Contribution of Five Titans to the Education & Research in pre and post Independent India: A personal perspective

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Desh Bhagat S LAL SINGH Oration

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Contributions of five titans to the education and research in pre and post independent India: A personal perspective

- The addition of Punjab to the territories under the British rule in 1849 nucleated the thought of regulation of school education and administration of higher education all across Indian sub-continent. The Universities Act 1904, which applied to the then five Universities of India located at Calcutta, Madras, Bombay, Lahore and Allahabad, enjoined them to appoint Professors and other faculty members to engage in research, concurrent to the teaching. The initiation of IISc. Bangalore (1909) and BHU (1916) spurred the research agenda on behalf of academic institutions in India. The establishment of more Universities after the first World War, through the 1920s, progressed the spread of higher education. The start of second World War in 1939 necessitated the Governmental support to Scientific & Industrial research and manufacturing & product development within India. The war ended with the two atomic bomb explosions in Japan, and this led to the expansion of Governmental support to Atomic Energy research programme within India. The Indian independence in 1947 accelerated the permeation of higher education and research in all the spheres. I shall share a personal comprehension of great contributions made to the education and research in different domains by the five titans, viz., S.S. Bhatnagar, H.J. Bhabha, B.P. Pal, P.C. Mahanolobis and M.N. Saha, in pre and post independent India. All five of them were elected to the Fellowship of the Royal Society, London, and have been honoured by the release of postal stamps by Government of India after independence.
Evolution of Higher Education and Research agenda in pre and post independent India

Titans of India’s tryst with Development

- **CSIR & Education**
  - Dr S S Bhatnagar (1894-1955)
  - FRS (1943)

- **Fundamental Research & Atomic Energy**
  - Dr H J Bhabha (1909-1966)
  - FRS (1942)

- **Statistics & Planning**
  - Dr PC Mahalanobis (1893-1972)
  - FRS (1945)

- **Agricultural Research**
  - Dr B P Pal (1906-1989)
  - FRS (1972)
Dr. Meghnad Saha, FRS (1927)
Theoretical Astrophysicist

Founder of NASI, NIS, SINP, IPS, Science & Culture
Regulation of Education in Colonial India

- **1849**: British annex Punjab & establish control over entire Indian sub-continent.

- **1854**: Sir Charles Wood’s despatch calls for enunciation of system of education from Primary School to University level.

- **1856**: Depts of Public Instruction (PI) created, DPIs appointed to regulate Schools in all regions of British controlled India. (1% Land tax to be spent for new Schools in Punjab)

- **1857**: Universities at Calcutta, Bombay and Madras as affiliating and examination bodies. College Entrance Exams initiated.
Situation in Punjab ~ 1860

- 1861: Only 4 students from Punjab Qualify College Entrance Exam of Calcutta University.
- However, there was no Degree College in Punjab till 1864.
- Medical School had though been initiated in 1860 for training assistance staff for British Doctors and a Training College started for School teachers.
Jan., 1864: Govt. Colleges at Lahore (GCL) and Delhi, the latter folds up in 1877 & merged with GCL

Dec., 1869: Panjab Univ College Lahore (PUCL) for Oriental studies, appended to GCL, as Constituent College of Calcutta University. It was permitted to have independent Senate at Lahore.

Oct 14, 1882: University of Panjab established at Lahore, centered around GCL & PUCL, and affiliating other colleges, like, Oriental College, Law School, St. Stephen’s College (Delhi), etc.

1886: DAV College, Lahore, Forman Christian College, Lahore, 1887: Mahindra College, Patiala

1901-02: 15 Colleges affiliated to P.U. at Lahore
Higher Education 1904 onwards

- 1904: Indian Universities Act for then 5 Univs.
- Universities empowered to appoint Professors & Lecturers, and asked to undertake Research, motivate students to learn skills and become self employed and not merely prepare themselves for Government jobs
- 1904 onwards: College Teachers allowed Study Leave for higher studies and Research
- Eminent teachers invited for extended stays at Indian Universities in ‘Cold Months’ in UK

(a la GIAN Scheme of MHRD initiated in 2014)
Universities up to 1947

- 1857: Calcutta, Bombay and Madras
- 1882: Panjab University (Lahore)
- 1887: Allahabad
- 1909: IISc. Bangalore
- 1916: BHU & Mysore
- 1918: Osmania (Hyderabad)
- 1920: AMU@Aligarh, Rangoon University in Burma
- 1921: Lucknow & Dacca; Also, Visva-Bharati
- 1922: Delhi
- 1923: Nagpur & Andhra (Waltair)
- 1927: Agra
- 1929: Annamalai
- 1943-47: Utkal (43), Sagar (46) & Rajasthan (47)
1904 : Scene at University of Panjab at Lahore

- 1912: Astronomical Observatory set up at Lahore
- 1916: M.Sc. Degree instituted
- 1919: Honours Schools (Integrated BSc/BA. & MSc/MA started in Oriental Languages, History, Mathematics, Chemistry, Botany & Zoology)

Mr. A W Woolner was first Academic Dean, S R Kashyap was Prof. of Botany, Dewan Anand Kumar of Biology, G S Chowla of Mathematics

- 1920s: Faculty of Commerce Instituted.
- Dr. S S Bhatnagar appointed founder Director of University Chemical Laboratories in 1924 & assumed charge 1925. Was at BHU from 1921-24.
Honours Schools @ PU, Lahore (1919-47)

Dr. S S Bhatnagar (1925-39) made pioneering contributions in fundamental research, applications to industry & consultancy.

Other Indian contemporaries of SSB and students of Honours Schools @PU, Lahore:

Botany: Prof S R Kashyap (Dr Birbal Sahni, Dr A C Joshi, Dr P N Mehra, Dr M S Randhawa)

Zoology: Prof Vishwanath, Diwan Anand Kumar

Chemistry: Bawa Kartar Singh, Dr. Sri Krishna, Dr. Mata Prasad, B S Bahl, Brahm Prakash, Mahan Singh, Gurbaksh Singh, Ram Chand Paul, Har Gobind Khorana, Sukhdev, Nityanand

Physics: Dr. Nazir Ahmed, Dr. P K Kitchlew, B M Anand, Dr Piara Singh Gill, F C Auluck, Yash Pal

Nobel Laureate A H Compton had visited Lahore on invitation from PU and conducted Cosmic Ray explorations at Gulmarg along with Dr. S. S. Bhatnagar and Dr. Nazir Ahmed (did Ph.D under Rutherford).
Honours Schools @ PU, Lahore (1919-47) ….contd.

Mathematics: Sarvadaman Chowla, Hari Ram Gupta, R P Bambah, Abdus Salam, F C Kohli, Satish Dhawan

Agriculture: Khan Bahadur Mian Mohammad Afzal Hussain

(First Full time VC of PU at Lahore (1938-44)

Also, Foundation Fellow of National Institute of Sciences (INSA) in 1934, along with Dr. S S Bhatnagar.

Prof. C V Raman invited 13 PU alumni to be Founding/foundation Fellows of IASc in 1934

Dr K S Bawa was invited to be one of the Vice Presidents of IASc in 1934. He had taught both Birbal sahni and SS Bhatnagar at PU

Ruchi Ram Sahni, his two sons Birbal Sahni & Mulk Raj Sahni ,and Shanti Swarup Bhatnagar, all four from Bhera (now in Pakistan) were made Fellows of IASc in 1934-35
Professor Ruchi Ram Sahni (April 5, 1863 – June 3, 1948)

Mentor of Shanti Swarup Bhatnagar

Contemporary of Asutosh Mookherjee at Presidency College in 1885.
Asutosh served as VC of Calcutta University, enabled C V Raman to do research at Calcutta.
Father of Shyama Prasad Mookherjee, who served as VC of Calcutta University.

Stamp released to honour on RRS on October 24, 2013
Prof. Ruchi Ram Sahni graduated (1884) and served (1887-1918) at Govt. College, Lahore

Today a Deemed University

(Established January, 1864)
Dr. Birbal Sahni, FRS & Dr. SS Bhatnagar, FRS
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<th>Journal/Source</th>
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<td>23</td>
<td>Effect of Polarised Light on Bacterial growth</td>
<td>Nature</td>
<td>117, 302, 1926</td>
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<td>24</td>
<td>Effect of Polarised Radiations on Animal Metabolism</td>
<td>Nature</td>
<td>118, II, 1926</td>
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<td>25</td>
<td>Conductivity and Surface Tension of Univalent Salts of Higher Fatty Acids in the Molten State</td>
<td>Kolloid Zeit.</td>
<td>38, 218, 1926</td>
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<td>26</td>
<td>Concentric Coloured Rings or the Beet-root and the Liese-gang Phenomenon</td>
<td>Kolloid Zeit.</td>
<td>39, 264, 1926</td>
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<td>27</td>
<td>Rates of Evaporation of Water absorbed on Metals and their Oxides</td>
<td>Jour. Chem. Phys.</td>
<td>25, 545, 1926</td>
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A very small weight of the substance, of the order 0.01 gm., a change in diamagnetic susceptibility of the order of 0.2 per cent or even less can, therefore, be easily detected.
“On turning over the pages of Nature my eyes changed across an advertisement of Macmillan’s in which I find your book* at last advertised. That the book is of a high standard is indicated by the most excellent review in Current Science by Professor Stoner, …

I very much specially admire your energy and perseverance in having produced such a book .... Your name now stands as one of the very few Indians who have written scientific books claiming the respect and attention of senior workers in every country". 
“...I read the other day in the newspapers that Messers Steel Brothers had in recognition of the great work done by Dr. Bhatnagar, made very generous gift of money to him and he had with a singular sense of patriotism and self denial transmitted a considerable part of that gift to the Chemistry Department of your university so as to create an Industrial research Department in which some research scholars could develop new processes for the industrial utilization of Indian raw materials.
“Congratulations on your noble gift to the Punjab University, you have hereby raised the status of the University teachers in the estimation of the public, not to speak of the benefit conferred on your Alma Mater.

India does not lack in men earning millions but if a few of these millionaires were guided by the fine examples set up by a comparatively poor teacher like yourself, ...
His Excellency Sir Henry Craik, Governor of the Punjab at the Annual Lunch of the Northern India Chamber of Commerce, Lahore, 13th April, 1940

“There is every reason to suppose that the war will give an immense filip to Indian industry. There will be a double stimulus. The great demand for industrial products created by the War will be the direct incentive to the existing industries while the difficulty of obtaining many of the articles, we are importing before will stimulate, the search for substitutes or ways and means of producing them here.

(a la Contemporary “MADE IN INDIA” CALL)
Sir Henry Craik ....contd.

- .. and in order to promote and coordinate and to facilitate the exploration of more fields of development the Central Government has just set up a Board of Scientific and Industrial Research on which a number of Scientists and Industrialists of this country have agreed to serve.

“Academic –Industry Partnership”
Cosmic Ray expedition to Gulmarg:

- The Cosmic Ray expedition was planned and financed by the University of the Panjab, members of which, in addition to Prof. Compton, were Prof. Benade, Dr. Bhatnagar and Dr. Nazir Ahmad#. Some science students also accompanied them.
- They had taken with them provisions for one month and also the instruments that Dr. Bhatnagar had had made for the experiment. Prof. Compton had with him his own equipment that he had brought from America.

*Wife of Mr. Philip Ernest Richards, Professor of English Literature, Dyal Singh College, Lahore

# Ph.D. student of Lord Rutherford at Manchester
Dr. Bhatnagar with Prof. P.M.S. Blackett and Dr. H. J. Bhabha
Sir Shanti Swarup Bhatnagar

- **1919**: Completes M.Sc. in Phys, takes three years as he has to earn while learning.

- **1919-1921**: D.Sc. Degree at University of London. Fellowship arranged by Prof. Ruchi Ram Sahni from Dayal Singh Trust.

- **1921-1924**: First Research Professor at Banaras Hindu University, on invitation from Pt. Madan Mohan Malviya - Establishes Chemistry Laboratory at BHU

Dr Homi J. Bhabha

- **1939-1945**: Stay at Dept. of Physics, Indian Institute of Science, Bangalore

- **19 August 1943**: Proposes the initiation of Tata Institute of Fundamental Research

  (Prof. A V Hill, NL, Secretary, Royal Society London visits India, advises both Bhatnagar and Bhabha)

- **1 June 1945**: TIFR Starts at IISc., Bangalore

- **19 December 1945**: TIFR inaugurated at Mumbai
Dr. Shanti Swarup Bhatnagar

- 1924-1939: Founder Director of University Chemical Laboratory, Lahore. **Initiator of Chemistry Honours School** at P.U..

- December 1939: Sir Ramaswami Mudaliar, Commerce Member in Viceroy’s Committee identifies him to conceive plans for Scientific and Industrial Research (SIR) to aid war effort of British in Europe.

- **1940: Director, Scientific and Industrial Research, Calcutta.**
  
  Sets up Research Laboratory at Alipore in Calcutta

Dr Homi J. Bhabha

- April, 1946: First meeting of CSIR Committee for Atomic Research conducted at TIFR, Mumbai in which Shanti Swarup Bhatnagar participated.

- 26 August, 1947: **Board for Atomic Research created in CSIR**

- April 1948: **Atomic Energy Commission** created with Dr Homi Bhabha, Dr Shanti Swarup Bhatnagar and Dr K.S. Krishnan as members.
Sir Shanti Swarup Bhatnagar

- Nov. 14, 1941: Industrial Research Fund Created with an annual grant of Rs.10 lakhs
- 12 March 1942: CSIR registered as a Society
- September 26, 1942: Research Fund transferred to CSIR, Hence the Foundation Day of CSIR.
- (SS Bhatnagar Prizes announced every year on this day)
- After August 1945: Creates Committee for Atomic Research
- Starts setting up chain of CSIR Laboratories

*CGCRI, Calcutta, 24 December 1945
* CFRI, Dhanbad, 17 Nov., 1946
NML, Jamshedpur, 21, Nov., 1946
NPL New Delhi, 4 January, 1947
NCL Pune, April 6, 1947
Dr Bhabha’s letter to Sir Sorab Saklatvala (1944)

I also hope that in time we shall receive liberal support from the Board of Scientific and Industrial Research whose avowed policy includes support of pure research.

It would be in the interest of efficiency if the Board of Scientific and Industrial Research decided to subsidise us to carry on pure research which is its intention to foster by paying us, say, ten percent of the annual expenditure it contemplates on the projected National Physical Laboratory.
First Meeting of TIFR Council (May 1945)

In this meeting, a tentative proposal for the budget of Rs 80,000 was passed for the year 1945-46. The income available was:

- Rs 45,000 from the Sir Dorab Tata Trust
- Rs 25,000 from the Government of Bombay
- Rs 10,000 from the Council of Scientific and Industrial Research
The Council of Scientific and Industrial Research sanctioned an annual block grant of Rs 75,000 to the Institute during the year 1946-47 and requested for representation on the Council of the Institute.

This grant was to enable the Institute to create a Chair of Astrophysics and to invite a Visiting Professor.

Sir S.S. Bhatnagar, Director CSIR, was appointed as a representative of the Central Government on the Council of the Institute.
Dr. Bhabha’s communication to Pt. Nehru (1960)

The **Atomic Energy Commission**, on the initiative of Dr. S. S. Bhatnagar, at its 27th meeting on the 22nd & 23rd April 1953 recorded the following:

“The Commission noted that it had recognized the **Tata Institute of Fundamental Research** as the only laboratory of the Commission for fundamental research in atomic science. **In view of this decision the Commission would not set up another laboratory of its own for fundamental research in atomic physics.”

* From TIFR Archives
Dr. S S Bhatnagar served as Secretary Higher Education from 20.11.1947- 1.3.1948 and 2.6.1952-15.11.1953.

He was appointed first Chairman of UGC from 16.11.1953.

Dr. Homi Bhabha was member of first University Grants Commission

The first act of Dr. Bhatnagar as Chairman, UGC was to announce increase in salary of all College and University teachers by twenty percent.

The first meeting of UGC happened on December 28, 1953. Dr. Bhabha attended that meeting presided over by Pandit Nehru in New Delhi.

The foundation stone of TIFR Colaba campus was laid on January 1, 1954.

SSB was member of Sarkar Committee (1945) for IITs.
PREMISE

Due to post war reconstruction in Europe, Engineers and Technologists would not be available for India, New Technical Education and Research programme ought to be initiated in India at utmost speed and determination in India.
Highlights of the Proposal

- Four Technical institutes on the lines of MIT (USA) be initiated; one near Calcutta, one in Kanpur, one in Bombay, one in South. (*first set up as IIT KGP in 1951 at the initiative of B C Ray, CM of Govt. of West Bengal*)

- Original proposal called for 4-year Bachelor degree after class XII (10+2). PG classes were also envisaged.

- UG/ PG students ratio was envisaged to be 2:1, students/teacher ratio was to be 10:1 for UG and 5:1 For PG.

- Estimated cost (1946) for creating an IIT was ~ **3 crores**.

- Annual salary ~ 30 lakhs, Other recurring expense ~ 38 lakhs, Income from students (Rs 200 p. a. from 2000 UG) ~ 4 lakhs, Income from other charges ~ 2.5 lakhs, Income to be generated from infrastructure ~ 4 lakhs.
Dr Bhabha’s address on foundation stone laying ceremony at TIFR

(January 1, 1954)

I would also like to record here my appreciation of the tireless efforts made by my colleague, Dr Bhatnagar, in securing this site.

We have associated with them as executing architects, the well-known firm of Master, Sathe & Bhuta who built the National Chemical and the National Physical Laboratories and with them we have also associated Mr. Kanvinde of the Council of Scientific and Industrial Research for working out the details.
The lack of sufficient funds made me propose that the Tata Fundamental Research Institute should be expanded to include all scientific research of a fundamental character in these fields and that it should be ranked and perhaps named as a national institute.
I hope my desire to see the grandeur and beauty of this new Institute with my own eyes will be fulfilled. I have decided to live to see it fully constructed and equipped.
Dr. S S Bhatnagar at laying of Foundation Stone of TIFR, Jan. 1, 1954
Architectural Model of TIFR
“….. We have eminent scientists in this country and people eminent in other ways. Dr. Bhatnagar was a special combination of many things added to which was a tremendous energy, with an enthusiasm to achieve things.”

“Bhatnagar-Nehru Effect”
“There are many things which he discussed with me and which he hoped to put through soon. *We want many more scientists like him if we are to go ahead and solve our problems*."

“*Bhabha-Nehru Effect*”
Dr Meghnad Saha : Theoretical Physicist
(October 6, 1893 - Feb. 16, 1956)

- Born to poor lower caste parents having small shop, whose other 4 siblings did not do well in school, however he topped middle school in Dacca Division. At Presidency College, Calcutta, S N Bose was his classmate, P C Mahalanobis his senior and Subash C Bose his junior. Studied under P C Ray and J C Bose. Did BSc. (1913), MSc. (1915) and DSc. (1919).
- ‘Saha Ionisation Equation’ gave him instant international recognition, he travelled to Europe met Einstein and Max Planck.

Meghnad Saha in Berlin (1923)
Elected FRS in 1927
Famous VC Asutosh Mookherjee of Calcutta University invited him as **Khaira Professor of Physics in 1923**, but he moved to Allahabad University soon after where he stayed till 1938; established its Physics Dept as Centre of Research as a counterpart of Chemistry Dept of Bhatnagar at PU, Lahore.

Thereafter, he returned to Calcutta, obtained a grant of Rs 60 thousand from Tata Trusts to build a Cyclotron to initiate experimental research in Nuclear Physics. After independence, he established in 1950 **(Saha) Institute of Nuclear Physics**.

He started **first Science Academy of India in 1930** at Allahabad (now called NASI) ; then, NIS (1935) in Calcutta, which became INSA ; IPS (1934); Founder Editor of Journal ‘Science & Culture’, etc.
Meghnad Saha: A Titan

# Influenced JL Nehru and SC Bose to start National Planning Committee of Indian National Congress (1939).

# Successfully contested election for first Lok sabha as an independent candidate (1952), participated in creation of Damodar Valley Corporation for control of annual floods in Bengal.

# His students include D S Kothari, R C Mazumdar, P K kitchlew, B D Nag Chaudhuri

# Died suddenly of Heart attack on Feb. 16, 1956, as he was on a visit to attend Planning Commission Meeting in New Delhi.

# A stamp was released to honour him at his Birth centenary in 1993.
“Scientists are often accused of living in the "Ivory Tower" and not troubling their mind with realities and apart from my association with political movements in my juvenile years, I had lived in ivory tower up to 1930. But science and technology are as important for administration now-a-days as law and order. I have gradually glided into politics because I wanted to be of some use to the country in my own humble way.”
Dr P C Mahalanobis: Statistical Wizard
(June 29, 1893, - June 28, 1972)

- Trained as Physicist (1912), however, assumed key role in the development of statistical infrastructure

- Had an abiding interest in cultural pursuits and served as secretary to Rabindra Nath Tagore, particularly during the latter's foreign travels

- Awarded the Padma Vibhushan for his contribution to science and services

- Was Secretary and Director of the Indian Statistical Institute and the Statistical Advisor to the Government of India

- Government decided in 2006 to celebrate his birthday as National Statistical Day
During his stay at Cambridge, he became friendly with Srinivasa Ramanujan.

In the summer of 1913 Mahalanobis went to England where his intention was to study for B.Sc. at the University of London. While in London, waiting for courses to start, he made a trip to Cambridge where he was stunned by the chapel of King's College.

By chance he missed the train back to London and stayed the night with a friend, studying at King's College and, hearing that Mahalanobis found the chapel so attractive, suggested he apply to study there.

Statistics must have a clearly defined purpose, one aspect of which is scientific advance and other human welfare and national development.
Mahalanobis devised a measure of comparison between two data sets that is now known as the Mahalanobis distance.

He introduced innovative techniques for conducting large-scale sample surveys and calculated acreages and crop yields through random sampling.

With the objective of providing comprehensive socioeconomic statistics, Mahalanobis established the National Sample Survey in 1950 and also set up the Central Statistical Organization to coordinate statistical activities in India.
Member of the Planning Commission of India from 1955 to 1967.

The Planning Commission’s Second Five-Year Plan encouraged the development of heavy industry in India and relied on Mahalanobis’s mathematical description of the Indian economy, which later became known as the Mahalanobis model.

He started the Journal “SANKHYAKI”
Dr Pal was born in Punjab on May 26, 1906, but his father (Dr Ralla Ram Pal) moved to Burma, then a British colony, to work as a Medical Officer.

Dr Pal studied at St. Michael's School in Maymyo, Burma, and perhaps his inspiration and love for roses came from that location, because the school was reputed to have a beautiful rose garden with several of the teachers very fond of gardening and painting.

Dr M. S. Swaminathan wrote in 1989: "Dr Pal was always first in his class at school. Once he was presented with a paint box as a gift and this led to a life-long passion for painting.
In 1929 Dr Pal qualified for the Masters degree in Botany at Rangoon University where he also won the Matthew Hunter Prize for topping among all science streams in the University. He was awarded a scholarship which permitted him to pursue his post-graduate education at Cambridge.

In March 1933, Dr Pal was appointed Assistant Rice Research Officer in the Burmese Department of Agriculture and, in October, he moved to Pusa, Bihar, to become the Second Economic Botanist at the Imperial Agricultural Research Institute, which was renamed the Indian Agricultural Research Institute in 1947.
Dr Pal was the first Indian Director of the IARI in New Delhi at its campus, which was named Pusa, in 1950 and continued to serve in that capacity until May 1965, when he became the first Director-General of the Indian Council of Agricultural Research (ICAR).

He held this position from May 1965 to January 1972, during which period the Green Revolution was launched with outstanding success.

His specialisation: wheat genetics and breeding.

‘It was during Dr Pal’s leadership that the agronomic research equalled the best in the world. He was truly the architect of India’s Green Revolution’ – Dr. Norman Borlaug, Nobel Laureate
He observed that rust disease was largely responsible for low yields of wheat and, therefore, developed a systematic breeding method to develop varieties with resistance to rust disease.

The Green Revolution was conceptualised and launched under Dr Pal's leadership.

Trustee of International Rice Research Institute, Philippines, during its formative years.

He was elected Fellow of the Royal Society of London (1972).

His catholicity of interests certainly made him the Homi Bhabha of Indian agriculture – Arvind Gupta in INSA Publication ‘Bright Sparks’
Dr Pal was a rose breeder of distinction and created several varieties and named some of them after famous Indian Scientists. He was founder President of the Rose Society and Bougainvillea Society.

He also founded the Indian Society of Genetics and Plant Breeding and edited *Indian Journal of Genetics and Plant Breeding* for 25 years.

Dr Pal was elected President of the Indian National Science Academy in 1975 and served as the President of the Indian Science Congress in 1974.

In addition to the Fellowship of the The Royal Society, UK and many other Science academies, he received numerous honours, including the Padma Vibhushan from GoI.

He assisted Dr M S Randhawa to create Rose Garden of Chandigarh
Professor Har Gobind Khorana  
(January 9, 1922 – November 9, 2011)  
Graduated from  PU Institute of Chemistry at Lahore  
(1942-46)
I have met people who believed they knew at a very young age what they wanted to do in their lives. I envied them, but my own life was not like that. At age 18, when I sought admission to the Punjab University in Lahore, I applied to two departments, English Literature and the honors course in Chemistry. Admission into the latter was restricted and required an interview. My shyness kept me from the interview, but they saved a place for me anyway, and thus I became a chemist. At the end of World War II, I was awarded a scholarship by the Government of India to study insecticides and fungicides in England. However, the Indian High Commissioner's office in London could only get me admitted into the Chemistry Department at Liverpool University, and I began to study Organic Chemistry. After I received my Ph.D. in 1948, I was eager to spend some time in a German-speaking part of Europe, and I managed to do this at the Eidgenössische Technische Hochschule in Zurich, Switzerland. I worked with Vladimir Prelog. He was inspiring and so was the institute with its long tradition of excellence in organic chemistry. I spent a great deal of time studying the German chemical literature. I realized that I was a chemist across Fritz Zetzsche's work on carbohydrates. Serendipitously, carbohydrates became important in my synthetic work later.

After a year in Switzerland, I returned to India. In the summer of partition of my province, Punjab, I could not find a job. In fact, many of my old friends and teachers were now refugees in Delhi without jobs. Fortunately, a postdoctoral fellowship in Alexander Todd's laboratory in Cambridge (England) turned up, for work on peptides related to the newly discovered adrenocorticotrophic hormone. Cambridge was a uniquely exciting place at that time. Todd's own work was at the climactic point of defining the chemical structures of the nucleic acids. Frederick Sanger was sequencing insulin, the first protein to be so tackled. At the Cavendish laboratory, Max Perutz and John Kendrew were embarked on the first x-ray structures of myoglobin and hemoglobin, and soon the Watson-Crick structure for DNA was to emerge from the same laboratory. Molecular biology was in the making.

At the end of 1952, the offer of a non-academic research job took me to Vancouver, British Columbia. The scientific stimulus was there. I was introduced to biochemistry and the concept of cold fusion, and I was able to work with the very best minds in the field. My work was on the synthesis of nucleosides of interest to biochemists, and I found that the methods I developed were applicable to the synthesis of nucleic acids. I also worked on the synthesis of short oligonucleotides with precise chemical linkages as in DNA. I had the privilege of working with the synthesis of peptides started by Fischer in the early 20th century, this work could be significant.

In retrospect, my success in applying methods to the synthesis of nucleosides of interest to biochemists came astonishingly rapidly. The methods I developed were used extensively, and a number of established biochemists began to visit my small emerging group during the summers. In 1956, Arthur Kornberg and Paul Berg's work provided my first intimate exposure to biochemistry and biochemical thinking. I decided to spend some time in Kornberg's laboratory to learn the practice of biochemistry from this great master. In the subsequent years, work in my laboratory became increasingly interdisciplinary. The one great enzyme discovered by the collaboration of Beadle and Tatum in 1941 had been important in illustrating the field of molecular genetics. By the early 1950s, genes were shown to be made up of nucleic acids. Therefore, nucleic acids directed the synthesis of proteins. During the same period, an in vitro system for protein synthesis was developed, culminating in 1961 in the electrifying experiment by Nirenberg that demonstrated the translation of polynucleotides into polyphenylalanine under the direction of polyuridylic acid. Subsequently, biochemistry took the center stage in further definitive work on the genetic code. The most exciting experiments in my laboratory started with synthetic DNA polymers of defined nucleotide sequence and arrived at polynucleotides of defined amino acid sequence. We prepared our high-molecular-weight DNA-like polymers by using short synthetic DNAs with specific sequences as templates for Kornberg's DNA polymerase. Fortunately, repetitive copying resulted in size amplification and multiplication of the products. The 1960s were the golden age of molecular biology. Scientists from a variety of disciplines came together and gave a unique momentum to the new field. However, many of my friends, with whom I had shared the most exciting period, felt that after the elucidation of the genetic code and the chemical basis of heredity, an era had ended. The new frontier had to be the brain. An exodus of scientists to neurobiology began. In my own work, I pursued the challenge I had posed in the late 1950s, namely, the total synthesis of genes. In the late 1960s, the necessity to amplify synthetic genes became clear and principles for their amplification, later discovered and named PCR, were worked out.

Making a radical shift in the mid-1970s, I became interested in biological membranes and in bacteriorhodopsin, the light-driven proton pump. This in turn led to interest in light transduction in the mammalian photoreceptor, rhodopsin, and in the photoreceptor cells in the retina. The transduction carried out by these cells—conversion of photons to chemical energy to drive biochemistry and conversion of chemical energy to electricity, the language of the brain—is extremely complex. This understanding is very different from my earlier projects. In organello chemical syntheses, the total synthesis of genes, and proton translocation by bacteriorhodopsin, I had been lucky to find answers at least in outline. In contrast, my current understanding of the sensory systems, in particular, sensitization and desensitization, still lies far in the future.
An extract from ‘A Life in Science’

I have met people who believed they knew at a very young age what they wanted to do in their lives. I envied them, but my own life was not like that. At age 18, when I sought admission to the Punjab University in Lahore, I applied to two departments, English Literature and the honors course in Chemistry. Admission into the latter was restricted and required an interview. My shyness kept me from the interview, but, they saved a place for me anyway, and thus I became a chemist.
Student at Govt. College and Dept of Mathematics at Lahore (1940-46)

The Inspiring Life of Abdus Salam

VC of Univ. of Punjab at Lahore
An inspiring life of Salam

His mathematics teacher Dr. Sarvadaman Chowla was particularly fond of Salam. He used to pose an unsolved problem at the end of a class. He and Salam would try to solve such a problem independently after college hours, and compare their answer the following day.
An inspiring life of Salam

- One of the problems posed by Dr. Chowla concerned four simultaneous equations in four variables – this was a problem due to Ramanujan.

- Salam’s solution was sent by Dr. Chowla to a magazine. Thus, in the year 1943, Salam’s first mathematical research paper titled “On a Problem of Ramanujan” was published in the March – July 1943 issue of Maths. Student (volumes XI, Nos 1-2).
Salam asked him (R P Bambah) to convey the following message to Dyson if he happened to come across him in Princeton: “I have renormalized longitudinal photons”. When Bambah conveyed Salam’s message to Dyson he responded “I don’t believe it, but if he has done so he will be very famous”.

When Bambah commented that Salam had picked up the problem on account of suggestion in one of Dyson’s papers, Dyson responded by saying “I had said that it should be done and not that it could be done”.
An inspiring life of Salam

- The nearest physicist in the region with whom Salam could engage in useful discourse was Bhabha at Bombay, and that was another country.

- On his return to Lahore from Bombay he was charge-sheeted for absenting himself from the station of duty without prior permission.
He (Dr. Salam) was not given an official residence in Lahore, as was his right. Minister of Education refused any help and declared: "Pugdi e te kam karo warna jao"