). Similarly Ostenfeld and Paulsen have published the determinations of specimens collected by Sven Hedin (Sven Hedin, Southern Tibet, Vol 6, 1921). These, with a few other papers, give us most of the information regarding the flora of Tibet. Since travelling in Tibet presents great obstacles owing to the rigorous climate of the country, difficulties of transport and provision, etc., collections have generally been made only along the roadside and for a short period only during the year. For this reason the number of specimens collected is, even for Tibet, not large in many collections. Hemsley's comprehensive list dealing with all the collections made till then consist of 283 names of vascular plants. Excluding the species of the families Cyperaceae and the Gramineae, the number is 241. A longer stay in the country and a more extensive search would no doubt yield many more plants and although the number of plants found in Tibet must always remain very small owing to the nature of the climate yet it is certainly much

2. The range has been crossed at the following Passes from west to east : (1) Zojila (Kashmir) ; (2) Shingon La (Zanskar) ; (3) Baralacha (Lahul) ; (4) shipki La (Tibet, on the Hindustan-Tibet Road) ; (5) Mana pags, and (6) Hoti Pass, near Niti Pass (both in Garhwal) ; (7) Kungri Bingri Pass, and (8) Lipulekh Pass (both in Kamaon), and (9) Tangla (Tibet, at the head of the Chhumbi Valley). Some of these Passes have been crossed twice or oftener. The Tangla leads to Central Tibet and all the rest lead to some part of Western Tiber including Ladak.

larger than one would be led to conclude from the collections dealt with so far. The area included in Hemsley's paper is very extensive. He defines Tibet as "bounded on the east by China Proper ; on the south by the Himalaya Mountain ; on the west by the Himalaya and Karakorum Mountains and on the north by the Keria, Toguz Daban or Kuen Luen, Altyn Tag and Nan Shan Mountains. Chinese or Eastern Turkestan in the western part and Monogolia in the eastern part are the countries immediately to the north. My own collection has been restricted to the southern part of Tibet and especially of Western Tibet. This part of Tibet is more elevated and far more dry and barren than central and eastern parts and the further east we go the better developed is the vegetation. A good many specimens in my collection have not been determined as yet but even then my list from a very limited area, as stated above, excluding the families Cyperaceae and Gramineae, includes 206 as against 241 given by Hemsley from the whole of High Asia. Out of this total of 206 only 85 are found in Hemsley's list and 121 are not mentioned there. Even taking into consideration the species enumerated by Marquand from the further east and restricting ourselves only to Western Tibet we still find that out of 140 species of my collection from Western Tibet alone 68 are not given in Hemsley's list. Several families have not been recorded by him from this region and I have been able to add their representatives to the list for example Violaceae (*Viola kunawarensis*), Rubiaceae (*Galium Aparine, Galium pauciflorun*) and Convolvulaceae (*Cuscuta sp.*,) The number of species belonging to the Boraginaceae is much larger than recorded by Hemsley, being 8 against 2, and the same may be said of a number of other groups. Thus a very simple result of a more extensive study of the Flora of Western Tibet has been to increase very largely the number of plants known from that region. A complete list of the plants is issued as a supplement to this address. The term Western Tibet as used above does not include Ladak and Spiti though these parts are botanically essentially similar to Tibet proper. If they are included the number of plants would be increased still further.

A mere enumeration of species, however, gives no idea of the actual state of vegetation in any locality, or what is worse, gives a wholly wrong impression. Although the number of species from a particular locality may be fairly large, yet it does not necessarily follow that the number of individuals would be large also and it is the number of individuals, rather than the number of species, which gives a proper idea of the vegetation of the place. In Tibet the number of individuals is very small and the soil is bare throughout the greater part of it. A good many plants are met with here and there under stones and other sheltered places, whereas the open country is very sparsely inhabited, the plants sometimes growing at very great intervals. Near water, however, on the banks of the streams and lakes the vegetation is usually very thick and forms a dense carpet of grass and other small herbaceous flowering plants. In such places the Himalayan element is often very conspicuous. To give one example only, Lancea tibetica is a common plant on the Indian side at 12,000′ to 15,000′ above the sea. It is quite abundant at Kuti 13,000′ and below the Lipulekh Pass at about 15,000′ in Kuamon. It is equally abundant

in Western Tibet in moist places, at Talklakot, 13,000′ round the sacred Kailas Mountain up to 16,500′ between Tirthapuri and Dulchu. 14,500′ to 15,000′ and in Central Tibet at Dochen, 14,700′ and other similar places.

ALPINE VEGETATION AND ALTITUDE

Tree limit is reached at about 12,000′ in the Western Himalaya (Lahul, Garhwal, Kumaon, etc.) and a little higher in the Eastern Himalaya 12,500′ to 13,000′ (Chhumbi Valley etc.) Beyond this level trees are replaced by shrubs which naturally differ in different parts of the range. On the east, Rhododendrons are predominant, whereas on the west Junipersand Willows are more common. There are, of course, many other woody species in addition, as *Lonicera, Caragana* etc. An interesting feature of this vegetation is a tendency on the part of its components to form a "carpet" like their brethren in the European Alps. A "carpet plant" in the words of Newell Arber (*Plant life in Alpine Switzerland*, 1910) "is a very dwarf recumbent shrub ; one might almost say a miniature tree. The plant is woody and not herbaceous. The stem is a very short and buried in the soil. Just above the ground a very large number of long prostrate branches spread over a considerable area, packed closely together. The branches bear numerous little tufts of leaves and thus a green carpet of close texture, often occupying many square feet in extent, is woven over the soil." Such carpets are very conspicuous in, among other places, the higher parts of Sikkim for example, below Nathula at about 12,000′, where they are formed of species of *Rhododendron*, and near the source of the Alakananda in Garhwal, formed of *Rhododendron Anthopogan* and *salix sclerophylla* at a slightly higher level. The *Rhododendron* is less than a foot high whereas the *Salix* is only 3 or 4 inches above the ground, in the latter locality.

Above this level we come to the herbaceous vegetation forming beautiful beds of large extent. The composition of such beds is naturally different in different places. They may consist merely of one or more grasses in the main or of flowering herbs of various kinds and colours, pure or mixed. These beds can be seen anywhere from the higher *margs* of Kashmir to the level spots in Sikkim in the whole range of the Himalaya. It goes without saying that local conditions regarding moisture and soil, etc., would manifest their effects by varying not only the altitude at which the various types occur but also the nature and composition of the vegetation.

FLOWER COLOUR AND SIZE IN ALPINE PLANTS

It has been accepted for a long time that in case of plants occupying a large vertical range the plant becomes practically dwarfed as its higher limit is approached. We shall, however, observe that what is lost in luxuriance of leaf and length of stem is compensated for often by increase in size and almost always by heightened colour of the flower. (Walton, *Flowers from the Upper Alps,* 1869). It is certainly true of the Himalayas that many species become dwarfed as they ascend higher and higher. Such a well-known common plant as *Chenopodium album* which may reach a height of 8 or 9 feet in the plains is reduced to an inch or two at 14,000′ or so at the adult flower-bearing stage. The second

part of the above statement, however, cannot always be so clearly demonstrated. Many plants become larger as they ascend, upto a certain limit, and at the same time bear larger flowers. So much depends on the amount of moisture and shelter that mere altitude is no guide at all in many cases. *Anemone regularis* was particularly observed in this respect in Garhwal. Up to about 10,000′ the plants grow bigger and many measurements showed that the flowers on the whole reached a larger size than those met with at lower levels. Occasionally large flowers were met with at lower levels also just as small flowers occurred at a higher level, but the number of large flowers at higher levels was very much larger and the absolute maximum size of the flowers was also greater at the upper limit.

Another phenomenon connected with the form and size of the flower is met within some plants at about 10,000′ and above. This is the replacement of the flower or the tertile shoot by vegetative shoots. Its significance in connection with the Alpine habit, however, is not yet known. I have noticed it in three different species. In *Euphorbia tibetica*, branches which would ordinarily end in cyathia are often replaced by vegetative shoots with ordinary leaves. It is a common enough observation in Western Tibet at about 13,000′ and was described by me at one of the meetings of the Congress in the Botany Section a few years ago. A second case is that of *Anemone rivularis* in which this abnormality is exceedingly common in the Western Himalaya at about 10,000′. Here in extreme cases the whole flower is replaced by a large tuft of green leaf-like structure. In less developed cases the carpels remain undeveloped and the sepals and stamens are modified into green leaves. In still other plants the stamens and carpels are undeveloped and the sepals are larger and more or less green in colour. The third case is that of *Rhododendron lepidotum* which possesses purple-coloured flowers. The abnormality was first seen in Sikkim at about 12,000′ where it is very common. In this case the flower is replaced by a tuft of red leaves. These examples can hardly be due to a coincidence but their significance, as stated above, is unkonwn.

As regards the intensity of colour it is difficult to pronounce any judgment. Species of *Potentilla* (especially *Potentilla argyrophylla*) and *Anemone* were observed but no appreciable difference could be detected. Arber says (*loc. cit.*, page 44) "It has been shown repeatedly that the pigment which is contained in the petals and to which the colour is due increases in intensity as we pass from the plains to the Alpine zone. While this is the general rule for all colours as well as blue it does not hold good in every case." He has also quoted figures giving the number of species with different colours of flowers. As pointed out above the enumeration of species does not always give us the true conception of the state of things. The number of species with a particular flower colour may be large yet the individuals may not be many and the flowers may not be very conspicuous. The percentages given (after Dr. Fisch) are, 30 percent white-flowered species to 27 per cent yellow-flowered, and 19 percent red-flowered and 24 per cent violet-or blue-flowered. Le Coq (quoted by Walton) after arranging Phanerogamous plants under four heads yellow, red, white and

blue, observes that the yellow decreases considerably, red slightly while the white are constant and the blue greatly increased. The flower beds at higher altitudes in the Himalaya as elsewhere show a mixture of colour yellow, red, blue, white, with intermediate tints, but in some cases there are almost pure beds of one colour belonging to one species covering large areas. In the Alaknanda Valley at about 12,000′ to 13,000′ there are bed consisting almost wholly of *Potentilla eriocarpa* or *Potentilla Sibbaldi* (both yellow) the former with medium-sized solitary flowers and the latter with clusters of small flowers covering hundreds of yards at a place. Simlarly in the upper Chhumbi Valley one finds small pure patches of Prigmulas especially a species with light yellow flowers. Whenever there is a mixture, the yellow seems to predominate both as regards the number of individuals as well as the conspicuousness of colour. Red and blue are both well-represented, the former usually more so than the latter but the white is not so conspicuous.

A few example may be given showing the predominant species with their flower colour :

1. Top of the Baralach Pass (Lahul), 16,200′ July and August, 1928

1. *Saxifraga sp*	Yellow
2. *Ranunculus sp*	Yellow
3. *Sedum sp*	Yellow
4. *Potentilla sp*	Yellow
5. *Draba sp*	Yellow
6. *Primula sp*	Blue
7. *Pedicularis sp*	Red
8. Crucifer	White
9. Caryophyllceous	white

The first three give the characteristic colour to large areas.

2. Top of Shingon La (Zanskar) about 17,000′ August 1928

1. *Corydalis sp.*	Yellow
2. *Corydalis sp.*	Yellow
3. *Saxifraga sp.*	Yellow
4. *Pedicularis sp.*	Yellow
5. *Draba sp.*	Yellow
6. *Potentilla sp.*	Yellow
7. *Gentiana sp.*	Blue
8. *Delphinium sp.*	Blue
9. *Polygonum affine.*	Red
10. *Oxyria digyna.*	Red
11. *Epilobium sp.*	Pink
12. *Composite.*	White

Yellow was the predominant colour.

3. Chakra-tirath, near the source of the Alaknanda (Garhwal), about 13,000′ to 14,000′ August 1931

1. *Potentilla argyrophylla*	Yellow to scarlet with all the intermediate stages, various shades of orange etc.
2. *Potentilla Sibbaldi*	Yellow
3. *Potentilla eriocarpa*	Yellow
4. *Saxifraga flagellaris*	Yellow
5. *Ranunculus hirtellus*	Yellow
6. *Polygonum affine*	Red
7. *Oxyria digyna*	Red

8. *Saxifraga Stracheyi*	Pink (Flowers nearly over)
9. *Sedum sp.*	Red
10. *Geranium Wallichiannum*	Blue
11. *Primula sp.*	Blue
12. Boraginaceous	Purple

Yellow colour was most predominant and red also quite conspicuous. *Potentilla argyrophylla* was particularly abundant in all the various shades from bright yellow through various grades of orange to brilliant red.

4. Head of Chhumbi Valley, a few miles before Phari, about 14,500′, July to August, 1930.

1. *Ranunculus sp.*	Yellow
2. *Primula sp.*	Yellow
3. *Corydalis sp.*	Yellow
4. *Corydalis sp.*	Blue
5. *Aster sp.*	Blue
6. Labiate.	Blue
7. *Polygonum viviparum.*	Pink to red
8. *Epilobium sp.*	Pink
9. *Geranium refractum.*	Pink to red
10. *Pedicularis sp.*	Red
11. *Leontopodium alpinum.*	White
12. *Anaphalis sp.*	White
13. A few more yellow and White Compsitae	

The beds showed a mixture of the various colours. The predominant yellow colour was due to No. 1, red colour due to Nos. 7, 8 and 9 and blue to Nos. 5 and 6. Some of them were found in pure beds. All the colours were about equally conspicuous.

In Tibet there is practically never any massed colour effect. There are sometimes isolated patches of individual plants or of small clusters of plants showing a particular colour. Species of *Corydalis, Aconitum, Sedum, Pedicularis, Meconopsis*, etc., are examples. *Ranunculus aquatilis* with its white or cream flowers with a yellow center, however, occurs in large patches in water and is the famous lotus of the holy lake Manasarowar. *Arenaria musciformis*, wherever found forms conspicuous cushions, scattered over large areas, easily seen from a distance on account of its fairly large white flowers. Similarly *Astragalus melanostachys* with its blue flowers forms even more conspicuous tufts and covers even larger areas in Central Tibet. *Stellera Chamaejasme* is another conspicuous plant in some localities with its tufts of branches and peculiar coloured flowers which are white above (inside) and purple below (outside). As pointed out by the writer (*Journ. Ind. Bot. Soc.,* Vol. IX, No. 4, 1930) the colour of the flower in this plant is not yellow as stated by so many authorities. The mistake has no doubt arisen owing to the fact that the flower becomes yellow on drying and even leaves a yellow stain on the mounting paper.

Near water, however, the vegetation forms dense carpets and here again the yellow *Ranunculus Cymbalariae* is the commonest plant. *Potentilla anserina* (yellow) is also fairly common and *Polygonum sibiricum* (pink) is abundant. *Lancea tibetica* with its purple flowers is met with here and there. Many other plants grow in smaller numbers. The predominant colour, however, is again yellow. Over very

large areas in Tibet we find only scattered tufts of grass or of some other flowering plant without any sign of any other colour but green or grey of the vegetative shoots.

A curious feature in connection with the colour of flowers is the occurrence in some plants of very dark almost or quite black colour in Tibet. The flower of *Clematis orientalis* is usually described as yellow or purple, but very dark, almost black flowers are very common in Western and Central Tibet. In some places, Taklakot in Western Tibet (13,000′) and near Khangma on the road to Gyantse in Central Tibet (about 13,000′) the writer found flowers of this colour only in all the plants. Yellow-flowered plants were met with at Tirthapuri in Western Tibet (14,800′). Similarly the glands on the involucre of *Euphorbia tibetica* which is abundantly met with in Ladak and Western Tibet are black. Black colour is exceedingly unusual in plants and its occurrence in two Tibetan species is noteworthy.

A large number of alpine plants in the Eastern Himalayas have pendulous flowers directed downwads or at least horizontally. This is no doubt an adaptation against rain. Some of them though not actually pendulous at first become pendulous by the force of the rain drops. This phenomenon is shown conspicuously by many species of *Primula, Polygonum, Geranium* and *Anemone*. In other cases the flowers close immediately on the approach of the moist weather. This is shown conspicuously by the species of *Anaphalis*. Pendulous flowers are not so common in the Western Himalayas as they are on the Eastern side, apparently associated with a lower rainfall. This phenomenon is well-known in the European Alps also.

COMPOSITION OF ALPINE PLANTS

Certain families are much better represented in Alpine regions than others. Families like the Compositae, Leguminosae and Gramineae would naturally include a large number of Alpine plants on account of the large size, but the same cannot be said of others like the Primulaceae, Gentianaceae and Polygonaceae which have a disproportionately large share in Alpine vegetation. Again, some genera like *Astragalus, Oxytropis, Arenaria, Draba, Potentilla, Saussurea* and *Polygonum* are very largely represented in the flora of the higher altitudes. This distribution would lead to the conclusion that a tendency towards adaptation to a cold and dry habitat is not due to haphazard variation in isolation species but is more deep-seated in circles of wider affinity and becomes manifest during the course of evolution in all the branches of the evolving group–the genera of a family or the species of a genus. I am afraid I cannot pause of follow this subject further.

ALPINE PLANTS IN THE PLAINS

Bonnier's experiments on the changes produced in alpine plants when cultivated in the plains and *vice versa* are well-known. He has been able to show that in many cases plants from one locality when grown in the other tend to acquire the characters of the plants of the second locality. So far as I know no such experiments have been tried with Himalayan plants. A number of seeds from the Western Himalaya and Tibet were germinated by the writer at Lahore three years ago. Some of them

died after a short time. Among those which have survived there is a species of *Ephedra*, apparently E. *vulgaris*. The seeds of this plant were collected in Zanskar at about 12,000' in August, 1928. They were sown in October the same year gemminated readily after a fortnight and went on growing for a little more than a month. Then they became dormant till next February and resumed the growth towards the end of that month when winter was over. Winter is the resting season in Zanskar and the seedings stuck to the habit of the parent plants in the first year. Since then, however, they have found that winter at Lahore is the more favourable season for growth and summer is the resting time. Growth is quite active in winter now and it stops during the hot months of summer—an undoubted adaptation to new conditions. The plants are still under observation and interesting results may be expected.

HABIT OF TIBETAN PLANTS

A good deal has already been said about this part of the subject by various writers. In my Presidential address to the Indian Botanical Society at Benares, published in the journal of the *Ind. Bot. Soc.*, Vol. IV., Nos. 9 and 10, 1925, I said something about the subject. The number of annuals in Tibet is very small just as their size is small owing to the short growing season, i. e., summer. The perennials have a long tap root and an underground woody root-stock which remains alive in winter while the aerial parts are killed. Another common feature is the small size of the leaves which are often thick or hairy. Some of the commonest plants are spinous. As already stated the plants are met with scattered on the surface with large bare intervals between them except when the plants are growing on the banks of a stream or lake and sometimes when they are growing under stones getting sufficient, protection aginst the desicating effect of the dry cold winds. Several stolon-bearing plants are common in most places both in Western and Central Tibet. They strike the eye on account of their long slender arms reaching out in all directions. *Potentilla anserina, Saxifaga flagellaris* and another undetermined species met with at Dochen (14,700') in Central Tibet, are examples. The most characteristic feature, however, of the Tibetan vegetation which strikes the eye is the cushion habit of many of the species which in its less-developed degree takes the form of fruits. In many cases the cushions are exceedingly compact so that from the ouside there is hardly any trace of branches and even of leaves. There are of course intermediate grades between loose tufts and compact cushions. Among the latter may be mentioned *Thylacospermum, rupifragrum, Arenaria musciformis, Androsace sp., Astragalus sp.* and *Caragana pygmaea*. Of these Thylacospermum. *Araneria* and *Astragalus* form the densest cushions. *Androsace* is very compact when growing in the soil but when the plants are taken out of the soil the branches usually become loosened and the cushion breaks up. Among the tufted plants there are many species of *Astragalus* and *Oxytrpis, Stellera Chamaejasme, Artemisia sp. Urtica hyperborea* and some species of *Caragana* etc. *Astragalus melanostachys* and *Urtica hyperborea* are the commonest tufted plants in Central Tibet.

The cushion habit is a very efficient adaptation on the part of the plants against the intensely cold winds of the country. The compact branches and the small, often minute, leaves are effectively protected in this way. Any projecting branch would be killed in a very short time. The annual growth naturally is very slight.

This cushion habit is also met with occasionally on the south side of the Himalaya (apart from the dry valleys mentioned before) but usually it is not so well-developed. In some cases this is not so much due to the effect of cold as to grazing by sheep and goats. The species of Fraxinus is ordinarily a tree with the usual tree habit but owing to excessive grazing when it grows on the roadside it forms a dense cushion and sometimes a part of it may be able to grow into an erect branched tree whereas the rest of it forms a cushion lower down. Perhaps the cushion habit in Tibet also, in some cases, may have something to do with grazing by innumerable herds of yaks, sheep and goats, but there is no doubt that in the main it is an adaptation against the intensely dry cold winds.

Another interesting problem is the occurrence of small-leaved and markedly xerophilous plants and very broad-leaved plants side by side. This is the case in some parts of Central Tibet where *Astrangalus melanostachys* is found growing side by side with a broad-leaved erect *Senecio* and *Urtica hyperborea*. Similarly the very broad-leaved *Senecio Ligularia* grows in the open near Phari at 14,500′. The tall *Rheum nobile* with its five feet or more of height and large broad leaves and bracts grows side by side with *Saussurea gossypiphora*, only a few inches above the ground and closely covered with a dense wool of hairs, on the Jelepla and Nathula in Sikkim above 14,000′. The explanation probably lies in the fact that the broad-leaved stems exist only in summer and are not present during the unfavourable period of the year. It also illustrates clearly what has been demonstrated by Maximov and others that drought resistance does not depend on leaf surface or the rate at which water is transpired and that it is more a property of the protoplasm itself (The *Journal of Ecology* : Vol. XIX, page 281, 1930). A wide field of research lies open in this direction in connection with the study of structure of the various parts of Alpine in relation to the environment.

MAXIMUM ALTITUDE FOR VEGETATION

Hemsley states that according to the figures given in his paper nearly half of the Tibetan species in our enumeration have been collected at 16,000′ and upwards. Whether these figures are very exact or not they go to prove that there is no altitudinal limit to flowering plants except perpetual snow. There can be no question about the truth of this conclusion. He has, however, recorded only six species which were known to occur above 18,000′. The Mount Everest Expedition has found plants at 20,000′ or even higher. Mr. Wollaston of that expedition mentions species of *Leonotopodium* and grasses at 20,000′ and *Arenaria musciformis* on 20,100′ (The *Reconnaissance*, 1921). I collected no less than 18 species between 18,500′ and 18,600′ on the Damala which was crossed during the circumambulation of Holy Kailas Mountain and it is probable that more than 31 other species

also could grow at this altitude as these were found on the way to the pass between 16,500′ and 18,600′. The following is a list of the species met with on the Pass between 18,500′ and 18,600′.

1. *Ranunculus pulchellus* C. A. Mey.
2. *Ranunculus lobatus* Jacq.
3. *Draba alpina* L.
4. *Cochlearia scapiflora* H.f. et T.
5. *Braya alpina Strenb*. et Hoppe.
6. *Thylacospermum rupifragum* Schrenk
7. *Arenaria musciformis* Wall.
8. *Stellaria decumbens* Edgw. var. *pulvinata.*
9. *Astragalus sp.* (probably a. *confertus* Benth.)
10. *Potentilla fruiticosa* var. *ochreata.*
11. *Potentilla nivea* L.
12. *Sedum asiaticum* DC. var. *wallichianum.*
13. *Senecio (Cremanthodium) goringensis Hemsl.*
14. *Saussurea stolicazkai* Clarke.
15. *Allardia glabra* DC.
16. *Leontopodium alpinum* Cass.
17. *Androsace Poissonii* Knuth.
18. *Lloydia serotina* Reichb.

and some grasses.

SOME FACTS OF PECULIAR DISTRIBUTION

Although there is nothing unusual in what is described below in connection with the distribution of plants, a few cases of peculiar distribution of certain cushion plants are mentioned as interesting, *Acantholimon lycopodioides* forms large dense cushions and has spinous-tipped leaves. It is common in Ladak and Zanskar but was not met with beyond the Baralacha Pass towards the east. *Thylocospermum rupijragrum* is very common in Ladak and western Tibet at about 15,000′ and above. The Phirtse La Pass leading from the Lingti sumdo to Zanskar at some distance below the top, espcially on the Lingti side, has numerous cushions of this plant scattered over a large area. This place shows the best development of the plant so far seen by the writer. The plant of course is common in other places in Western Tibet also, scattered about on the ground or growing on the Damala Pass at 18,500′ among stones. It can hardly be distinguished from the stones in the photograph. It becomes scarce further east at 15,000′ to 16,000′ and below. *Arenaria musciformis* is common both in Western and Central Tibet. Its dense cushions are met with scattered over large areas and the white flowers are very conspicuous from long distances as already mentioned above. This was one of the plants found on the top of the Damala at 18,600′. *Androsace sp.* are also very common in Western and Central Tibet. They require further examination for their full determination. A very compact species of *Astragalus* has been seen only in Central Tibet. It has not been found possible to name it so far. Some of these cushion plants belonging to different species grow not only side by side but actually into one another so that it is impossible to seperate them without breaking the cushions. This is particularly true of specious of *Andrasace* and *Arenaria musciformis*.

ORIGIN OF THE TIBETAN FLORA

Some people have given Central Asia great importance in connection with the origin of the Alpine plants. Arber states (*loc. cit.*, page 305-306), "It has been urged that Central Asia was the origin of the Alpine Flora." Hemsley says, "No arguments are required to prove that the Tibetan is a derived flora ; that is to say, derived since the tertiary period ; and its composition is so largely Himalayan that there can be little doubt as to its origin." This would seem to imply that Tibet was bare at some time when the Himalaya was covered with vegetation. The high altitude of Tibet makes this very improbable. The upheaval of the Himalaya and Tibet must have developed simultaneous and the vegetation also must have developed simultaneously. Marquand very recently has remarked (*loc. cit.*) "Material available now makes it quite clear that one homogeneous flora extends from Sikkim to Eastern Tibet and the whole of the Eastern Himalayas, South-Eastern Tibet and Western Szechuen as well as the upper portions of Yunnan should be considered as one botanical area." Central Tibet is not sharply marked off from Eastern Tibet with its more luxuriant vegetation on the one hand and from the higher-and wilder Western Tibet with its scanty vegetation on the other. The latter possesses a much more rigorous climate but it cannot be said that the Flora of Western Tibet has had a different origin. It possesses a smaller number of plants, more highly adapted to more unfavourable conditions than their eastern relatives. The flora of Western Tibet must naturally be poorer as fewer plants can be expected to adapt themselves to extreme conditions.

Considering all the data it would be more in accordance with facts to say that the flora of the Himalaya and Tibet and Western China have had a common origin and differentiation gradually took place as the Himalaya and the Tibetan plateau gradually rose from the sea level to become the highest region in the world.

THE GIFTS OF PHYSICS TO MODERN MEDICINE

Sisir K Majumdar*

Discoveries of basic principles of physics have been translated into developments of many instruments. Many of these equipments were later found to be essential for diagnosis and treatment of a large number of diseases. Usefulness of X-rays, Magnetic Resonance Imaging, Ultrasound, Tomography, Laser radiations and different spectroscopic techniques in modern medicine are briefly discussed in the article.

INTRODUCTION

The advancement of medical science was, and is, and will always be dependent on the progress of fundamental sciences like mathematics, physics and chemistry. It is true that pure science is not rapidly converted to applied science. That has always to depend on further technological advancement and on craftsmen's innovation. The role of physics in the evolution of some modern medical equipment–both diagnostic and therapeutic, is simply unique. A chemical pathology laboratory comprises overall physics (i.e. laboratory machinery, pressures, radioactivity, voltage, etc.)

'The Book of Nature is written in Mathematical Characters'–said Galileo Galilei (1564–1642) and nothing is static in nature ; nature is dynamic. That earth moves around the sun (helio-centric, Greek 'helios'–'sun') was the discovery of Nicolaus Copernicus (1473-1543). Nature is in motion. William Harvey (1578-1657) was influenced by both Galileo and Copernicus ; blood is not static inside the body ; it circulates. A physician's mentor were the astro-physicists. Here lies the importance of fundamental sciences in the making of modern medicine. The year–"1543" is the "Anna Mirabilis" in the relationship between Natural Sciences and Medical Sciences when "De Revolutionitus Orbrium Coelestium (On the Revolution of Heavenly Bodies) of Nicholaus Copernicus and "De Humani Corporis Fabrica Libri Septem" (The Seven Books on the Structure of the Human Body) of Andreas Vesalius (1514-1564) were published. It was an auspicious year. The Evolutionary Tree of Medicine is given in ANNEXURE.

The discoveries of eminent physicists like Wilhem Conrad Roentgen (1845-1923), First Nobel Laureate in Physics in 1901, Albert Einstein (1879-1955), Nobel Laureate in Physics in 1921, and Georg Von Bekesy (1899-1972), Nobel Laureate in Physiology on Medicine in 1961 made significant contribution to the development of many essential medical equipments. Medical men like Niels Ryberg

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Finsen (1860-1904), Nobel Laureate in Physiology on Medicine in 1903, and Willem Einthoven (1860-1927), Nobel Laureate in Physiology on Medicine in 1924 also applied principles of physics in the development of medical instruments used in both therapeutic and diagnostic fields.

MEDICAL EQUIPMENTS

X-RAYS

X-rays are invisible electro-magnetic readiation having a much shorter wavelength than light, 10^{-9} metre. It was discovered by Wilhelm Rontgen in 1895. Originally this was called Rontgen rays. An anatomist, Rudolf von Kolliker (1817-1905), who was the subject at a lecture demonstration by Rontgen, proposed that the rays be called 'X' and they susequently received the discoverer's name. They produced by transitions of electrons in the inner levels of excited atoms or by rapid deceleration of charged particles. A common means of production is by firing electrons into a copper target. X-rays are useful in medicine since different components of the body absorb x-rays, to a different extent, but enough radiation passes through the body to register on a photographic plate beyond. Unlike light and heat waves, X-rays pass through wood, metal and other materials.

Being an avid photographer, he set up a film before the screen, laid his wife's hand on the plate, and got the world's first x-ray picture, showing both bones and the wedding-ring ! Weeks later (December 28th, 1895) he sent a report to the scientific academy (Medical–Physical Society) in Wurzburg- 'On a New Kind of Radiation' (Ubercine neue Antvon Strahlen) : It was his first communication. The second on January 13th, 1896, was in Berlin in the presence of Kaiser Wilhelm II. The last time he spoke in public on the subject of x-ray was again in Wurzburg on January 23rd, 1896. At the end of the presentation his friend Professor von Kolliker lent his hand for the production of a radiography in front of the audience. On March 9 and 10, 1897 Rontgen published two other papers on this subject. That was all ...

The news of Rontgen's discovery spread, at first by the press. On January 2, 1896 Röntgen sent a reprint of his report of December 28, 1895 to his fellow physicists, including Franz Serfin Exner (1849–1926) in Vienna, Frederich Wilhelm Kohlrausch (1840 – 1910) in Göttingen, Henri Poincare (1854–1910) in Paris and Arthur Schuster (1851–1934) in Manchester. The information spread from friend to friend, and Exner passed it to Ernst Lecher (1856–1926), son of the editor of the Freie Presse of Vienna. This is the reason why the first public mention of the discovery of x-rays was published in Vienna on Sunday, January 5, 1896 in the Freie Presse. From these, a small number of European daily papers became aware of the discovery, the first London publication appeared in Monday's Daily Chronicle. On January 6, 1896 a cable from the Evening Standard Correspondent informed the rest of the world. The first notice of Röntgen's discovery in a scientific periodical was published on January 8, 1896 entitled 'Electrical Photography Through Solids' in the Electrical Engineer of New York. The test was the one used for the international news. On January 11,

1896 the same information was published in the medical press–both in the Medical Record of New York and the Lancet of London.

Röntgen took no patent on his work, and it is a tragedy that the died in some poverty in the period of high inflation in Germany after the World War I (1914–1918).

The tentative applications of x-rays marked the beginning of diagnostic radiology. They were promoted by a break-through some months after Röntgen's discovery : the discovery of 'radio-active' materials (uranium salts) that generate rays spontaneously by Antoine Henri Becquerel (1852–1908), Pierre Curie (1859–1906) and Marya Skoldowska Curie (1867–1934), who jointly won the Nobel Prize for Physics in 1903. Radiotherapy (later used to treat cancer) began with Becquerel's observation that radium carried in his pocket produced a burn. This S I Unit of radioactivity is the Becquerel unit (Bq) defined as an activity of one disintegration per second. Marie Curie was awarded the Nobel Prize for Chemistry in 1911 for her discovery of polonium and radium–till today she happens to be the first and only double Nobel Laureate in two science subjects–Physics and Chemistry (also the first lady Nobel Laureate).

Satiric Poem in 'Punch' Magazine, London in 1896 :

"O Röntgen, then the news is true, and not a trick of idle rumour that bids us each beware of you, and of your grim and graveyard humour. We do not want, like Dr Swift, to take our flesh off and to pose in our bones, or show little rift and joint for you to poke your nose in".

OTHER RAYS

Many more kinds of beams were gradually recognised, including electro-magnetic waves (such as radio, X-rays and gamma rays) as well as particles like electrons and neutrons. In time, rays of varying energy could be produced by sources ranging from low-voltage X-ray tubes to high voltage linear accelerator on radiactive elements like cobalt. The world of atoms and nuclei was brought into service of medicine. Recently, Electron Beam Tomography (Greek 'tomo'–slicing) EBT, is used to assess the vascular health of the heart.

ULTRA SOUND

Modern medical ultra-sound has its origin in the work on marine SONAR (SOund NAvigation and Ranging), during the First World War. Ultrasonics is the branch of physics dealing with the theory and application of ultrasound : sound waves occurring at frequencies too high to be heard by the human ear (that is above 20 kHz). During 1930's experiments were initiated into the possibility of using these high frequency sound waves for medical diagnostic purpose.

All sound waves consist merely of mechanical vibrations conducted through a medium. Audible sound waves fall in the range of 20–20,000 cycles per second (termed hertz or Hz) ; frequencies above this level are called ultrasound. The frequencies employed in medical diagnostic and therapeutic devices normally lie in the range of 1–10 million Hz (1-10 MHz). At this frequency, the sound can be focused in as much the same way as light. Despite its high frequency, the sound is still conducted merely as mechanical vibrations within the tissues and is therefore

devoid of the potentially damaging ionisation associated with x-rays. As the sound travels through the tissues it is partly reflected at any point where there is a change in tissue density, the strength of the echo being proportional to the density change at the interface. As the sound travels at a constant speed in soft tissues, echoes occurring from deeper structures take longer to return to the surface and thus the depth and direction of the tissue giving rise to an echo can be determined by appropriate electronic detector inter faced to a computer. Accurate representation of the structure of body organs (medical scanning) can be made. It is produced and detected by high frequency transducers.

Echo aortography is the application of ultrasound techniques to the diagnosis and study of the aorta, particularly the abdominal aorta. Echo cardiography is the ultrasound cardiography using ultrasound in the investigation of the heart and great vessels and diagnosis of cardio vascular lesions, espcially mitral disease, pericardial effusion, and abdominal aortic aneurysm. Doppler ultrasonography techniques are used to augment two dimensional echo cardiogram by allowing velocities to be registered within the echo cardiographic image. Echo encepalography uses reflected ultrasound in the diagnosis of intracranial processes.

TOMOGRAPHY IN NUCLEAR MEDICINE

Tomography (Greek word–'tomos'– a cutting (section) and 'grapho' – to write) is a technique using x-rays on ultrasound in which a clear image of structures in a single plane of body tissues at a particular depth is achieved.

It is sectional roentgenography–planigraphy, planography, stratigraphy and laminagraphy taken by having the X-ray tube in a curvilinear motion synchronous with reciprocal film motion while the patient remains motionless ; the selected plane for imaging remains stationary on the moving film while structures in all other planes have a relative displacement on the film and therefore obliterated or blurred.

Computerised axial tomography (CAT) is a method of obtaining a three-dimensional view of the interior of an object by building up a series of sectional views. It is an elaboration of X-ray techniques. X-ray image is two-dimensional.

Positron Emission Tomography (PET) is tomographic imaging of local metabolic and physiological function in tissues, the image being formed by computer synthesis of data transmitted by positron-emitting radionuclides often incorporated into natural biochemical substances and administered to the patient ; a computer traces the path of photons (produced by collision of positrons emitted by the radio-active biochemical with the negatively charged electrons normally present in the tissue cells) and produces a composite image, often in colour, representing the metabolic level of the biochemicals in the tissues, as an indicator of the presence or absence of disease.

Single Photon Emission Computed Tomography (SPECT) is imaging of local metabolic and physiological functions in tissues–the image being formed by computer synthesis of data transmitted by single gamma photons emitted by radionucleides administered in suitable form to the patient.

MAGNETIC RESONANCE IMAGING (MRI)

Electrons in motion produce a magnetic field. In a permanent magent, such as a horseshoe magnet, the field is generated by electron spinning inside the atoms of the magnet. In an electromagnet (a temporary magnet) the field is generated by electrons flowing from atom to atom through wires (an electric current). Such a field is called electromagnetic field. MRI is the technique using a magnetic field to cause resonance within atoms, producing an image by means of the resonance.

Patient lies on a bed placed inside a powerful electromagnet, whose field is of the same frequency as of hydrogen—the element most common in living tissue (H_2O = Hydrogen Oxide). Hydrogen is everywhere in the body, and it is detected everywhere, but its concentration varies greatly—very little in bone, more in muscle, more in certain glands and less in others, a great deal in blood, even more in urine and so on. This varying concentrations is detected, stored by a computer and analysed and made into a computer-graphic picture. By changing the direction of the magnetic field continually, obtaining numerous pictures, a three dimensional image is obtained. MRI is non-invasive and relatively harmless.

Magnetocardiography is measurement of the magnetic field of the heart ; produced by the same ionic currents that generate electrocardiograms, and shows the characteristics—P, QRS, T and U waves. Magnetoencephalogram (MEG) is gausstime ('gauss'—a unit of magnetic flux density named after the German physicist and mathematician Karl Frienderich Gauss (1777–1855)—equal to one ten–thousandth of a 'tesla'—the unit of magnetic flux density in the SI (Systeme International) System named after the US electrical engineer–Nikola Tesla (1856–1943). Magnetoencephalography is the process of recording the brain's magnetic field. Magnet is also used in therapy (magnetotherapy).

Nuclear Magnetic Resonance (NMR) uses the nucleus of a single atom which has its own natural frequency. Frequency of hydrogen nuclei is different from that of oxygen. Because every kind of atomic nucleus responds (resonates) to its own unique frequency, these frequencies are signatures of the atomic elements in a mixture. With the added use of a strong magnetic field, substances can be analysed for their composition, a process called nuclear magnetic resonance. NMR is harmless and can be used to assess the physiological and biochemical functions of different organs. Metabolism and utilisation of oxygen and glucose can also be assessed by this method.

LASER

The name 'Laser' is an acronym of 'Light Amplification by Stimulated Emission of Radiation'. It is a system of coherent amphification of energy ; it is a device which produces visible, infrared or ultraviolet radiation with special properties, using a system of excited atoms. The first working model of Laser was built in 1960 by the US physicist Theodore Harold Maiman (1927–), following theoretical work by Charles Hard Towanes (1915 -), Nobel Latreate in Physics 1964 for development of MASER (Microwave Amplification by Stimulated Emission of Radiation) and Arthur Leonard Schawlow (1921 -), Nobel Laureate in

Physics in 1981. Atoms absorb energy in well-defined amounts, raising electrons to excited states ; the electrons are said to move from one energy level to a level of higher energy. An atom is a unit of matter, consisting of a nucleus of positively charged protons and unchanged (neutral) neutrons, orbited by negatively charged electrons. A complete atom has the same number of electrons as protons balancing the charge. After being excited, an electron usually returns to its original level after less than 10^{-8} seconds, releasing energy as photon of light.

Photon is the quantum or particle of light–a particle that carries the energy in visible, x-rays and other forms of electro-magnetic radiation. Eectro magnetic radiation comprises a stream of photons. If photon of energy similar to that of another photon about to be released strikes the excited atom, then the photon production is more rapid ; this is called 'stimulated emission' after Einstein's work in 1917. The result is two photons identical in phase moving in the same direction. Should these photons themselves interact with more excited atoms, eventually a cascade of identical photons will be produced, all moving in one direction. Laser action depends on the choice of special atomic systems for which an energy supply is able to raise a large number of atoms to excited states, ready to emit photons when stimulated. Mirrors at either end of the 'Laser' reflect light end-to-end inside the 'Laser' to maintain its action. At one end, the mirror is partially transparent allowing a portion of light to escape to produce a Laser beam. Typically, energy is supplied to the 'Laser' by electrical discharge or a powerful light source to pump the atom to excited stotes.

'Laser' light is monochromatic (all one colour), coherent in step, produced as a beam which does not spread, and travels large distances undiminished in intensity. The light is produced either as a continuous beam or as pulses.

'Laser' has got many uses ; in medicine it is used on phototherapy, eye and brain surgery, and in other aspects of surgery. 'Laser' waves have high energy–can be focused to a microscopic point and are perfectly sterile, and cause minimal bleeding and scarring.

Medical 'Lasers' are made mainly of carbon dioxide, argon or materials like neodymium and YAG (Yttrium–Aluminium–Garnet). They cut tissue rapidly by heating and coagulating it, or by producing photochemical reactions. Some of these optical 'knives' or 'cauters' are employed in eye surgery, while others penetrate more deeply for tumour treatment. The beam can also be aimed from inside the body with endoscopy. However, 'Lasers' will never fully replace the mechanical scalpel, but their uses are expanding steadily in all fields of surgery.

Interestingly, it was Einstein who unveiled the fundamental theoretical basis of 'Laser' first in 1905 in his Nobel Prize-winning work–'On a Heuristic Point of View Concerning the Production and Transformation of Light' (Annalen der Physik, Vol 17, p891, 1905 - all his five epoch-making papers were published in the same volume : 1905–Anna Mirabilis of Einstein) and then elaborated it in 1917. This turned out to be his sole contribution to medicine. The practical application of his photoelectric theory has been the "electric eye" used for opening and closing doors by remote control,

for detecting intruders, for counting and sorting goods and for making radio and television possible. US experimental physicist – Robert A. Milikan (1868–1953), Nobel Laureate in Physics, 1923, confirmed Einstein's theory of the photoelectric effect.

ELECTROCARDIOGRAPHY

Einthoven devised a sensitive string galvanometer by using a fine wire stretched between the poles of a magnet. When a current passed through the wire it was deflected, and optical system magnified this for recording. Electrocardiography is the investigation of the electrical activity of the heart. The electric voltages produced by heart beats can be recorded from the surface of the skin in the form of an electrocardiograph (ECG). Electrodes are attached to the skin of the limbs and chest, and voltages of between various pairs of electrodes are recorded on sensitive electronic machines. Einthoven made electrocardigraphs (ECG's) from the chest wall and from contacts on the arms and legs, and described his results from 1903 onwards. Einthoven and others (especially Thomas Lewis of University College Hospital, London) related the ECG tracings to clinical data for coronary artery disease and other heart diseases. This became an important diagnostic method, and Einthoven won a Nobel Prize in 1924. Electrocardiography is second only to the X-rays discoverd by Rontgen in importance among the physical methods used in clinical medicine.

FIBRE-OPTIC ENDOSCOPY

In 1868, Oesophagoscope and gastroscopes (half a metre long pipe fitted with a light and lenses) were introduced. Light conduction was a formidable obstacle for endoscopes. It was solved when transmission along aligned bundles of specially coated flexible glass fibres was achived [(H H Hopkins and Kapany NS–A flexibile fibrescope, using static scanning. Nature (Lond.) Vol. 173, p39-41, 1954)]. In 1954, Hopkins and Kapany summarised their achievement and introduced new terminology : '..... an optical unit has been devised, which will convey optical images along a flexible axis. The unit comprises a bundle of fibres of glass, or other transparent material, and it therefore appears appropriate to introduce the term 'fibrescope' to denote it. An obvious use of the unit is to replace the train of lenses employed in conventioanal endoscopes'.

At present, endoscopes, some with electronic devices like video, are used extensively for both diagnostic and therapeutic purpose. Many more ingenious developments and applications of the technology are currently at the point of availability viz ; wireless capsule endoscopy for examination of the small bowel, high magnification endoscopy for detection of minute lesions and confocal microscopy to obtain histological information at endoceopy.

MICROSCOPE

Microscope is an instrument for producing enlarged images of small objects. Microscopes range from simple lens magnifiers to complex electronic instruments. Simple microscope is a good example of an ordinary magnifying glass and has only one lens which can magnify clearly perhaps 10–20 times. The compound microscope has sets of convex lenses at each end of a tube. The first set of lens (the objective) forms an

enlarged image of the object, and the second set (the eye piece) enlarges the image. The compound microscope was first made into an effective instrument by Galileo Galilei (1564–1642). It was, as it were, a by-product of his invention of the telescope. Both simple and compound microscopes make use of light waves and are therefore light or optical microscopes. Magnifying power is limited to about 2000 times and if pushed higher, images become fuzzy because these microscopes cannot form images of objects that are smaller than the light waves. In 1925, Joseph Bernard, a London microscopist devised the ultra violet microscope achieving 2,500 times magnification and larger viruses could be seen for the first time by naked eye. The Belgian, L. L. Morton (1901–1979) used the physical principles of electrons to devise the electron microscope. Electrons have a wave motion similar to that of light but have a wavelength which is 10,000 times shorter. Objects could now be magnified many times over. By the end of 1930's a magnification of close to 40,000 times was achieved, so that the innermost secrets of the human cells and of small particles called viruses were laid bare to the scientific eye. To get higher magnification, something even smaller than light waves–beams of electrons need to be used. Electron beams cannot be used in optical microscopes because, unlike light waves, they are not bent by glass tubes. But electromagnetic fields can bend them, to form images. In electron microscopes, right shaped electro-magnets act as lens with beams of electrons spreading them out into cones, like the cone of water in the showerhead. However, the images formed by electrons are invisible to human eyes. To make them visible, the images are formed on a glass screen coated like a television tube with material that glows when struck by electrons. These are two basic kinds of electron microscopes, both capable of magnification of 1 million times or more. In transmission electron microscopes, the electron beams are transmitted through extremely thin slices of the material being examined. In scanning electron microscopes, a thin beam of electrons sweeps back and forth over the specimen. The electrons scan the material without penetrating it, so there is no need to slice it thin. This makes it possible to examine and photograph very small living objects. The images produced by this instrument have a strongly three-dimensional character.

In video-intensification microscopy the coupling of image intensifiers and video techniques to light microscopy systems makes it possible to amplify dim images a million fold. Minute quantities of fluorescent material can be located and it is possible to continue to examine light-sensitive fluorescent material over long time intervals using weak illumination. The use of computers has developed better and more flexible lens systems and also video-enhanced microscopy systems where randon background information is subtracted electronically from the image, giving greatly improved quality. Lasers have been employed to record three-dimensional photographic plate–that is the application of holographic methods, they may also be used to vaporise selected parts of a specimen. Spectrometers built into the systems analyse the vapour and hence allow correlation of structure and chemical composition. Recent innovations include scanning acoustic microscopy, where the object is scanned by a tightly focused acoustic

beam, the method being capable of giving information from the interior of optically opaque material. In electron microscopy, the use of a variety of histo-chemical and immunochemical methods allows the identification of specific chemicals in their subcellular locations.

Microscope is also helpful in the surgery of minute structures (microsurgery).

SPECTROSCOPY

It is the study of energy levels in atoms or molecules, using absorbed or emitted electromagnetic radiation. Inner atomic electrons give spectra in the x-ray region ; outer atomic electrons give visible light spectra ; the rotation and vibration of molecules give infrared spectra ; the precession of nuclear magnetic moments gives radio-wave spectra. Many types of spectroscopy exist, they are often used to identify the structure of an unknown substance or to detect the presence of known substances, drugs etc. It is widely used in clinical chemistry.

FINSEN LAMP

It is a high power device to emit concentrated or converged and filtered rays which have bactericidal properties. Ulteraviolet sections of sunlight have strong bactericidal power. Finsen, a Dutch physician, is considered as the founder of modern photo-dynamic therapy. Modern treatments like radiation and drug therapy owe a lot to Finsen's pioneering work with light therapy. He was awarded the Nobel Prize in Physiology on Medicine in 1903, in recognition of his contribution to the treatment of diseases especially lupus vulgaris, with concentrated light radiation whereby he has opened a new avenue for medical science. From the age of 23 years he was invalid and directed from his bed the Light Institute which he founded in Copenhagen in 1896.

AUDIOMETER

The new audiometer that can be operated by the patient was designed by the Hungarian scientist George von Bekesy, Nobel Laureate in Physiology or Medicine in 1961 and is based on his discovery of the physical means by which sound is anaysed and communicated in the cochlea, a portion of the inner ear. The vibratory tissue, most important for hearing, is the basilar membrane stretching the length of the snail-shaped cochlea and dividing into two interior canals. Bekesy found that sound travels along the basilar membrane in a series of waves, and he demonstrated that these waves peak at different places on the membrane ; low frequency to the end of the cochlea and high frequencies near its entrance or base. He discovered that the location of nerve receptors and the number of receptors involved are the most important factors in determining pitch and loudness. His research led to the construction of two cochlea models and highly sensitive instruments that made it possible to understand the hearing process differentiate between certain forms of deafness, and select proper treatment more accurately.

OPHTHALMOSCOPE

'In the whole history of medicine beautiful episode than the invention of the ophthalmoscope, and physiology has few greater triumphs', thus wrote American ophthalmologist Edward G Loring in his 'Textbook of Ophthalmology Part I' in 1892

(London, England : Henry Kimton), 2 years before the death of Herman Ludwig Ferdinand von Helmholtz (1821–1894)—the great German physicist and physiologist of the 19th Century. Helmholtz first demonstrated that there were three essential elements to the working of an ophthalmoscope : a source of illumination, a reflecting surface to direct light toward the eye, and a means of correcting an out-focus image on the fundus. Over the last 100 years or more since his time, the essential elements have been achieved. In the process candle lamp, oil lamp, gas lamp were used for illumination–prisms and lenses are and for reflecting the light. Method of correction needed mirrors and condensing lenses.

An ophthalmoscope is basically an apparatus for illuminating the retina using a battery and small bulb. For normal vision the ophthalmoscope consists simply of a small hole to look through and a source of illumination. The light is reflected into the eye by a mirror. The observer looks directly through the hole in the centre of the mirror. The ophthalmoscope has lenses to correct for visual defects of either the obsever or subject.

MISCELLANY

Human body is a physico-chemical consortium. Hence the basic principls of physics and chemistry are widely applied in the detection of any irregularity or aberration inside the consortium as well as in its correction or normalisation. Electrical activity is assessed for diagnostic purpose : electro-encephalography (EEG) for recording the electrical activity of the brain, using electrodes applied to the scalp, and usually recorded as tracing on a paper ; electrolaryngography for recording the vibrations of the vocal cords electronically–electrodes are attached to the neck on each side of the thyroid cartilage, and the vocal cord as traces on the screen–the rises and falls of the fundamental frequency of the vibrations (corresponding largely to the intonation of the voice)–now widely used in speech science, in relation to both normal and abnormal use of the voice ; electromyography to study muscular contractions which take place during speech–muscles produce tiny amounts of electrical activity when they contact–activity recorded by applying electrodes to the individual muscles of the vocal tract and displaying the signals on a screen or on paper.

In December, 1896, W. B. Cannon (1871–1945), still a student of Harvard Medical School, noted that if bismuth salts were fed to animals, they allowed a visualization of the gut on a fluorescent screen. This technique was applied to humans from 1904, barium sulphate being used to opacify the gut so that structural abnormalities in the stomach, duodenum and the rest of the intestine could now be diagnosed.

Electroconvulsive therapy (ECT) is a highly successful treatment for patients with severe mental depression in which a current is passed through the brain of an anaesthetised patient. In 1937 Ugo Cerletti (1877 - ?) and Lucio Bini (1908 - ?) of Rome first used an electrical method (110 volts for half a second) to produce convulsion.

THE NUCLEAR MEDICINE

The use of radioactive tracers in diagnostic and therapeutic medicine is widespread today

since 1971. This new medical speciality was recognised by the American Medical Association through the establishment of the American Board of Nuclear Medicine. About one in three hospitalised in a modern hospital will have a diagnostic procedure performed in which a radio-active tracer has an essential role, i.e. assessment of haemodynamic response of the heart during exercise in the diagnosis of coronary artery disease, by a scintillation camera assessment of blood flow in the lungs in pulmonary embolism, plasma levels of hormones to assess hypo or hyperactivity of endocrine glands and so on.

The Hungarian radio-chemist–Gyorgy de Hevesy (1885–1966), Nobel Laureate in Chemistry in 1943, is the father of the deveopment of techniques and methods for the practical use of radioisotopes in analysis. In his Nobel Lecture Hevesy stated : 'The application of isotopic indicators opens new lines of approach not only to the solution of known problems but also by directing our attention to trains of thought not previously considered. Isotopic indicators open the only way to determine the rate, place and sequence of formation of many molecular constituents of the living organisms. The very existence of such methods was instrumental in opening new trains of thought in demonstrating the dynamicity of metabolic processes in concentrating our interest on the problem of velocity of fundamental biological processes'.

The use of radioactive tracers–Nuclear Medicine rather Medicine of Radiophysics–has made possible an improvement in perception and conceptualisation of disease in ways we never dreamt of only a few decades ago. Nuclear imaging provides us with symbolic representations of pattern and changes in the spatial and temporal distribution of the chemicals that make up living organisms. To picture a biological system, including human, at a single instant in time is inadequate ; we must also concern ourselves with the perception of events that occur one after the other ; motion and dynamic change are the essence of physiology. Limiting our perception to static patterns is equivalent to assuming that nothing ever happens. Therfore, our images must be concerned with time, with the order of events and their duration, with the periodicity of body processes, such as the beating of the heart, the emptying of the gall bladder, and so forth.

The distribution of X-ray densities as in computerised axial tomography, or the spatial and temporal distribution of chemical susbtances within the body as in nuclear medicine imaging or the distribution of body surfaces that reflect sound waves, as in ultrasonics, the use of electromagnetic spectrum as, source of information about the patient's bodily structure and funcation are some of the gifts of physics to modern medicine. Microscopes and biopsy techniques are the new essential tools in the hand of clinicians to precisely understand the pathophysiology of diseases at the cellular level. Radiochemicals (Technitium–99m) and radio–pharmaceuticals offer added advantage.

Advances in the field of medicine have been along three lines : better chemicals, better instruments and better quantification.

Tomography in nuclear medicine is of two types : single photon emission computed tomography (SPECT) and positron emission computed tomography (PECT). The latter permits more accurate quantification, but the former provides significant improvement over planar imaging, where the three-dimensional distribution of radio-activity is projected on to a single plane. Positron tomography has made possible measurement of regional glucose metabolism in regions of the brain, such as the frontal lobes, auditory cortex, striatum, thalamus and visual cortex. It has been possible to show the biochemical events related to the psychological processes of vision and hearing, a major achievement in the history of psychology and philosophy. In the study of brain, both SPECT and PECT have their greatest impact. It is now possible to demonstrate by imaging dopamine, serotonin and opiate receptors in the living human brain.

PHYSICS AND NEW DENTISTRY

State-of-the-art dental technology now offers faster, better and less intrusive services. Physics and modern technology has made dental procedures safer, more-effective, faster and hassle free for most patients. Radiovisiography (RVG), intra-oral camera, CAD-CAM, electronic anaesthesia, fibre-optic hand piece and Lasers are now used to treat common dental maladies.

RVG or computerised digital radiography makes use of an elctronic sensor instead of a conventional X-ray film. The electronic sensor captures the X-ray and sends the signal to the computer. This technology gives an incredible advantage over coventional X-rays in diagnosis as a sharp and clear image of the concerned tooth and periodontal structure is available on the screen in seconds. The dental surgeon can zoom in on a certain portion of the image and manipulate the image in a wide variety of ways to diagnose the underlying pathology before commencing treatment. This technology also conspicuously reduces patient and staff radiation exposures and keeps environment green by eliminating chemical wastes.

Another technology-driven diagnostic aid is the intra-oral camera. It is a tiny video camera which tours the mouth picking up images that could be enlarged on a television or a computer monitor enabling the patient to view his own oral exam. Periodontal disease, cavities, plaque, stain, fractured restorations and other oral conditions can be diagnosed early with this terrific tool. Intra-oral images help the patient better understand his dental condition and treatment options as he can see what the dental surgeon is describing.

Electonic anaesthesia uses a device which has a receptor placed on the patient's gum and another unit held in the patient's hand with which the comfort level can be adjusted. The system sends out a "wave" to block the body's naturally occurring electrical pain signals where the dental treatment is being done. The patient does feel a tingling sensation on the gum.

Electronic anaesthesia is the most modern dental Surgery process and is under consideration for future use in dentistry.

The dental air turbine hand piece is a *sine qua non* for the dental surgeon. It is an equipment that is indispensable in operative dentistry. The

airotor hand piece has a bur fitted into its head. When the hand piece is connected to the motor, the bur rotates at a high speed of 370,000-430,000 rpm (depending on the hand piece type). The bur is usually made of tungsten carbide or diamond grits. The hand piece is held by the dental surgeon like a pen and is carried into the oral cavity to the carious tooth where the rotating bur's firm cutting action removes carious lesions in seconds. The airotor hand piece also has a water spray directed towards the bur tip to minimise the heat generated during cutting. The chic dental hand piece made of stainless steel body is one of the most prized possessions of a dental surgeon. The latest technological advancement has been the development of Fibre optic high speed air turbine hand pieces. These classy equipment have fibre-optic lighting systems which illuminate the cavity while the dental surgeon prepares it. The lights look like the headlights of a car directed towards the bur tip. Now, cavity cutting will be more precise and faster.

Electronically pre-programmed dental chair is available where the patient can be positioned in the ideal posture for a particular treatment simply by pushing a button. The modern chairs are fully equipped to be called a mobile dental clinic.

Lasers are being used in dentistry to perform periodontal surgery (like gingivectomy) to expose dental implants, to relieve the pain of apthous ulcers and mouth sores, to collect biopsy samples and many such dental procedures. It is presumed that very soon laser might be used to cut cavities where a flash of light would be enough to remove caries. Carbon dioxide and argon lasers are the commonly used ons in dentistry.

CAD-CAM (computer-aided design and computer-aided machining) system is nowadays being used in prosthetics for crown and bridge work. A CAD-CAM system digitally records the image of the prepared tooth and stores it in the memory of a computer. The image data can be retrieved immediately to grind a metal, composite or ceramic prosthesis by computer control from a solid block of the chosen material. The prosthesis can be fabriacated within minutes and placed on a prepared tooth and bonded in the mouth of the patient within one hour.

So technology is an integral component of modern dentistry. Application of the principles of physics has ushered in an era of new dentistry.

THE FUTURE

The ongoing contribution of fundamental and applied sciences to the steady advancement of contemporary medicine is going to usher in a new era of excellence in this millennium.

Mathematics, Physics and Chemistry form the sheet anchor of any science including Medical Science. The award of Nobel Prizes in Physiology or Medicine and in Chemistry in 2003 is again a glaring example. Mathematical precision is the core of all medical assessments to be perfect and flawless. The Hardy–Weingberg law (equilibrium) formulated independently by the English mathematician Godfrey Harold Hardy (1877–

1947) and the German physician Withelm Weinberg in 1908, established the mathematical basis for studying heredity in population. Influence of heredity is, of course, recognised since prehistoric times.

The development of Magnetic Resonance Imaging (MRI) is a breakthrough in medical diagnosis and research. Atomic nuclei in a strong magnetic field rotate with a frequency dependent on the strength of the field. When such nuclei return to their previous energy levels, radio waves are emitted. For discovery of nuclear magnetic resonance in solids, Felix Broch (1905-1983) and Edward Mills Purcell (1912–1997) of U. S. were awarded jointly the Nobel Prize in Physics in 1952. Magnetic resonance was initially used mainly to study the chemical structure of substances. In recent years it is used successfully in medical imaging and for this, two physicists– Paul C Lauterbur (1929 - ?) of U. S. and Peter Mansfield (1933- ?) of England were jointly awarded the Nobel Prize in Physiology or Medicine in 2003.

They took a chemists' technique to study solutions and developed it in a way to image the body, which, contrary to appearance, is mostly water (about 70%). Unlike CAT (Computerised Axial Tomography) scanner which employs radiation, Magnetic Resonance Imaging (MRI) examines the body only with magnetic fields and radio wave pulses and has replaced invasive techniques for examining joints, the brain and other vital organs. The technique is so sensitive that it can locate the site where different mental tasks are performed in the brain by essntially tracking the extra blood flow to the active regions. Lauterbur obtained spatial information to build an image of the molecules arranged in a structure. Mansfield supplied a major step to make Lauterbur's concept a practical reality. He showed how to speed up the imaging process by deveoping new mathematical techniques to analyse the information from rapidly varying magnetic fields.

Human cells consist of about 70 per cent salt water. Transport of salt (ions) and water out of and into the cells of the body is very important in understanding many disease processes in the body. For detailed study of potassium land water channels in cell membranes by standard genetic techniques, medically qualified Roderick Mackinion and biochemist Peter C Agre, both of U. S. were jointly awarded Nobel Prize in Chemistry in 2003. Their work has immense implications in understanding the diseases of kidney.

Bioinformatics (use of computers in solving information related to problems in the life sciences) involves creation and analysis of extensive databases on genomes and protein sequences. It is crucial to acquire massive bilogical data sets. This includes protein structure data, protein–protein interaction data, protein–DNA interaction data, data on enzymatic and biochemical pathways, webs of neurological structures and pathways, population–scale data, large scale gene expression data, ecological and environental data, etc.

Biological modelling used in solving any problems in biology, require mathematical modelling and computer simulation. Modelling techniques can be helpful in proposing and testing hypothesis in molecular biology,

such as inferring bilogical function, in drug–designing and testing remote protein relationship.

Biomedical Engineering is getting more and more dependent on computer hardware and software such as in modern pacemakers, some artificial limbs and implanted instrumentation in the muscles of paralytic patients. Modern radiology, is, in fact, applied biomedical engineering fully dependent on computer hardware and software as used in ultrasonography, laparaoscopy, scanning, x-ray, etc. Other felds are telesurgery, tomography, virtual anatomy and other medical visualisation. Tele medicine, a big promise in future health care, also uses computers and Internet extensively.

Biometrics is another exciting area. It is an automated method of identifying a person with his or her unique physiological or behavioural characteristics such as finger printing, hand geometry, ear contour, hand writing, iris, retina, vein, voice and DNA.

Algorithm is a process or a set of rules used for calculation or problem–solving especially with a computer. Genetic Algorithm can evolve Cellular Automata which describes an n–dimensional space divided into regular cells. Each cell is characterised by one or several state variables. The cells synchronously change state based on information from the neighbouring cells.

Molecular biophysics, nanolithography and electron lithography constitute biomolecular electronics, a promising aid in Information Technology (IT). Analysis of an array of protein molecules has given rise to the idea of development of computing chip containing billion of protein molecules, offering the possibility of developing very small but an extremely fast computer. A biochip would be able to perform thousands of biological reactions such as decoding genes, in a few seconds.

A self-assembled single metallo-protein transistor should be able to operate at room temperature and its performance is expected to be superior to those of single electron transistor based on semi conductors.

Nanotechnology is the building of devices on a molecular scale–micro-machines such as gears smaller in diameter than a human hair. A robot small enough to travel through the blood stream and into organs of the body, inspecting or removing diseased tissue is under development. The scanning electron microscope can be used to see and position single atoms and molecules, and to drill holes a nanometer (billionth of a metre across a variety of materials including human body).

Bio-electromagnetics is concerned with the effect of use of cell phones on human body. It is a new hazard to youngsters among whom cell phones are a "status complex" all over the globe.

With the advances in genetic engineering technology, large number of macromolecules from various sources–plants, etc. have been identified to have therapeutic properies. However, the development of dosage forms for such molecules and their penetration into the site of intended action inside the body (bio-avauliability)

is a formidable challenge for the pharmaceutical industry. Transdermal Iontophoresis is a technique (by using low intensity electric current) that can facilitate the delivery of such molecules through the skin. A drug reservoir is placed on the skin upon which an electrode is placed. The basic principle involved is electro-repulsion. The drug ions get repelled by the electrode and are driven into the skin. Hence a positive drug ion should be repelled by an anode (anodal Iontophoresis) and a negative drug ion by a cathode, (cathode Iontophoresis).

We seem to be advancing towards the centre of the mystery of health and disease. Only time will tell. Over-optimism today may land us in the den of disappointment tomorrow. A word of wisdom from Max Karl Ernst Ludwig Planck (1858-1947), Nobel Laureate in Physics, 1918 is relevant :

"Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of the nature and therefore part of the mystery we are trying to solve".

Let us be optimistic. But we should always remember our limitations.

Secondly, in spite of spectacular progress so far, the message of modern medicine has not yet reached every hearth and home on this planet ; the vast rural world (80% of population live there) is still beyond its reach. It is a formidable task in this century. It is the main medico-socio-moral obligation to each and everyone of more than 6 billion souls on this planet. Health cannot be allowed to become a purchasable private commodity in a globalised economy.

Thirdly, the cardinal principles of medical ethics in medical treatment–autonomy, beneficence, non-maleficence ("do no harm") and justice, cannot be universally applied at present in the developed, developing and underdeveloped worlds because the North-South socio-politico-economic divide is so wide. This gulf of difference needs to be eliminated first.

THE EPIOLOGUE

The contribution of physics and other basic science to modern medicine is immense. It has gathered pace with the march of centuries. Throughout our contemporary era, the science of medicine is inseparable from the science of physics and some of the other natural sciences.

We have come a long way–but still longer to go. The contemporary state of affairs is best expressed in the poetic words of the famous poet–Thomas Steans Eliot (1888–1965), Nobel Laureate in Literature in 1948 :

'Dust in the air suspended

Marks the place where a story ended'

(Little Gidding (1942), Four Quartets, Part II)

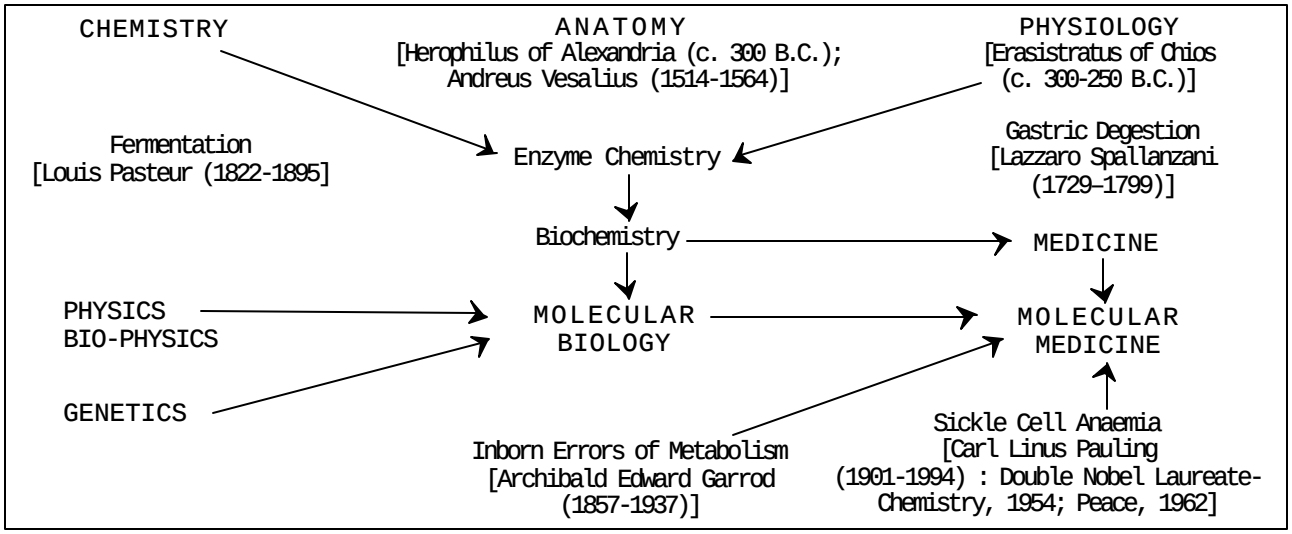
But the past supplies the key to the present and to the future. The longmarch is on. Litterateur–Statesman–Winston Leonard Spencer Churchill (1874–1965) Nobel Laureate in Literature in 1953, has already infused a ray of optimism for all of us while addressing the Royal College of Physicians in March, 1944 :

'The longer you can look back, the further you can look forward'.

A N N E X U R E

HISTORY OF DEVELOPMENT OF MODERN / RATIONAL MEDICAL SCIENCE

[HIPPOCRATIC (c460-370 B.C.)]



INFOSYS FOUNDATION AND ISCA TRAVEL AWARDS FOR SCHOOL STUDENTS

With a donation from Infosys Foundation, Bangalore, the Indian Science Congress Association has instituted an award namely, "Infosys Foundation – ISCA Travel Award" from 2004-2005 to be given annually to five students (upto Class XII) during the Annual Session of the Indian Science Congress Association. The awardee will be paid TA (AC III–tier/Chair Car Train Fare), local hospitality, and a Plaque for attending the Congress.

Five more deserving students will be funded for attending the Science Congress Sessions from the amount accrued from interest on sale of the special volume on "Shaping of Indian Science" published by ISCA on the occasion of the 90th Indian Science Congress. The students will also be given TA (AC III-tier/Chair Car Train Fare) and hospitality for attending the Congress.

The selection of the awardees will be made by a committee constituted by the host university on the basis of a write-up on—**What developments in Science during the last two years have influenced you and why ?**

Interested students (upto Class XII) are requested to submit applications with the above write-up and brief bio-data (name, address, school, date of birth, class, phone/e-mail, extracurricular activities etc.) Applications should be forwarded by the School Principal/Headmaster to reach the office of the Local Secretary on or before 15 November, 2005.

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HIDDEN DIMENSIONS OF STRESS RESPONSE

Amere S. Sreedhar*

Stress response is a universal phenomenon. The term, "stress", generally refers to any physical or psychological change that disrupts the organism's balance or homeostasis. Stress activates many systems in the body, however, through a defined mechanism, which starts at the cellular level. All organisms, from bacteria to humans, have evolved mechanisms to deal with significant changes in their external or internal environments, that is, stressors, though the biochemical mechanism lies behind remains the same. The following discussion focussed to understand the significance of stress at molecular level.

ORIGIN OF STRESS

Primer of Stress-A Parable

Old days versus present day : Undoubtedly, evolution is the process in which traits such as the stress response are shaped by natural selection. It would be very interesting to understand how this natural selection gives a selective advantage, over the dramatic changes both in socio-economic and environmental-biochemical perspectives. Let us imagine the evolution of cavemen to chemist, which is a course exploring landmark technologies on the road to modern industrial civilization. In a comparison with the old days, imagine that cavemen come across with a tiger when he was happily picking up berries in the wild. The sight of tiger, makes him to respond immediately, as his hypothalamus sends a message to his adrenal glands, and within seconds he responds to the situation, can hear clear, think faster, jump higher than he could only seconds earlier. All this happens in response to the biochemical changes within his body, once he finds a safe place he relaxes bringing back all his flexes to normal and cools down. In the present day, despite of the technological advances, the human body did not change, essentially modern man has the same set of internal body parts as that of the cavemen. However, there are certain evolutionary adaptations, once needed for survival, can now work against us. For instance, we are no more threatend by carnivorous animals, yet the daily annoyance and anxieties that we encounter trigger the same response as those of cavemen spotting a tiger do. This situation results in our blood pressure elevated. Exposure to this kind of continuos pressure/stress over the years leads to various civilization diseases, like cancers, hypertension, etc. In a way, all these constant stress events result in a change in gene expression which is the molecular basis for life.

EVOLUTION OF STRESS

Chronic stress : There hasn't been time for us to evolve physiologically from the high-

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threat, short-duration stress situations that primitive man faced to the relatively low-threat, long-duration stresses of modern society. Chronic stress can have an impact on the overall effectiveness of immunizations designed to protect against infectious diseases. Chronic stress also associated with many cellular dysfunctions such as hypertension, infertility, atherosclerosis, etc. Chronic stress is believed to have evolved with modernization and speed of change in every aspects of life.

Acute stress : The best way to envision the effect of acute stress is to imagine oneself in a primitive situation, such as being chased by a lion. After a sudden loss, injury or complicated illness, a person may go through a period where they experience feelings of fear, helplessness or horror as well as some physical symptoms. Acute stress evokes immediate responses in the cardiovascular, endocrine and immune systems.

Adaptive stress : The ability of a cell, tissue, or organism to better resist stress damage by prior exposure to a lesser amount of stress is known as adaptive response. Adaptive stress has been extensively studied at the molecular level how cells/organisms cope up with the damage caused by either environmental factors or trauma (for instance in post operative conditions) etc. The differential response of stress depends to some degree on individual's conditioning and on the amount of adaptive energy that the particular individual is born with.

The word stress comes from the language of engineering meaning 'any force which causes an object to change'. The Austrian-Canadian Scientist Hans Seley, first coined the word stress in relation to humans back in the 1930's. In human terms, it refers to the body's response to physical, chemical, emotional or spritiual forces that may called to adapt to. However, Stress is hard to pin down : fatigue, overwork, loss of blood, physical injury, grief and joy can all produce stress, but none of them accurately describes what it is. Though the reflex of stress response is seen at the organismic level, the initiation and the act of stress response occur at cellular level.

STRESS PROTEINS

The adaptive response of the early cell that existed over 30000 million years ago adjusting itself to the environment resulted in the evolution of a spectum or more organized life-forms, from the photosynthetic bacteria to man. In this process, more than 99% of all species of living organisms that existed at one time or other are now extinct and they have no present day descendents. The ones that have survived are more equipped with transforming abilities to the adverse conditions around and within their environment. What enabled them to do so was the evolution of stress response genes, a set of highly conserved and abundant genomic sequences.

Almost every organism (except, the fresh water cnidarian *Hydra oligactis* and the antarctic fish, *Trematomus Bernacchii*) responds to stress and synthesizes a set of proteins called stress proteins. This response is highly conserved and hence the stress response is a universal phenomenon. The stress proteins (also called as heat shock proteins) hereafter called Hsp-s,

appear to be induced in response to a wide variety of stressors such as heat shock, metabolic stress, hydration, genotoxic stress, oxidative stress, osmotic stress, radiation stress, chemical and carcinogenic stress, etc. and are associated with protection from further insults.

Hsp-s are assigned to gene families based on their molecular weight, the high molecular weight proteins, Hsp100, Hsp90, Hsp70, Hsp60 and Hsp40 followed by low molecular weight proteins, the small Hsp-s such as alpha-crystalline and Hsp 27 members. The basic function of all Hsp-s under normal unstressed conditions is to facilitate folding and transport of denatured or newly synthesized proteions, hence these proteins are also called "molecular chaperones".

DISCOVERY AND CURRENT RESEARCH

The dicsovery of Hsp-s in *Dorsophila* salivary glands by Ritossa unraveled the mystery of stress response theory and further studies proved that stress response[1] is a universal phenomenon. In the early days of research on Hsp-s, it was postulated that Hsp-s are mainly involved in the cytoprotection after stress, also protection from subsequent stress. However, the discovery that a large amount of these proteins present in cells under normal unstressed conditions (~1% in case Hsp70 and 2-5% in case of Hsp90 total cytosolic proteins) suggests that these proteins are involved in the maintenance of cellular homeostasis. In support of this delection of Hsp90 is lethal in higher eukaryotes though these effects were not seen in prokaryotes, bacteria (*E. coli*). But, both in plants and in higher eukaryotes these proteins serve as major ceonstituents of cytoprotection and cellular management.

The bacterial stress response is a global regulatory system required for effective adaptation to changes in the environment. The stress proteins, which are associated with this adaptive-cytoprotective process are highly conserved among and between species. This is true in case of plants too, where environmental adaptations have been extensively studied. For instance, drought tolerance in plants in a case study revealed that, loss of water in their vegetative stage to the extremes of desiccation, shapes to the adaptation which involves, rapid, non-destructive drying of existing leaves and their subsequent survival after water is returned. What makes the decision in such cases for these adaptive reponses? Interestingly, it is an in-built pre-existing protective system, which helps in this process. The repair capacity, stored in the form of RNPs (ribonucleoprotein particles), is believed to be the major effector in making the dehydrin transcript, a protein helps in this protection which is similar to Hsp-s. Recently tremendous amount of work has been done on plant Hsp-s and their role in adaptations and cytoprotection. In highly evolved systems, however, when the cells become dehydrated, it triggers a catabolic state accompanied by muscle wasting, cell hypoxia (oxygen starvation), DNA damage, and accelerated aging. Therefore, the cell becomes more sensitive to free radicals and more susceptible to viruses and autoimmune diseases. Virtually all symptoms of aging are the result of cellular dehydration accompanied by free radical damage.

In the early stages of a successful adaptive response, cells may have enhanced cellular function, which is similar to the stress response during pathophysiological conditions. Thus, it is

hard to distinguish between a pathologic response vis-a-vis an extreme adaptation to an excessive functional demand. However, the first and far most important thing for a cell to do is to protect itself from further damage. There are multiple pathological conditions, which are associated with induction of Hsp-s. In many instances, this kind of induction does not correlate with the protective efficacies, instead may serve as a kind of danger signal for the imune mediated cell killing or escape from the immune invasion thereby resulting in malignant cell transformation. In such cases, the Hsp-s end up in enhancing the danger causing tumors to spread to the by-stander cells. Other forms of stress such as inflammation, fever, UV irradiation, viral infection, malignancy, oxidation, heavy metal exposure, etc. also involved in the induction of Hsp-s. Hsp-s play a housekeeping role in immune system responses and hence have been implicated in the autoimmune diseases such as rheumatoid arthritis, systemic lupus erythmatosis, and ankylosing spondylitis. Seematter[2] has shown the relationship between stress and metabolic disorders.

Fever is one of the most common forms of stress experienced by most organisms. Fever occurs when either exiogenous or endogenous pyrogens affect the synthesis of prostaglandin E_2, the modified fattyacid and the messenger which is involved in the inflammatory responses. Prostaglandin E_2 slows down the rate of firing of worm sensitive neurons and results in increased body temperature. Fever induces the production of Hsp-s, critical for cellular survival during stress. Hsp-s apart from their function as molecular chaperones also have an anti-inflammatory role. Hsp-s and the heat shock response appear to inhibit the activation of transcription factor, NF-$\kappa\beta$, which is also, involved in the inflammatory responses, thus decreasing the levels of proinflammatory cytokines. What makes fever? Fever arises as a result of alterations in hypothalamic thermoregulation, with and increase in the normal body temperature value in the thermoregulation center of the anterior portion iof the hypothalamus. Do we see the same response in the modern human as our cavemen ancestors come across the similar hypothalamic responses? The answer is, Yes, we do, and in both instances, the stress response is beneficial.

CHRONIC STRESS : Hsps

Chronic stress is associated with psychological distress, where elements such as unsatisfactory social supports and poor coping skill may contribute to the factors. The psychological distress is associated with poor health habits, such as insufficient execrcise and poor diet, besides a number of changes in body composition and metabolism that are well-established risk factors for heart disease. Chronic stress is also associated with constant elevation of Hsp-s. In an interesting study[3] frequent exposure to radiation from the commonly used cell/mobile phones induce cancers, also induce Hsp-s. In fact chronic expression of Hsp-s is known to induce or promote oncogenesis, metastasis and/or resistance to anticancer drugs. Repeated exposure to mild stress was also shown to enhance the resistance to bigger stress. The most common example of chornic stress is tobacco use, and the rats fed with this smokeless tobacco are under chronic stress exhibit elevated

amounts of Hsp90. In addition, chronic hypoxia also induces Hsp90 and helps adapting the current situation. Low calorie diet and exercise also shown to induce Hsp-s, where enhanced Hsp-s protect cells from the stress induced tissue damage. In contrast, although short exposure to electromagnetic field induces Hsp-s protects chick embros, continuous exposure reverses this protective effect.

Acute Stress : Hsp-s

Acute stress is a immediate effect on the physiological system. Acute stress is often considered non-adapted stress response, hence at times considered as pathological if the organism is not ready enough to respond. As these flexes for acute stress are so fast, one can imagine/expect its role by neurological means. The actue stress inducers include such as ischemia and reperfusion, hyposia and reoxygenation, byperthemia and oxidative stress at the physiological level. While chronic stress has been shown in many studies to have a suppressive effect on our body's immune responses, new research shows that short, acute stresses might actually be good for our immune system where a stress response which alters the expression of Hsp-s and activates immune mechanisms involving Hsp-s. There are several reports regarding the involvement of Hsp-s in tumor immunity and autoimmune disorders. Among many acute stress inducers, hyperthermia is extensively studied. Hyperthermia, many a times, is beneficial as it protect cells/tissues from further damage using Hsp-s as lifeguards. Post-operative conditions, trauma are the best example in this case. Only in a few cases hyperthermia is associated with heat cramps, heat exhaustion, or heat stroke. It is frequent in hot working or living environments and results in auto-antibodies, probably maintaining the protein titer.

ADAPTIVE STRESS : Hsp-s

The adaptive stress response can be well compared to our day to day activities as to adjust with the life style with constant changes. It can even better be explained by the evolution to species. At cellular level, there are multiple molecular interactions, which help in this adaptation. We can draw 'n' number of example for adaptive responses from our simple experiences how we changed ourselves to the changes in our surroundings during our progression. These changes are accumulated over the years with constant adjustment and accommodating to the situation, which include lot of compromise and sacrifice. However, at cellular level there are plenty of examples how these adaptations involve a change in the gene expression and contribute such an adaptation. For example, how a mortal cell changes its phenotype to immortal, the best example is cultured cells, which can be maintained through passages and are considered immortal phenotypes compared to their parental origins. It was shown that certain family members of Hsp-s called mortalins contribute for this change. Interestingly these phenotypes exhibit entirely different type of cell growth progression and execution where they are devoid of normal death (apoptosis) process, and drives to a state called senescence, followed by cell death. This is the same in case of cancer cells, where these cells are associated with high expression of Hsp-s which contribute for the protection from

damage and helps in their speed of growth which demands rapid folding and transport of various melocules between the cellular compartments.

The evolution which deals with the gene pool of the population gradually changes in response to environmental pressures, natural selection and genetic mutation, has a major role in the adaptive responses, hence considered as a long process. This can be explained in a better way saying that the ability or the capacity of an organism to evolve, the evolvability. In case of cellular environment, the adaptive responses are not stable and keep changing with the environment as to fit to the need and mould themselves to the requirement. For example, tumor cells need constant changes in their phenotype to escape from the immune attack, where Hsp-s were shown to play a major role in these quick adaptations.

SMALLER STRESS VERSUS BIGGER/ PERSISTENT/CONSTANT STRESS

If one debates on the kind of stress, which is beneficial, it is small and quick stresses which helps cell to respond quickly. In fact similar to the protective mechanism which is stored in plants during dehydration in the form of RNPs, though the mammalian stress response is tightly regulated at transcriptional level, the response is very quick and in fact Mosser *et al* have shown that 3-5 minutes is enough to have first stress responsive Hsp mRNA synthesis. Bisht *et al* have shown that this response though quick, the proteins are stable for more than 8 hours and the system maintains this inducible amounts for more than this time. In contrast, bigger stress though shown associated with inducible Hsp synthesis failed to protect cells from stress induced damage or death. In addition, when cells fails to get protection from Hsp-s they opt for necrotic death. In case of persistent or constant stress, cells try to adapt to the situation where Hsps plays a major role in contributing for this process. However, longer persistent stress contributes for civilization diseases due to accumulation of mutations and damaged proteins with the help of Hsp-s.

Summary and Conclusions

Because so much investigation on Hsp-s is going on these days, the question arises as to whether and how frequently organisms in nature undergo Hsp-inducing stress. From the major three stresses, chronic, acute and adaptive, it is evident that stress is part of life and every organism must have had experience of it (Figure-1). As we see old days stress is beneficial

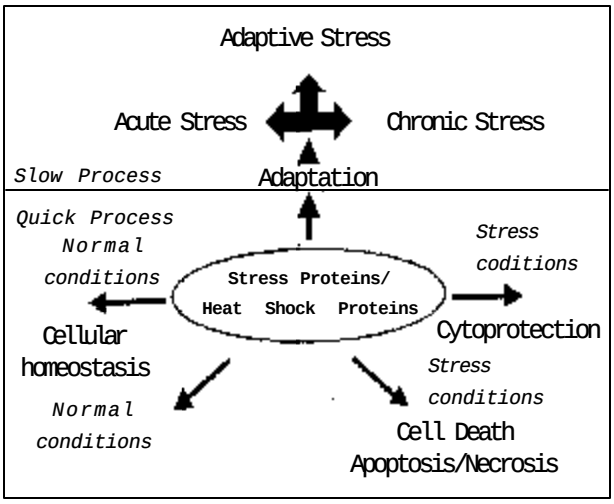

Fig 1. **Depicting the role of stress proteins in various cellular and adaptive processes.**

and is short lived, in contrast in the current days stress is an integral part of day to day activities

Qutick Process

and exhibits deleterious effects. It is also interesting to understand the functional contribution of natural variation in the quantity of biochemical efficacy of Hsp-s to physiological stress tolerance as well as response. In addition, the innate and adaptive immune responses regulated by Hsp-s also tell us the evolutionarily conserved phenomenon of immune response and its role in civilization diseases[4]. According to Prof. Peter Csermely, the accumulation of stress proteins contributes for the civilization diseases. In addition, they also shown to act as capacitors/buffers for morphological evolution[5] in *Drosophila* and *Arabidopsis*. Whether organisms undergo such stress in the wild is no longer equivocal, having been demonstrated many times in diverse species and natural enviornments. Indeed, numerous investigators and commercial concerns have begun to exploit this feature to assess biological and anthropogenic stress. We do not know if natural exposure to stress and consequent gene expression is routine, frequent, or rare; nor whether the studied species are typical or deviant in their exposure to stress and gene expression. Such knowledge is needed, because it is fundamental in evaluating the effects of stress and their significance.

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DO YOU KNOW?

Q1. What is laparoscopy?

Q2. Who beat the Britisher Robert. F-Scott in reaching South Pole first?

Q3. What is a blue moon?

Q4. What are Pangaea and Panthalassa?

MODERN AGRICULTURE AND ENVIRONMENTAL POLLUTION

Koushik Mukhopadhay* Ranjan Bera*, Ratneswar Roy**

In this era, advances in modern agriculture to meet the increasing food grain demands have adverse effects on environment. Increasing chemical inputs in agriculture, in terms of inorganic fertilizers and pesticides, along with the inefficient use of organic wastes without careful handling, affect adversely the biophysical environment creating serious threats to human beings. Liberal application of organic manure, in addition to judicious application of inorganic fertilizers and pesticides, should be encouraged as far as possible.

INTRODUCTION

With the present growth rate in population, which is anticipated to cross billion mark by 2020 AD, for which 325 million tones food grain will be required[1] against the present level of food grain production at about 203.9 million tones during 1999-00. Since there is no scope for horizontal expansion of land area, to achieve the targeted level of food grain production, the major emphasis has, therefore, been given on increasing the existing level of productivity of different crops through wider adoption of cost effective technologies, bringing more areas under high yielding varieties, hybrid and imporved varieties of principal crops and increasing the cropping intensity with the help of irrigation facility along with use of chemical fertilizers and pesticides.

Since India's independence in 1947 till the mid-eighties, spectacular development of agriculture took place, with the adoption of improved agricultural technologies by farmers leading to green revolution in food grain production and white revolution in milk production. But, simultaneously; it has given rise to pollution of nature in various ways thus it is becoming more difficult in sustaining the crop production.

SOURCES OF POLLUTION

The environment is plagued with different kinds of pollutants. Continuous imbalanced use of fertilizers and indiscriminate use of pesticides on crops and soil along with organic wastes, including domestic and industrial sewage sludge and food processing wastes, cause serious environmental pollution. A group of heavy metals such as arsenic, cadmium, lead, mercury have also been proved to be toxic to human being and other animals as they move along with food chain. Salts and acid rains are other major sources of environmental pollution.

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ENVIRONMENTAL EFFECTS OF FERTILIZERS

Fertilizers play a key role in increasing agricultural production. The fertilizer consumption of India has increased many folds in recent years (Table-1).

Table 1 : All India Consumption of N, P_2O_5 and K_2O in million tonnes

Year	N	P_2O_5	K_2O	Total
1951-52	0.0587	0.0069	–	0.0656
1956-57	0.1231	0.0159	0.0148	0.1538
1961-62	0.2498	0.0605	0.028	0.3383
1969-70	1.356	0.4160	0.210	1.982
1974-75	1.765	0.4715	0.3361	2.5726
1980-81	3.687	1.2136	0.6239	5.5245
1985-86	5.660	2.005	0.808	8.473
1990-91	7.997	3.221	1.428	12.646
1994-95	9.510	2.944	1.0644	13.5184
1997-98	10.91	3.92	1.37	16.2
1998-99	11.35	4.11	1.33	16.79
1999-00	11.59	4.80	1.68	18.07
2000-01	10.92	4.21	1.57	16.70
2001-02	11.42	4.42	1.71	17.55

Source : Fertilizer News, November, 1999.

Continuous, increased and imbalanced use of chemical fertilizers, has caused alarm regarding possible side effects in relation to environmental pollution in different states of our country. Repeated use of chemical fertilizers without adding adequate amount of organic manure is causing the soil to become more and more hard and impervious to water.

Effect of Long Term Continuous Use of Nitrogenous Fertilizers on Soil Properties

In developing countries, unabated use of nitrogenous fertilizers has the largest contribution to the depletion of soil fertility and its adverse effects on physical properties of soil It is reported that whereas an application of 174 kg N/ha in a fermer's field increased the rice yield by a factor of 2.9, it enhances the removal of P, K and S by factors of 2.6, 3.7 and 4.5 respectively[2]. It has been also proved that long-term use of N causes reduction in moisture content at different soil moisture tensions. Decrease in total carbon and nitrogen content and reduction in bacterial and fungal growth and population in 0-18 cm soil depth.

It is reported that continuous application of nitrogen through ammonium sulphate for 28 years at Kanke, Ranchi, reduced the pH of soil by more than 2 units and increased the % aluminium (Al) saturation to more than 60, improvised the soil with respect to exchangeable cations and reduced the availability of Zn, Cu, Mn, while NPK + lime and NPK + FYM treated plots did not suffer from such maladies[3].

Nitrate-Nitrogen Contamination of Water

Chemical fertilizers mainly N, P and some heavy metals like cadmium and lead cause Environment pollution, nitrate-nitrogen being most important. Again with nitrate-nitrogen, the focus is on pollution of drinking water or surface water and elltrophication. Plant nutrients, specialy NO_3–N in solution form of 3 ppm or above when added to surface natural water, encourage the undesirable growth of aquatic microflora and aquatic algae which is

termed as eutrophication[4]. This unwanted growth eventually leads to accumulation of considerable masses of dead organic materials that undergo decomposition. Since decomposition uses up oxygen in water, causing the other aquatic life to die and near anaerobic condition to develop. Higher concentration of nitrate in ground water is unfit for drinking. World Health Organisation (WHO) recommended that drinking water should not contain more than 11.3 mg NO_3/L as permissible for drinking water but upto 50 mg NO_3/L is aceptable in European Economic countries.

Effects of Excess Nitrogen (NO_3 or NH_3) on Atmosphere and on Humus and Animal Health

Fertilizer-nitrogen contamination of water increases the possibility of hazardous NO_3 concentration. A high nitrate ground water (10 mg NO_3^- N/L) when used for drinking is involved in the incidence of methemoglobinemia or blue baby disease[5], which occurs in baby mammals. High amounts of nitrate (100-150 ppm) are also alleged to cause birth defects, gastric cancer and nervous system impairment.

Among the gaseous products of fertilizer-N transformations, N_2O (nitrous oxide) is of major concern. Nitrous oxide is capable of promoting destruction of the stratospheric ozone layer, which protects the biosphere from the harmful ultra violet radiation. Denitrification is the source of nitrous oxide from agricultural fields.

Environmental Effects of Phosphate and Potash Fertilizer

The environmental pollution due to leaching of phosphatic compounds from agricultural fields and the eutrophication resulting from it, are in general more localized and of minor importance compared with other sources of phosphatic pollution in ground and surface water viz. industrial detergent, washing powder, phosphate factory effluents, etc.

It has been found that during the production of SSP in the factory, byproducts like sludge, which contains objectionable amount of fluoride, might cause pollution if and when mixed with finished product superphosphate as filler.

Available literature indicates that potassium does not cause enviornmental problem at present.

Hazardous Effect of Pesticides on Environment

Pesticides play an important role in controlling different types of pests causing damages to the crop plants. Pesticides not only protect our crops and livestock from insects, diseases and weeds but also helps to save lives from yellow fever, encephalitis, malaria, plague and other insect transmitted diseases.

Unfortunately, excess and indiscriminate uses of pesticides are now-a-days causing serious problem to the environment. The major problems are—

(a) Some pest organisms (particularly the insects) have developed resistance to chemicals. This necessitates higher doses or development of new chemicals to replace those chemicals to which the pests are resistant.

(b) Some pesticides are not biodegradable and tend to persist for years together in soil resulting the movement of chemicals to the other parts environment[6].

(c) Detrimental effects of chemicals have been found on ecofriendly organism other than

targeted group of organisms. It has been proved that as little as only 1% of the applied pesticide is used to knockdown the targeted organisms where as the rest 99% moves into the soil.

Pesticide Residues in Crop and its Effects on Environment

The improper and continued use of pesticides over the years may pollute the environment. The movement of pesticides between soil, living organisms, water and air can contaminate all the parts of environment. The residues in the soil may concentrate into the bodies of soil invertebrates and arthropods, and from these, they may get transported into the bodies of higher organisms through the food chain[7]. Further, pesticides are known to affect reproduction in some species, both through the reduced egg laying and decreased thickness of eggshell. In addition, pesticides may adversely affect the soil microorganisms and thus cellulose decomposition, nitrification and symbiotic nitrogen fixation in soil are reduced.

In recent past, a survey carried out by Indian Council of Medical Research, New Delhi, it was found that 51% of our food commodities were contaminated with pesticide residues and out of this, 20% had pesticide residues above the maximum residues limit.

Persistence of Pesticides in Soil

Pesticides applied to either soil or crops are subjected to volatilization, leaching, chemical modification and microbial degradation. The persistence of pesticide is the length of time that a pesticide (chemical) remains active in soil. The persistence of pesticide varies from chemical to chemical. Majority of pesticides generally degrade rapidly after application to soil or on crop but which do not do so, have the potentiality to build up of concentration of chemicals in soil indicating the risk of environmental pollution. Common ranges of persistence of some pesticides are given in **Table–2**. Those chemicals with greatest persistence have the higher risk of bringing about environmental pollution.

Table 2 : Common Range of Persistence of Some Pesticides[7]

Pesticides	Persistence
Arsenic	Infinite
Chlorinated hydrocarbon insecticides (DDT, Chlordane)	2.5 years
Triazine herbicides (Atrazine, Simazine)	1-2 years
Benzoic acid herbicide (Amiber, Diuron)	2-12 months
Urea herbicides (Monouron, Diuron)	2-10 months
Phenoxy herbicide (2, 4-D)	1-5 months
Organophosphate insecticide (Malathion)	1-12 weeks
Carbamate Insecticide	1-8 weeks

Contamination of Soil and Envirnoment with Toxic Inorganic Heavy Metals

Public attention has been drawn during the recent years on the environmental pollution through a number of inorganic compounds including those containing mercury, lead, cadimium, nickel, copper, zinc, molybdenum, flourine and boron.

Effects of some heavy metals on crop growth and human health are as follows :

Nickel (Ni)

Nickel content in soil veries from 4-55 ppm but it can be as high as 1000 ppm. Nickel is a strongly phytotoxic element, being several times more toxic than Cu^{++}. The normal concentration of Ni in plant is 0.1-5 ppm of dry weight but at 50-100 ppm it becomes toxic to plant.

Higher concentration of Ni causes skin disease, dermatitis, kidney and liver disfunction of human being.

Cadimium (Cd)

Cadmium is a highly biotic element due to its close association with public health and tendency to get accumulated in mammals and plant. Cadmium content in soil varies from 0.06-1.1 ppm, at 10 ppm concentration it becomes toxic to plant. Increasing level of Cd concentration in plant has depressing effect on plant growth. It has been found that P helps in counteracting the depressing effect of Cd on the yield of rice.

Cadmium concentration below 10 ppm is toxic to human being causing pulmonary disorders, renal discunction, hypertension etc.

Arsenic (As)

Arsenic was used for many years as an insecticide on cotton, tobacco and fruit crops. It is still being used as defoliant or vine killer on lawn. This heavy metal is found as constituent in specific fungicide, herbicide, insecticide and tend to be concentrated in domestic and industrial sweage-sluge. The toxic effect of arsenic residues had been found in vegetable crops grown in the field[8]. This metal exerts its toxic action by attacking SH group of an enzyme, thereby inhibiting enzyme action. It also prevents the generation of ATP. The major action of arsenic is coagulation of protein, complexation with co-enzyme and uncoupling of phosphorylation. The maximum permissible concentration of arsenic in drinking water is 50 ug/L. The averse effects of excess arsenic on human health include perforation of nasal septum, black foot disease, paralysis of nerves, skin and lung concern etc.

Copper (Cu)

Sewage-sludge contains 'Cu' in the range of 840-4000 ppm. The EPM limit is 4300 ppm with a maximum loading of 1500 kg Cu/ha., 25-300 ppm 'Cu' of dry matter can be phytotoxic. 25-300 ppm dry diet can be the tolerable limit by domestic animals.

Environmental Effect of Organic Waste

The domestic and industrial sewage-sludge is used frequently in different countries as organic manure for crop production. These organic wastes exert beneficial physical effects on soils and are significant source of plant nutrients. But they commonly carry considerable amount of inorganic as well as organic chemicals **(Table–3)**, which may have harmful effects on environment. Sludge should not be used on crops which are grazed (grasses, cloves) or those eaten fresh by human (lettuce, carrot, radish)[9]. The crops such as leafy vegetables like spinach are most likely to be high in heavy metals when grown on sludge treated soils and the least effected are the grain crops, fruit and other seed crops.

Table 3 : Average Consumption of Sewage-sludge from Municipalities in U.S.A.

Composition	Concentration on dry weight basis	Elements	Concentrations in ppm
Organic carbon	30.4	Zinc	1740
Total nitrogen	3.3	Copper	850
Total phosphorus	2.3	Chromium	890
Total sulphur	1.1	Nickel	82
Calcium	3.9	Cadimum	260
Sodium	0.2	Lead	500
Potassium	0.3	Mercury	5
		Arsenic	10

*Source : Selected data from L.E. Sommer J. Environ. Quality, **6**, 225-232, 1977.*

The most serious environmental threat caused by food processing waste disposal is that of water pollution by nitrogen. If such materials are dumped these erode into surface water, they also reduce oxygen in the water because of high chemical oxygen demand value and cause eutrophication from nitrogen and phosphorus added by the wastes.

Effect of Salts on Soil Environment

Contamination of soils with salts is one form of soil pollution, primarily agricultural in origin. Salts accumulate in soils because most of them involve into the root zone of the plant and then move out. In high concentration, they hinder plant growth, speed up corrosion of metals, make drinking water unpalatable and interfere in many other uses of water. Salts move up from lower horizon and conentrate in the surface soil layers. Some sewage-sludge have sufficiently high levels of salts to cause crop plants damage when the sludge is applied. The control of salinity depends entirely on water, its quality and management.

Effect of Acid Rain on Environment

Scientist in Europe and North America have drawn attention to the marked increase in the acidity of precipitation over recent decades. Rainwater normally has a pH of about 5.6 owing to the presence of H_2CO_3 formed from the CO_2 in the atmosphere. Acid rain is apparently due to the oxidation of nitrogen (N) and sulfur (S) containing gasses that dissolve in water vapour of atmosphere to form HNO_3 and H_2SO_4. Following reactions are thought to occur.

$$2NO + O_2 \Rightarrow 2NO_2 \xrightarrow{H_2O} \Rightarrow HNO_3 + HNO_2$$

$$2SO_2 + O_2 \Rightarrow 2SO_3 \xrightarrow{H_2O} \Rightarrow 2H_2SO_4$$

The effects of acid rain are more pronounced on the acidity of water, since most of the fishes cannot tolerate pH level below 4.5. The effects of acid rain on soil are less hazardous. But continued input of acid due to acid rain at pH 4-4.5 has significant effect on the pH of soils specially those that are weakly buffered since increased acidity can make them less fertile. Many adverse effects of acid rain were seen on forestland and on steep mountainous areas in North America where application of lime was difficult.

CONCLUSION

It is quite evident that though we require more food to feed our huge population for which more and more crop production is vital but not at the cost of polluting the environment, which in turn will cause health hazard of both

human being and cattle. It is true that crop production cannot be sustained if inorganic fertilizers and chemical pesticide are used in indiscriminate way resulting in pollution of soil and water. Further, it is true that we cannot achieve the target of producing more and more crops year after year with the use of only organic manure and phytobased chemicals to combat war against insects, diseases and weeds. Some of the agricultural technologies appropriate to preserve the environment quality with priority are—

(a) Integration of traditional conservation oriented farming techniques with current scientific technologies.

(b) Emphasising soil based practices (crop rotation, green manuring, crop residues and animal residues use).

(c) Integrated pest management (cultural, biological and biotechnical control of weed, insect and disease pathogens).

(d) Integrated nutrient management.

(e) Conservation of natural resources.

Therefore it can be concluded that to boost up the yield of the crop on sustainable basis without affecting environment, liberal application of organic manure, in addition to need based application of inorganic fertilizers, along with judicious application of chemical pesticide are essential. Indiscriminate use of fertilizers and pesticides should be discouraged as far as practicable.

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TRADITIONAL AND PRESENT DAY TOYS : A CRITICAL APPRAISAL

Usha Kothari and Nasreen Gazdar*

This article presents a critical appraisal of traditional and present day toys meant for pre-school children. The study has been undertaken to determine the safety aspect, cost, educational values, appropriateness and durability of toys. A purposive sample of 100 mothers who has pre-school children were selected within the municipal limit of Jodhpur City (Rajasthan). These mothers were interviewed on a structured schedule by the investigators at parent-teacher meetings and at homes. The findings lead to the conclusions that maximum consideration in choosing toys bought by parents is given to child's age, safety and the price of the toys. Safety, educational values and cost were observed in both types of toys. Overall majority said that weapon toys and Barbie dolls should be banned, these stimulate feeling of aggressiveness, violence and sex at an early age. Toys are simply the best for pre-schoolers. Traditional building blocks and play-doll are far better for children's learning than high-tech educational toys and videos.

INTRODUCTION

"Let the child skip and play, Tip, tap, top, Swing & Sway, Let his mind dance with joy, In a world full of toys"

An eminent educationist once said, "Just as a poet cannot restrain himself from writing a poem or a musician from singing, so too the child cannot restrain himself from playing". Perhaps no other period of life involve as much significance and importance in human development as the early childhood years. It is this period when the foundation for the future is laid in one's life. Early childhood is often called "toy stage" because at this time the child's play makes use of toys in one form or another.

Children's plays, down the ages are in all historical documents, and excavations in the ruins of ancient Egypt, Babylonia and Mohenjodaro reveal toys, dolls and rattles which prove that play and toys have been a part of child's life since time immemorial. This has been recognized by eminent psychologists, educationists and child specialists like Frobel, Montessori, John Dewey, Gandhi, Tagore, Madam Montessori, Rousseau, Froebel, Pestolozzi and others stress that the sense are the Pathways of knowledge.

Some believe that play is a pure spiritual acitvity at this stage. It gives joy and a sense of freedom.

POSITIVE ASPECTS OF TOYS

Play is children's work and toys are the tools used in play. In addition, toys can keep children occupied and, properly chosen, should assist in physical, mental, social and emotional development.

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Toys can also help imagination and stinulate inquiring minds. Through play, concepts and ideas are taught and reinforced. Some toys encourage social interaction and others suggest "quiet time". Toys can be used in clinical situations to assess mental development or to probe psychological problems in children who may lack verbal skill. With the right blend of creativity and design, toys can enhance the process of discovery, learning and imagination.

Toys can foster physical and motor development in children and stimulate creativity when there is something to create from the available materials. Toys can contribute to child's social and emotional development. The psychological meaning of toys is considered in terms of building of ego function and as developmental precursor to friendship especially among children from 3 to 6 years. They foster language development perception, meaning, thinking processes and other areas of cognition. The educational value of toys is generally measured in the ability to "teach" or reinforce concepts and methodologies. Through toys, the child learn new color, textures, movement and objects.

Toys that are part of the preschool life experience induce children to learn their society's values and perhaps also to discover more about themselves. With children thinking about toys as product of culture they may realize that 'Toys are us'.

NEGATIVE ASPECTS OF TOYS

Children are surrounded by a plethora of present day toys. Parents worry about the negative effects of hi-tech toys, weapon toys, video games. Cambative toys like fighter planes, robots and the range series pose bodily harm to children and stimulate feelings of competition, aggression, violence and war. Continued use of such toys may make children prefer violence in setting conflicts instead of trying peaceful means and may make them prefer warlike activities instead of relating with people and nature. If toy makers continue to produce these toy weapons, they will have a negative impact on children's emotional and physical growth, and in future, may disturb the peace of our soceity.

Professor Hirsh Pasek, of Temple University, Philadelphia said (2004) that now-a-days, toys we select for children are supposed to make them learn, but those toys do the opposite.

TYPES OF TOYS

Toys are of the following two types.

Structured Play Material : Structured plaything that have more detail but lack multipurpose, can be used for one situation only. They are less flexible in a play setting. Most are designed for a specific play use : for example, a milk truck designed with great detail can be used only for milk delivery.

Many experts worry that in today's society there are less and qporotunities for our children to exercise fantasy. Nothing is left to the imagination and thus, it is conceivable that imagination and fantasy may decline in some groups for lack of practice.

Unstructured Play Materials : As child has more play choices with unstructured play materials in which the reward lies in the excitement of discovery and in the play activity

itself. There are no preconceived goals engineered into unstructured play and no adult-imposed objectives. Most often such toys are the raw materials of play and include nursery school unit building blocks, clay, sand, finger paints, water poster paints, peg boards, design cubes, collage materials, scissors and paste for which there are no blueprints to follow. A child gains pleasure and a sense of confidence in herself everytime she masters the elements in her play world.

SOME RESULTS OF SURVEY

The result of our survey shows that most of the respondents (73.34 per cent) had not experienced having their children hurt by toys. The study also pointed out that toys like balls, building blocks, dolls/soft toys and house utensils, in early childhood offer good mental exercises. Even these toys are capable of involving children in play for longer time and provide opportunity to assemble. Mothers were the main buyers of toys. Fathers, grandparents, friends and any other ranked second, third and fourth respectively. There were 34 percent of respondent donating an old toy to a social work organization, 30.66 percent of worn out toys were kept somewhere in the house, implying the possibility of re-use.

It is good to note that in the present sample around 53.34 per cent of the mothers actually made traditional toys for the children. Many mothers had made more than one toys from various waste materials like clay toys, soft toys, paper toys, building block, wind chime and puppets. 92 percent of the mothers said that traditional toys help children in learning the adult task. The mothers were generally satisfied with the toys they had bought. When a comparison was made between Indian-made toys and foreign made toys, 50 percent said they would buy locally made toys and 50 percent said that they would purchase foreign made toys because their quality is very good.

Both the present day toys and traditional toys are found to be safe. However, the biggest problem of locally made toys is low durability. Many mothers suspected that some were made out of materials, hazardous to child health. These toys were never worn-out and they were either given to the poor, or stored in the child's room.

The result reveals that 'time' is not specified for playing with video games and watching T.V. Whenever the children are free, they play with video game and watch T.V. Parents are worried about the negative effects of video games on eyes and effect of T.V. on child's personality. 65.34 percent of respondents said they had purchased weapons toys i.e. guns, tanks, etc. The majority (70.66%) of respondents said that they bought the toys at the behest of the child.

Nearly half of the respondents (53.34 percent) said that weapon toys should be banned, as these toys tend to make children aggressive. Similarly, they felt that Barbie doll should also be banned because Barbie is more a grown up figure and not fit for a child.

RECOMMENDATIONS

To refine the decision making process and select on age-appropriate toy, the best guidelines are "Common Sense and read the label" Age-appropriate means buying a toy without

removable parts for a toddler who can easily swallow and choke on a small item. Age-appropriate means selecting a game that will challenge and stimulate an older child. It was found that the toys of present day were appropriate to their ages.

The range of packaging is broad and consumers can generally find the following types of information on the label :

Name of Manufacturer, trademarks, licensing, etc., "Small parts warning" (e.g. toy parts may present a choking hazard), Suggested age (e.g. "Recommended for ager c+", "Not suitable for under age 3")

There may also be a mention about washability, safety standards and price.

Most accidents or injuries related to toys usually assign the blame to the toys, not the user or the purchaser. In fact, most accidents or injuries are directly attributable to the lack of adults supervision. Statistics indicate that in most cases injury occurs as a result of tripping over or bumping into a toy and the swallowing of small toys or parts by age inappropriate children. Some safety tips will be as follows.

- Before purchasing the toy or game, read the label for detailed information. Determine suitability for age, interests and environment.
- Monitor usage. All toys are not suitable for children of all ages.
- Check toys regularly for broken parts, deterioration, defects, cleanliness and general safety.
- Be alert. Toys chould not be left unattended in potentially dangerous places, such as on stairs.
- Supervise play activities appropriately.

DO YOU KNOW?

Q5. Who amongst these can recognise themselves in the mirror ?

(a) Cats, dogs and horses.

(b) Monkeys

(c) Apes (Chimpanzee Orang-otang, Gorilla etc.)

Q6. How do you call a mass equivalent of a dozen suns confined in a space as small as 10^{-23} cm – less than a billion-billion, billionth part of the width of a hair?

Q7. What according to Aristortle was the element of heredity?

GLOBAL SCENARIO OF INDUSTRIAL LOW BACK PAIN WITH SPECIAL EMPHASIS ON INDIAN PROFILE

Ankan Gupta, Sanchari Sinha & Amal Roy Chowdhury*

Low back pain, a major occupational health hazard across the world, is actually a musculoskeletal disorder associated with neurological and other factors like work stress, nutritional status, age, sex and other socio-eco-psycho-physiological factors. Information on the prevalence and incidence of low back pain are available from multiple sources including insurance and hospital data, interviews of questionnaires and clinical studies. Productivity loss in relation to man-hour loss due to absenteeism and financial loss due to compensation have become a very serious trouble for many industrial sectors. Management and workers both should be aware about the spectrum of the problem. Proper awareness teaching by different audiovisual aids may be adopted to combat the problem.

INTRODUCTION

Low back pain affects lumbosacral region of spinal cord, associated muscles and nerves innervating the concerned region, mostly sciatic nerve. Low back pain causes disfunctioning of various body portions such as lumber vertebrae, innervertebral disc, spinal cord and nerves, facet joints, muscles and ligaments.

Occupational low back pain is clearly related to lifting, carrying and repetitive activites that require the change of working posture every now and then causing stress on lower back. It has become a gigantic problem in the industrial sectors where a huge fraction of the workers are suffering from this disease.

Multifacet studies have revealed that the problem can lead to various socio-eco-physiological setbacks, which in turn, may generally affect our society. Based on national data, occupational groups with highest estimates of prevalence of low back pain include mechanics and repairers of vehicles, engines and heavy equipment, operators of extractive, mining and material morning equipment, and people in construction trades and other construction occupations.

Therefore, it can be revealed that different industrial sectors are very much susceptible to low back pain in terms of productivity loss as well as financial loss upon compensation.

Our aim, therefore, is to identify the industrial sectors being affected by low back pain and to evaluate the socioeconomic determinants and impact of low back pain.

PREVALENCE AND EPIDEMIOLOGY OF LOW BACK PAIN IN GLOBAL AND INDIAN CONTEXT

Information on the prevalence and incidence of lower back pain was available from multiple

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sources including insurance and hospital data, interviews or questionnaires and clinical studies. Various industrial sectors, which were mostly affected by occupational lower back pain, include miners, construction workers, drivers & heavy industry workers.

In the coal mining industry of New South Wales, it was primarily found that the industry generates a considerable number of worker's compensation claims for back injuries, which are arising directly from rough rides. An epidemiological case control study taking the workers engaged in contruction works indicated that persons with the jobs requiring lifting objects of more than 11.3 Kg. (25lb) with an average of more than 25 times per day had a high risk for development of low back pain. In this respect, 54% construction workers in USA suffered from low back pain of which 7% cases were severe. The prevalence rate of low back pain was also measured in the Dutch working population showed that a total of 27.66% of the workers had low back pain. Drivers were mostly suceptible group in this regard. Prevalence of low back pain in one month of the survey was 50.3% in case of 153 **truck drivers** of a large chemical industry corporation. In USA, 52.9% drivers pointed out the relationship between low back pain and work, which involves the vibration or road shock. Prevalence of low back pain was investigated among 1155 tractor drivers exposed to whole body vibration and postural stress. It was found that the prevalence of low back pain was higher in the tractor driver and this low back pain was found to be significantly associated with both vibration level and awkward postural load. Back accidents and age were also significant predictors for low back pain. Another working population very much susceptible to low back pain was **Heavy industry workers.** A study done in American offshore petroleum drilling company revealed that workers performing the heaviest physical labor were at highest risk of low back pain. 114 male workers of a concrete manufacturing plant in Japan were investigated and the prevalence of low back pain in the 12 months preceding the investigation was found to be 59%. A survey among 33 crane operators of a steel factory of UK suggested that workers in sedentary position with exposure to whole body vibration were at high risk for low back pain. An electronics manufacturing plant in USA also showed a srtong increase in low back pain incidence for both males and females.

Although it was apprehended that the various industrial sectors in India are susceptible to low back pain, but since a huge fraction of the total industrial belt is unorganized, documentation of overall comprehensive scenario of low back pain was extremely difficult. However, the industrial sectors in India susceptible to low back pain can be broadly classified into two categories namely organized and unorganized sectors.

In case of organized industrial sectors, too nominal studies had been made in this regard among which **software professionals** are found to be susceptible to low back pain. Considering

all physiological risk factors, it was found that 27% of the professionals are suffering from back pain.

Prevalence of low back pain in India was mostly analyzed in case of unorganized sectors. In case of **Textile industry**, a cross sectional study among 514 textile workers of Sri Bapurao Deshmukh, Girini, Wardha, India revealed that 57 workers suffered from low back pain. Mumbai **dockworkers** were very much susceptible to low back pain. In the **brick kiln industry**, it was found that 8.56% workers suffered from low back pain due to various awkward postures. Gold smiths also suffered from low back pain due to their fixed sitting posture. Most of the milk vendors in our country suffered from severe low back pain.

A cross-sectional study among 167 employees in a plastic moulding factory of kolkata revealed that total morbidity of musculoskeletal disorder along with low back pain is 28%. Molasses producing workers are exposed to hazards of both molasses production and agriculture, where low back pain is quite frequent. In North Bihar, it was revealed that 39.2% workers suffer from low back pain due to exposure to uncomfortable posture, job stress and long duration. Manual material handling workers were very much susceptible to low back pain due to their strainous working schedule and awkward working posture. Out of 72 male workers involved in **manual material handing** at the central market area of Kolkata, 21% suffered from low back pain. In case of **Automobile transport workers**, it was found that out of 239 workers been examined, 24.68% suffer from back pain. Study conducted among 34 workers in the FCI godown, kolkata, explored that 26.35% of these storage grain workers suffer from low back pain.

TABLE 1 : Intensity of Low Back Pain In Different Occupations In India

Occupation	Percentage Aggected	Reference
Software professional	27%	Ind. J. Occup. Env. Med, Jan–Apr. 2003 ; 7(1)
Textile industry	11%	Ind. J. Occup. Env. Med, Jan–Apr. 2003 ; 7(1)
Brick kiln industry	8.56%	Ind. J. Occup. Env. Med, Oct–Dec. 2002 ; 6(4)
Plastic moulding factory	28%	Ind. J. Occup. Env. Med, Oct–Dec. 2002 ; 6(4)
Molasses producing factory	39.2%	Ind. J. Occup. Env. Med, Oct–Dec. 2002 ; 6(4)
Manual material handling	21%	Ind. J. Occup. Env. Med, Oct–Dec. 2002 ; 6(4)
Automobile transport	24.68%	Annual–on going projects and New project proposal 2000–2001. Regional Occupational Health Centre (E). ICMR
Storage grain worker	26.35%	Annual-on going projects and New project proposal 2000–2001. Regional Occupational Health Centre (E). ICMR

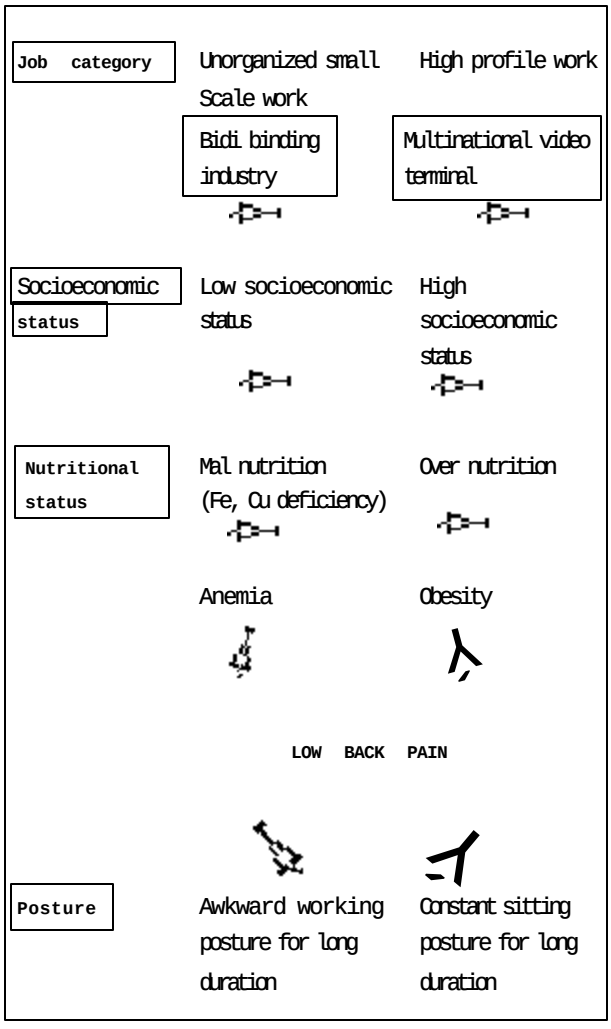
SOCIOECONOMIC DETERMINANTS AND IMPACT OF LOW BACK PAIN

There are several socioeconomic determinants of low back pain such as nutritional status, family size, duration of work, etc which directly influence upon the causation of low back pain or passively result in the same by altering several factors such as psychophysiological factors which include motivation, anxiety, excitation etc. Gernerally it has been observed that a large number of *bidi* binding female workers at Murshidabad, West Bengal, are suffering from low back pain due to the maintenance of constant awkward posture for a long duration. The nutritional survey revealed that they are nutritional deficient and are anemic, the haemoglobin concentration being as low as 6-7 mg/dL. Another study showed that copper deficiency may lead to the low back pain. On the contrary, female workers of high socioeconomic group working in multinational video terminal also suffer from low back pain due to awkward sitting posture and perhaps also due to obesity. Therfore, socio-economically nutritional status is a prime determinant of the causation of low back pain.

Many workers are forced to take leave temporarily or in the severe case permanently from their workplace due to the suffering from low back pain. The absenteeism thus, has become a serious problem in the socio-economic aspect as the productivity declines owing to it and the authority of the respective industry has to provide compensation to the sufferer. Various data regarding the rate of absence of workers and the compensation cost provided by the various industries were abtained from various studies on specific industrial populations. Such data are useful in defining the magnitude of the problem.

Various epidemiological information regarding the absenteeism of low back pain from different countries are considered separately because the differing socio-economic factors of these populations may influence the results.

Flow Chart : Socio-Economic Determinants Of Low Back Pain



Global Scenario of the Absenteeism

In the United States, low back pain was the most common cause of decrease in work capacity. An average of 28.6 days per 100 workers was lost in each year due to this problem. In New York over a 10 year period, low back pain was second to upper respiratory illness in terms of length of sickness absence period. The yearly sickness absence per worker was estimated to be four hours. It was established that 2% of all employees in the US had a compensable back injury each year. It was found that the number of sickness absence episodes per 1000 persons was 11 for women and 22.6 for men in case of United Kingdom. The data obtained from National Coal Board, suggest that 14.8% of the total work force was absent from work because of back injuries. In case of Scandinavian working population, 12.5% of all annual sickness absence days were related to low back disorders. This means that 1% of all workdays were lost annually because of low back condition. The average sickness absence period was 36 days. 49,000 subjects from 20 to 65 years of age in the district of Gothenburg in Sweden were analyzed and reported a total of 7,526 sickness absence episodes for LBP over an 18 month period. Based on the 1978 to 1979 Canada Health Survey, it was found that the total number of disability days exceeded 21 million and the average sickness absence period was 21.4 days.

Compensation Cost : An Overall Profile

In the United States, payments for direct costs of low back pain come from many sources, such as worker's compensation insurance (including federal, state and private insurers), group and individual health insurance plants, and social security benefits. These direct cost typically include wage loss and wage replacement, medical care, temporary and permanent disability, rehabilitation expenses and death benefits. The indirect costs associated with production losses and personal suffering. These costs include loss of production, new hires, training supervision, administration and legal expenses.

From a study of worker's compensation statistics of 9 states it was found that back injuries averaged 21% of all compensable work injuries, ranging from 15% in Kansas to 24% in California. National Council on Compensation Insurance found that cost of LBP comprise about 33% of all compensation costs. In a report, Social Security Administration stated that total cost of occupational injuries was $ 8 billion in US, out of those, compensation costs for LBP was 33% of $ 8 billion i.e. $ 2.7 billion in a year.

CONCLUSION

Management and workers both should be aware about the spectrum of the problem. The current scenario reflects that the concern over the matter lacks behind, so, proper awareness teaching by different audiovisual aids may be adopted to combat the problem. Development of training programme to maintain proper posture during manual material handing should be adopted. Evaluation of baseline data regarding low back pain in occupational and industrial sectors of developing countries needs to be made and last but not the least, proper rehabilitation programmes and preventive measures should be taken.

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DO YOU KNOW?

Q8. Name an animal that cannot jump ?

Q9. Who blinks more–men or women ?

RAW JUTE (TOSSA-DAISEE) GRADING

M. K. Sinha, H.S. Sen, S. Mitra and S. Nandy*

Eight grades are recognized for each of the two classes of fibre viz. 'tossa-daisee' (*Corchorus olitirious L.*) and 'white' jute (*Corhourus capsularis L.*). The quality parameters considered in the market are strength, colour, lustre, density, fineness, extent of 'root' (present in the sample) and the nature of 'defects' ; besides CRIJAF other institutes at Kolkata have facilities to measure them accurately. In the primary markets, 'hand and eye' assessment of quality continues because assessment by instrument is not possible. The buyer determines the grade. It is felt that a discriminating person intending to standardize his/her own 'hand and eye' method, may find the information provided in the pages useful. The merits of the grading system suggested in this article should be considered on its own and not a replacement of the system laid down in IS : 271 of BIS.

INTRODUCTION

The current raw jute grading system was introduced in 1974. The parameters considered for defining a grade include strength, colour, lustre, density, fineness, extent of 'root' (present in the sample) and the nature of 'defects'. The Bureau of Indian Standards (BIS) gives the details in its publication IS : 271-1969.

Thus, eight grades are recognized for each of the two classes of fibre viz. 'tossa-daisee' and 'white'. The grades are built up by a marking system, according to which the TD_1 is to attain 100 marks. (Table 1) ; TD_2 demands 75, TD_3 60 and so on, After about 27 years, one finds that the marking system is seldom followed in the market. We have sophisticated instruments to accurately measure strength, fineness and density. There is an instrument even to measure lustre. But such instruments are available only with Institutes like NIRJAFT (National Institute for Research in Jute and Allied Fibres Technology), IJIRA (Indian Jute Industries Research Association) and CRIJAF. Hence, in the primary markets, 'hand and eye' assessment of quality continues. Largely, the impression on the buyer determines the grade. The grading system, however, has achieved one important achievement to its credit ; it has eliminated the geographic bias. For example Bihar jute used to be earlier condemned as 'jungli' ; now one finds grade V or IV in good quantities in Purnea, Bihar.

Table 1 B.I.S gives a brief description of the quality characters demanded by each grade and allots corresponding marks in parentheses. However, no one, not even the Jute Corporation makes use of the marking system. In Table 2, the quality columns have been placed in order of importance by the authors. Full marks are indicated above each column in the third bar. In column II qualifying marks are given for each grade and the quality expected has been mentioned in rest of the columns.

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Table-1 : Requirements For Each Grade Of Tossa and Daisee Jute. (IS. 217-1969)

Grade	Strength	Colour	Lustre	Density	Fineness	Maximum Root-content (by Weight)	Defects	Total
TD_1	Very good (29)	Very good (15)	Good (5)	Heavy-bodied (5)	Very fine (7)	5 percent	Free (12)	100
TD_2	Good (20)	Good (9)	Good (5)	Heavy-bodied (5)	Fine (3)	10 percent	Free (12)	75
TD_3	Strong (17)	Fairly good (7)	Lustrous (4)	Medium-bodied (3)	—	15 percent	Substantially Free (10)	60
TD_4	Strong (17)	Fairly average (5)	Slightly Lustrous (1)	Medium-bodied (3)	—	20 percent	Free from major defects (6)	45
TD_5	Average (11)	Average (4)	—	—	—	25 percent	Free from major defects except speaks (3)	30
TD_6	Average (11)	Any (0)	—	—	—	35 percent	Free from HUNKY and sticks (2)	18
TD_7	Weak mixed (4)	Any (0)	—	—	—	40 percent	Free from HUNKA and sticks (2)	8
TD_8	—	—	—	—	—	—	Free from HUNKA and sticks (2)	2

Table-2 : Assessment System for Grades of Tossa Daisee Raw Jute

Grade	Strength	Defects	Maximum	Colour	Fineness	Density	Total scores	Earlier
	Very good	Freedom from defects M = major defects m = minor defects	(4%) (by wieght)	Very good	Very fine	Heavy	100	
TD_1	30	15 -M –m	5	15	30	5	100	$TD_1 + TD_2$
W_1	30	15 -M –m	5	15	30	5	100	$W_1 + W_2$
	Very good	Do	(20%)	Good	Very Fine	Heavy		
TD_2	25	15 -M –m	5	10	20	5	80	TD_3
W_2	25	15 -M –m	5	10	20	5	80	W_3
	Average	No centre root dazed, entangled stick	(30%)	Average	Average	Light mixed		
TD_4	15	15 —	—	5	10	—	45	$TD_5 + TD_6$
W_4	15	15 —	—	5	10	—	45	$W_5 + W_6$
	Weak/ Mixed	(30%) Some centre root, Hunka, entangled stick	(40%)	Below average	Below average	Very high mixed		
TD_5	5	5 —	5	—	—	—	15	$TD_7 + TD_8$
W_5	5	5 —	5	—	—	—	15	$W_7 + W_8$

QUALITY PARAMETERS FOR MARKETING

The quality parameters considered in the market are given below :

Root Content :

When a fibre sample (reed) retains un-retted or incompletely retted barky bottom, it is called 'rooty'. It is easily detected by its brown or dark brown colour. As jute crop grows older beyond 100 days or so a tough tissue called periderm develops at the bottom and spreads upwards. The cells in periderm have tough wall due to suberization. The usual enzymes of retting bacteria connot break this wall in 12 to 15 days. Older the crop greater is the extent of periderm. The *capsularis* varieties develop more periderm than *olitorius.* JRO-524 (*olitorius*) has the least periderm. In fact, it is due to progressive increase of area under JRO-524, in replacement of *capsularis* varieties in many areas, that jute market is getting progressively smaller bulks of rooty fibre from year to year.

Strength :

In the primary market strength of fibre is assessed as per age old method i.e., tearing stress by hand and fingers. Correct retting retains the genetic strength. Over-retting weakens the fibre, which has a 'dazed' look and dull colour, Fineness and strength have some positive correlation.

Defects :

A. Due to faulty retting :

a. Dazed : If over-retted, fibre loses shine and has a dazed look ; such fibre is always weak. If jute stem bundles remain in contact with the muddy floor of retting ditch, the fibre often becomes dazed. Fibres stored in damp godown for over a year, lose the normal shine and give a dazed, discoloured look.

b. Croppy : Under-retted stem produces croppy fibre. Incomplete immersion of jute bundles may also result in croppy coarse fibre.

c. Leafy : A sample of fibre, otherwise good, may retain dark, papery pieces of plant debris on it ; these leafy objects are pieces of epidermal tissue or periderm, seldom-true leaf. Proper washing, after retting, removes them off.

d. Sticky : Broken pieces of jute stick may remain fast entangled with or loosely adhering to fibre. This defect arises from the beat-break-jerk process of extraction. Careful washing and cleaning of dry fibre with jerks reduces their number. When extraction is done plant-wise, sticks are completely absent.

e. Mossy fibre : In flood-prone areas, adventitious roots of endogenous origin develop on submerged portion of the stem. These roots persist even after retting as they are of endogenous origin. Retting cannot eliminate them. Fibre from such roots remains entangled with stem fibre and gives a mossy look.

Harvest above the water line is the only remedy. Fortunately, with introduction of new improved varieties (*C. capsularis and C. olitorius*–both) and improved technique of cultivation, mossy fibre is fast disappearing from the market.

B. Due to insect and fungal attack :

A. Knots : The female insect pest *Apion corchori* lays fertilized egg on the node of softer upper part of stem. The emerging grub feeds on the tissues around, its faecal matter subsequently gets mixed with tissue debris and gets bound with the gum of the plant. This forms a bard knot which persists through retting, resulting in knotty fibre.

b. Specky : Sometimes the female apion punctures the node to lay egg but the grub fails to emerge. In such cases a callous tissue as 'speck' is formed. These specks persist even after retting.

c. Centre Root : Fibre, which is more or less soft and clean in upper and lower region but retains in the middle a hard strip, is known as 'centre-root'. This result from plants infected by stem rot, killing tissues at nodal region. Dead tissues refuse to ret and hence an unretted usually brown portion persists.

d. Hunka : Plants killed by root rot or soft rot, do not ret. Thus the fibre bearing bark of such plants remains hard throughout the length and is termed 'hunka'. Such reeds are dark brown. Preretting elimination of dead plants from bundles is the only way to avoid 'hunka'

Colour and Lustre :

When retting is perfect and washing is thorough, the resulting 'tossa' fibre is golden yellow, bright cream or of yellow gloss. Though it is not as important as 'strength' yet colour influences the judgement. It is difficult to judge colour and lustre separately.

In Hooghly (West Bengal) and Kendrapara (Orissa), one finds 'shyamala' or dark coloured jute that has good lustre. The dark colour is due to iron-tannin reaction in retting water.

Fineness :

Fineness is easily detectable ; fine fibre has some positive association with strength. Fine fibre usually has a good lustre as well,. Fineness is a genetic property, whose expression depends on perfection in retting.

Density :

Weight of unit volume of fibre, including air space, is the measure of density. At field level density is judged by the force required to lift a given sample ; if the feel is 'heavy' the sample is taken to be 'heavy bodied' or of greater density.

Depending on the present day necessity of quality fibres in the jute trade, reallocation of sources in different grades is suggested.

Rationale for reallocation of scores :

1. Jute fibre in the trade is mostly free of root contents at present (Tossa jute fibre is free of roots, 120 days crop does not produce root)

2. Fibre quality has assumed much greater importance for producing all types of jute products.

3. Defects due to incidence of pests and disease are comparatively less than before.

4. W3, TD3 and TD4, W4 have been placed in two separate grades as 70% of total jute belongs to these two grades.

Based on the aforestated observations and inferences, a new grading system (Table 2) had been worked out for tossa-daisee raw jute fibre. The number of grades has also been reduced to five. It is felt that discriminating person may make use of the grades proposed in Table 2 to standardize his/her own "hand and eye" method.

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1. Burean of Indian Standards publication, 1969, IS : 271.

ERRATUM

The name of the Vice-Chanceller, Acharya N.G. Ranga Agricultural University, Hyderabad, mentioned under 'Know Thy Institution' in Vol. XL No.2, 2005 should read as **Dr. S. Ragu Vardhan Reddy** instead of Dr. P. Raghava Reddy.

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The error is regretted

Editorial Secretary

SHORT COMMUNICATION

THE LEVINTHAL PARADOX

D. Balasubramanian*

Consider a piece of sewing thread about a metre long, strewn about randomly. What is the probability that it will coil up, all by itself, into a compact neat ball ? How long would it take for it to pack itself into this ball ? The answer is immediate and intuitive–an astronomically long period of time. So long that one can dismiss it as an impossibility ; the strewn about thread simply will not roll up into a ball until "kingdom comes", as the phrase goes. One estimate is that it will take 10^{150} years ; that is one followed by 150 zeros. Compare this with the fact that the universe itself is only about ten to twenty billion years ($1–2 \times 10^{10}$ years) old, or with the estimate that it may take the subatomic particle, the proton, about 10^{30} years to disintegrate.

Let us move from a whimsical example to a real life one. The protein tropomyosin makes up our muscles and is shaped as a screw, wound up into a right-handed spiral. Tropomyosin is a polymeric molecule, strung together using about three hundred amino acids, rather like a necklace is strung together with hundreds of beads. Just as the beads are more or less fixed but the attached string is flexible, the bonds connecting two neighbouring amino acids take on several conformations in space. The final shape that the protein molecule adopts depends on the individual bond conformations. About thirty years ago, Professor G N Ramachandran and his students, Professors C Ramakrishanan and V Sasisekaran, all of whom are now in Bangalore, elucidated the grammar or protein conformations, namely, what shapes can a protein chain adopt and what it cannot–a magnificent feat that brought forth a new paradigm in biophysics.

Now, let us consider a molecule of tropomyosin that is just being synthesized inside a cell in the body and ask how long will it take this molecule to organize itself into the desired right-handed helical shape. This requires each of the hundred bonds that make the chain to take on one unique conformation out of the three or four that are possible. This is similar to asking three hundred people to fall in a straight line and make a perfectly aligned queue, or to make a precise pattern of the type that athlethes do at the opening ceremony of The Asian Games meet. Each one has to search for the appropriate position and, having searched, stand at the correct posture. If this were to

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happen randomly, the pattern would take years, decades or centuries to form !

The situation with the tropomyosin molecule is the same. If each amino acid residue were to search randomly in space before it takes on the correct conformation, the helical shape of the protein would take until "kingdom come" to form ! And, unlike the people in the queue who have minds, ideas and the goal of forming the queue, the protein is a molecule. It has no ideas, aim or goals. Yet, the protein folds in the cell, and does so in a second or even less. How it does so is the question that Dr Cyrus Levinthal of Columbia of New York posed. This question is now referred to as "Levinthal's Paradox".

Several scientists have attempted to solve the paradox. The main thrust behind all these attempts has been a single point ; namely, the protein does not search through all shapes. One solution is that it is guided in the folding pathway by the formation of modular structures which are put together by all the blocks. That is, parts of the protein chain fold into blocks first, like a meccano set and the blocks assembled into the final form. With such regional autonomy, several parts of the chain do their thing simultaneously, thus cutting down on time. Another model implicates a guidance system, of a "chaperone" molecule to help in the job. Somewhat like the doughty spinster of Victorian England who used to accompany damsels to dances and ensure appropriate steps (and behaviour !). This of course begs the question of who chaperons the chaperone ! How does the chaperone molecule know how to fold itself into the conformation appropriate for its function ? We tread dangerously close to teleology or goal-directed behaviour here, and that is not tenable in molecular systems.

A clue to resolving the Levinthal Paradox comes now from Robert Zwazig, Attlia Szabo and Biman Bagchi. They applied the principles of statistical analysis to the properties of molecules, a branch of science termed statistical mechanics. First of all, they emphasized that molecules, or for that matter any natural systems, do not evolve towards a goal. Instead, they obey the laws of physics and in particular the thermodynamic principle that all systems tend to move towards a state of lowest energy. If a system or a collection of molecules has energy higher than the surroundings, it would spontaneously release the extra energy into the surroundings and thus relax itself into a low energy state. This is a unique principle.

The consequences of this simple law of spontaneous downward path towards low energy are truly remarkable and far-reaching. This is what makes a cup of hot coffee become unappetizingly tepid, the river Ganges flow from the Himalayes into the Bay of Bengal, and the stars, planets and moons to arise out of the cosmic 'big bang' of about twenty billion years ago. In the case of molecules, this means that the correct state, at any temperature and pressure, is the lowest energy state under these conditions. When a bond has several conformational states available to it, it will take on that conformation which has the lowest energy. That is the

"correct" one (call it C) and the other conformation shapes are "incorrect" (call them /) and expensive in terms of energy. In the tropomyosin molecule, with several successive bonds joining the amino acids in sequence, the helical shape such as CC/CCCC/CC... would break the helix and make the molecule non-functional. The Levinthal Paradox is then as follows. Starting with an arbitrary distribution of correct and incorrect bonds, and some rules for making changes, how does the protein get to the perfect shape CCCC... within seconds ? In other words, what is the rule for making the change from / to C ?

Zwanzig, Szabo and Bagchi have suggested that the rule is none other than the stability of the lowest energy state. Any other state is to be "penalized" and given a lower weightage in the statistics. In other words, the bias in selection is the natural law itself. If the / state is only slightly higher in energy, the time taken for it to reach the C state is longer than when / is much hotter than C. This is akin to saying that water flows slower when the slope is shallow, while it rushes down when the incline is steep. Generally, in the case of protein molecules, the / states that let the chain stray away from the C states are only half a kilo-calorie or so higher in energy. Hardly enough to vibrate a few bonds like a butterfly. But the interesting thing is that even this little penalty acts as the slope that hastens the path of the molecules towards the CCCC... state, or the functional state. Out of several states, / and C available to the bond ; the state C is preferred over the / just because it is lower in energy under the given conditions of temperature, pressure, concentration and so on. The lowest energy principle biases the system towards C, tips the scales in its favour and the C states are given greater weightage.

The surprising thing that the three scientists note is that this weightage towards the slightly preferred C state is sufficent to cut the sampling time from millions of years down to a second or two ! The lower the C state is in energy from the / state, the faster the system attains the correct conformation and folding. The only chaperone or guiding light needed is the lower energy state principle !

We have clouded the issue somewhat here by using the symbols / and C, which are value-laden. "Correct" and "incorrect" are biased words and also goal-directed. How do we know what is correct and what is not ? In answer, we can only offer the statement that the state C is the *preferred* state, being lower in energy under the conditions and circumstances that obtain. What C is at room temperature might actually be incorrect at ice temperature or steam temperature. Since much of biology operates close to room temperature, the preferred state is usually the state C (and hence the "correct" state as well). Thus, there is no telenomy here but just thermodynamics. The Zwanzig-Szabo-Bagchi analysis is model-free. It does not hold any preconceived notions about which shape is right or wrong ; it does not specify what the C state looks like or the /. All it does is to say that under physiological conditions, the one-bond conformation might be

energetically preferred. This conformation can be anything–helix, ribbon, hairpin or spaghetti-shaped. But once this preference is established purely by energy criteria, the system will rush into, or gush forth to, or fold into that conformation as rapidly as water cascades down steep ridges and slopes and forms a placid pool or the Pacific Ocean. This is the resolution of the Levinthal paradox. It is an accumulation of small changes and not a de *novo* design. Spontaneous downward movement to low energy states is the moving finger, to paraphrase Omar Khayyam :

The moving finger, having writ, moves on. Nor all thy piety nor thy wit shall change a word of it.

ANSWERS TO "DO YOU KNOW?"

A1. Inspection of the abdomen.

A2. Norwegian R Amundsen by a month During return of 900 miles Scot perished with four of his companions with in II miles of a base camp with food & oil that could heve saved them.

A3. When two full moons occur in the same month, the second is usually called the 'Blue Moon' although it is really not blue. Since all the months except February are more than 293 days long, it is possible to have two full moons in a month–this happens seven times in every nineteen years i.e. every 33 months on averge (1999 had two blue moons).

A4. Earth's continents were all joined together in a giant continent called Pangaea surrounded by a single ocean, called Panthalssa before it broke up and pieces moved apart to form present days continents.

A5. Only the apes.

A6. A black hole where the gravitational pull is so high that even light cannot escape from it.

A7. Blood

A8. The elephant.

A9. Women.