# Biological Research in India
## Historical Perspective and Future Possibilities

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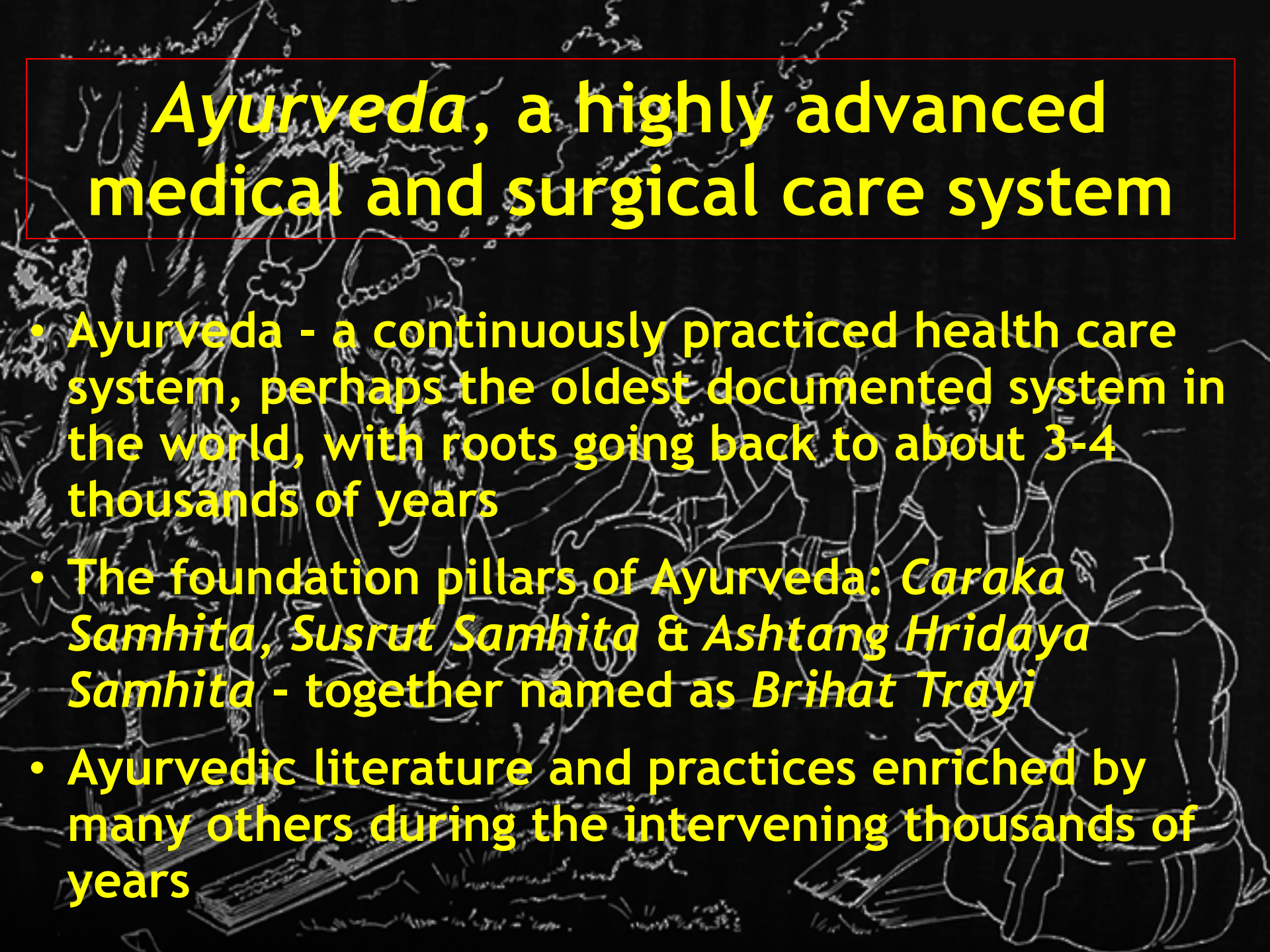
# Formal teaching in Biology started in India with the introduction of University system by the British

- Unlike remarkable advancements in mathematics, physical sciences, astronomy, alchemy, etc, in historical periods, the biological sciences apparently did not attract scholars, except those working in fields of health-care and those interested in natural history (e.g. the Mughal Emperor Jehangir), till the beginning of the university education system introduced during the British period
- Following the introduction of the university education system in India in the $19^{th}$ century, teaching of Biology started in some universities/colleges in the late $19^{th}$ and early $20^{th}$ century. Biology teaching was initially part of the medical education. Later independent department of Biology, soon bifurcated into Botany and Zoology, were established in most universities and colleges.
- Much of the early studies related to Natural History (Fauna and Flora of British India)



# *Ayurveda*, a highly advanced medical and surgical care system

- Ayurveda - a continuously practiced health care system, perhaps the oldest documented system in the world, with roots going back to about 3-4 thousands of years
- The foundation pillars of Ayurveda: *Caraka Samhita, Susrut Samhita* & *Ashtang Hridaya Samhita* - together named as *Brihat Trayi*
- Ayurvedic literature and practices enriched by many others during the intervening thousands of years

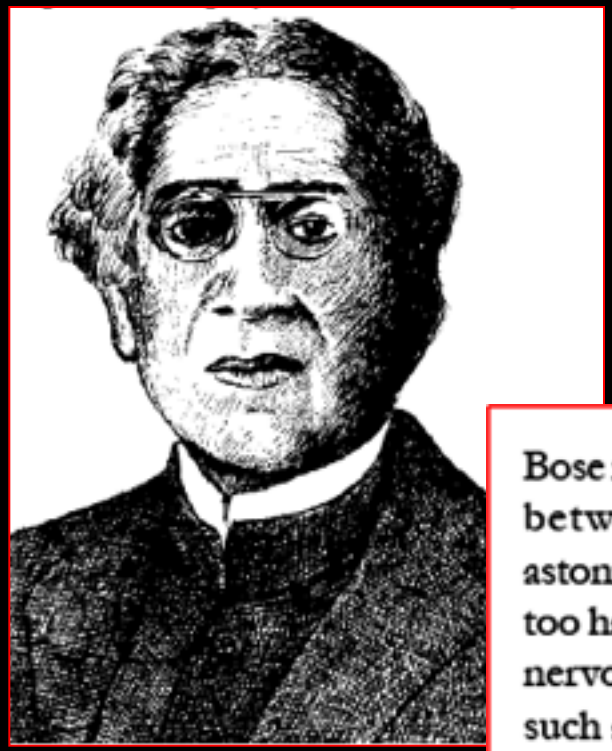
# Garcia d'Orta (1501 - 1568)

- Portuguese physician settled down to practice medicine in Goa for 36 years
- Pioneered studies in indigenous medicine
- Wrote *Colloquies on the Simples and Drugs of India in 1563* based on years of observations on diseases in India, medicinal plants, their use in medicine, and his views on the practice of medicine
- Translated into several European languages

# Hendrik Adriaan van Rheede tot rakenstein (1636 -1691)

- A military man and a colonial administrator of the Dutch East India Company and a Naturalist
- Served as Governor of Dutch Malabar (1669-1676), employed twenty-five people for his book *Hortus malabaricus* (*Garden of Malabar* in 12 volumes), describing 740 plants in the region

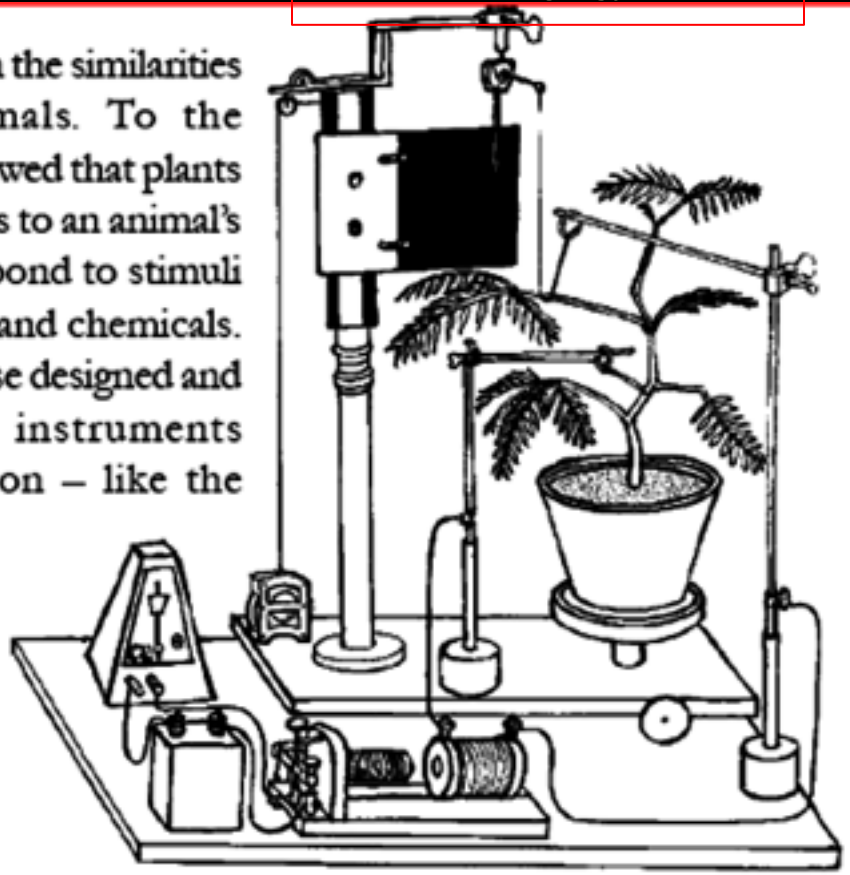
Knowledge about herbs and their medicinal uses in India, acquired by travelers and visitors, was passed on to Europe, contributing significantly to the modern medicine and pharmaceutical industry



# J. C. Bose
(1858-1937)

## One of the first experimental biologists in India

Bose next became interested in the similarities between plants and animals. To the astonishment of many, he showed that plants too have something analogous to an animal's nervous system and they respond to stimuli such as electric current, heat and chemicals. Since this subject was new, Bose designed and constructed many of the instruments required for experimentation – like the *Crescograph* which measured the growth rate of plants. With this instrument it became possible to carry out accelerated tests to determine the effects of fertilisers and insecticides on plants.



# School of Tropical Medicine Kolkata

## Government of India's justification to set up the School of Tropical Medicine in Calcutta (1910)

The establishment of which could hardly fail to stimulate scientific research, would be most useful. It is anomalous that medical men resident in India should have to go for the scientific study of tropical diseases common in this country, to such places as Liverpool and Greenwich, where the material must necessarily be scanty. Also, there must be a large number of men trained in the medical schools of this country anxious to undergo a course of training in tropical medicine and capable of profiting by it, but unable to afford to go through a postgraduate course in England. It seems desirable therefore that special facilities for the study of tropical disease should be provided in India for both official and non-official medical men.

# Brevet Colonel Sir Ram Nath Chopra (1882-1973)

- Pioneer of Pharmacology in India through systematic studies of indigenous drugs, promoter of Indian systems of medicine
- Joined the Calcutta School of Tropical Medicine in 1921 as the first professor of pharmacology.

# John Burdon Sanderson Haldane
(1892-1964)

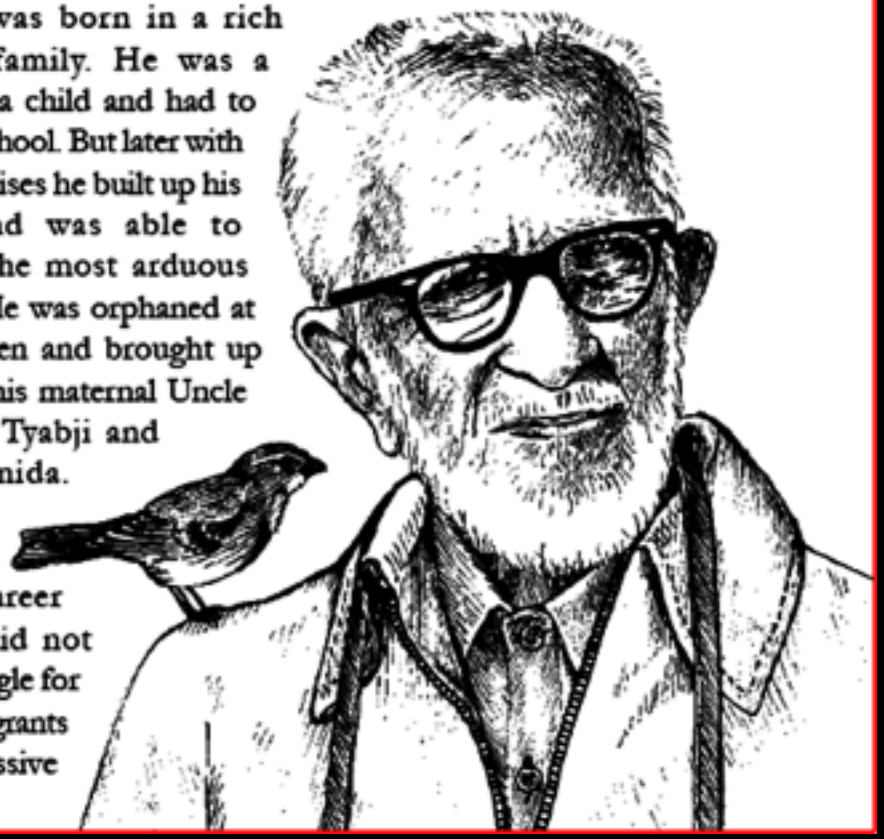
A British, later Indian, scientist known for his work in the study of physiology, genetics, evolutionary biology, and in mathematics, where he made innovative contributions to the fields of statistics and biostatistics. He was a professed socialist, Marxist, atheist, and humanist whose political dissent led him to leave England in 1956 and live in India, becoming a naturalised Indian citizen in 1961

# Salim Ali
## (1896-1987)



Salim Ali was indisputably the greatest field biologist of twentieth-century-India. Known as the *Birdman of India* he meticulously observed and documented the birds of the sub-continent for almost 80 years.

Salim Ali was born in a rich merchant family. He was a weakling as a child and had to often miss school. But later with regular exercises he built up his stamina and was able to withstand the most arduous field trips. He orphaned at the age of ten and brought up lovingly by his maternal Uncle Amiruddin Tyabji and aunt Hamida. Throughout his long research career Salim Ali did not have to struggle for government grants as his progressive



# V. N. Shirodkar

**(1899 – 1971)**
**Mumbai**

*"With all due respects to the old masters, I did not reconcile myself to some of the operative procedures which fell far short of the ideal; ideas came to my mind for improving the time-honoured methods."*

The Shirodkar stitch keeps the cervix closed so that the pregnancy in an incompetent uterus can continue for the full term

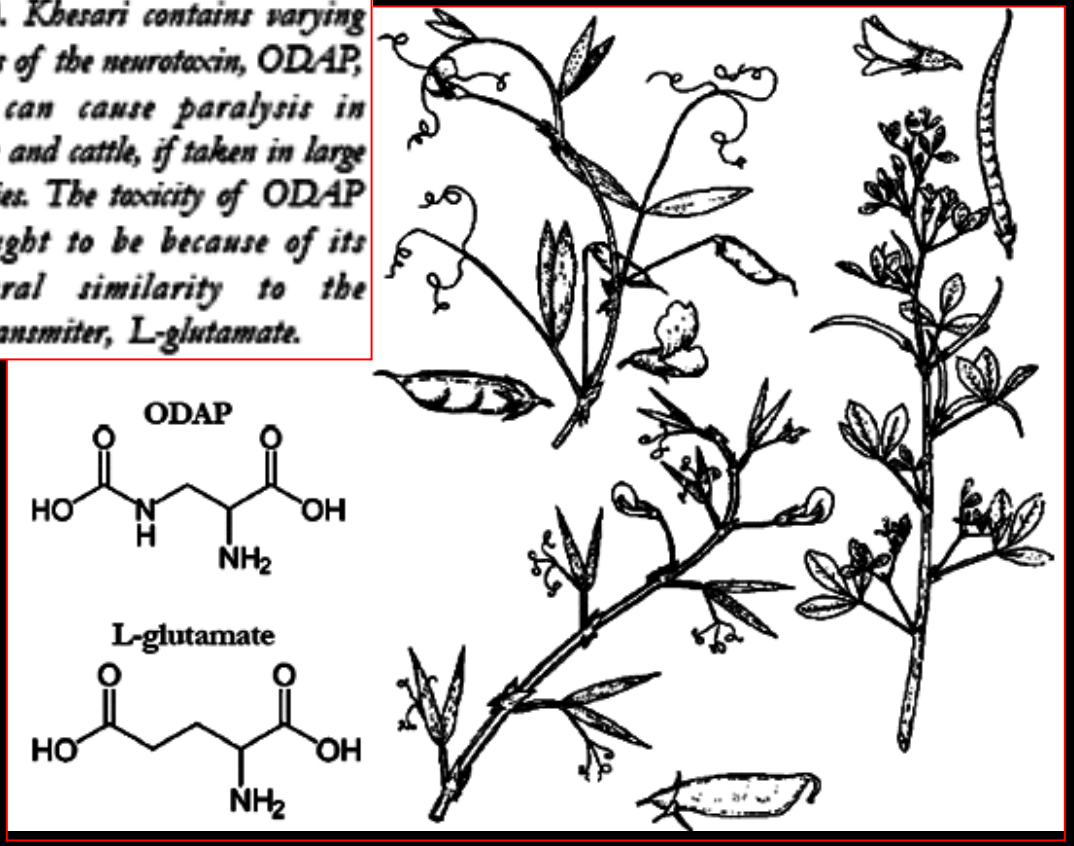
BRIGHT SPARKS INSPIRING INDIAN SCIENTISTS FROM THE PAST – by Arvinda Gupta
Indian National Science Academy

# T. R. Sheshadri

**(1900-1975)**

**Delhi University**

*Seshadri did research on the toxin in the pulse, khesari (Lathyrus sativus). Khesari contains varying amounts of the neurotoxin, ODAP, which can cause paralysis in humans and cattle, if taken in large quantities. The toxicity of ODAP is thought to be because of its structural similarity to the neurotransmiter, L-glutamate.*

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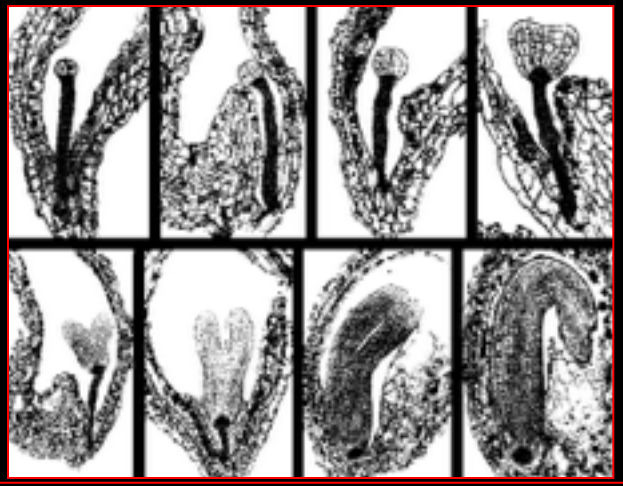
# P. Maheshwari

## (1904-1966)

## Delhi University



Growth of *Arabidopsis* embryo

Maheshwari's work embraced almost all branches of botany – and he can be considered among India's last complete botanists. Maheshwari and his students collaborated and investigated over one hundred families of angiosperms! In the process they detected and corrected many dubious errors. *An illustrated Flora of Delhi* was written under his supervision. This remains an authoritative field-guide for laymen and professionals alike for over half a century.

For BSc (1923) he studied at the Ewing Christian College - affiliated to the Allahabad University. Here Maheshwari came under the spell of a remarkable American Missionary teacher, Winfield Scott Dudgeon, a renowned American botanist and founder-President of the Indian Botanical Society. Although students revered him, he was also feared as a hard taskmaster. But in Maheshwari, Dudgeon found a student he had long been looking for. Dudgeon took the young Maheshwari on expeditions to collect botanical specimens and taught him the basic techniques of plant morphology. On one occasion Dudgeon told Maheshwari, *"A Hindu father believes his life's aim is fulfilled if he has given his son a good education. My son is dead, but I wish to leave behind at least one student who will carry on my mission."*

# Kamala Sohonie

(1912 - 1998)

Kamala Sohonie was the first Indian woman to get a PhD in a scientific discipline. She carried out detailed biochemical studies on three major groups of food items consumed by the rural poor and established their nutritive values

She joined the newly opened Biochemistry Department at the (Royal) Institute of Science in Bombay. She inspired her students to do relevant research. Many of her research students later became distinguished scientists. Kamala along with her students carried out detailed biochemical studies on three major groups of food items consumed by the rural poor and thus established their nutritive values. These studies involved leguminous proteins, trypsin inhibitors and other compounds which reduce the digestibility of Indian legumes, Neera, palm gur and palm molasses, and dhanata paddy flour—formed during milling and polishing rice. The subjects of her research were of great relevance to Indian societal needs as these food items are consumed by the poorest people. She started her pioneering work on Neera at the suggestion of the first Indian President Dr. Rajendra Prasad

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# Vulimiri Ramalingaswami
(1921 - 2001)

While honouring Professor V. Ramalingaswami with the prestigious Leon Bernard Foundation Award, Sir Harold Walter, President of the 1976 World Health Assembly, described him as "physician, research scientist, teacher, and humanist." This was a true reflection of his multifaceted personality.

A large incidence of goitre (swelling of the neck due to thyroid problems) led him to conduct a classic experiment in public health. It involved a population of over 100,000 people in the Kangra Hill. Consumption of iodized salt led to a drastic reduction in the disease. This work laid the foundation for the National Iodine Deficiency Control Programme and provided protection to nearly 300 million people!

Ramalingaswami successfully introduced 'iron' supplements in the diet of pregnant mothers. This single measure led to a significant improvement in the health of women and children worldwide.

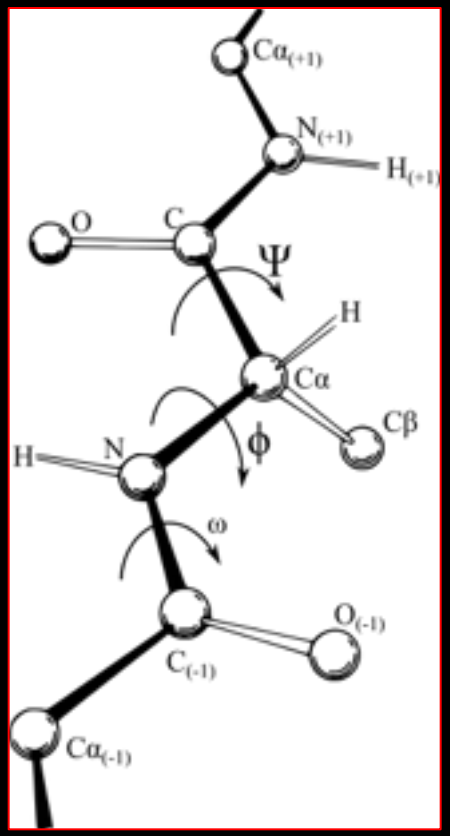
His other major contribution was the discovery of a new syndrome of liver disease known as Indian Childhood Cirrhosis (ICC).

*Normally, the insides of our lower eyelids are red, and our fingernails are pink - due to healthy red blood inside.*

*If we have insufficient iron in our blood, we are anaemic. This causes the insides of our lower eyelids to be pale, and our fingernails to be white.*

# G. N. Ramachandran

(1922 - 2001)




One of the most brilliant scientists of the 20th century who did India proud by his research. Ramachandran did all his work in India following the footsteps of his mentor C.V. Raman. He made several important discoveries in molecular biophysics, especially in the study of protein structure (Ramachandran Plot). His discovery of the triple helical structure of collagen was a fundamental advance in the understanding of peptides.

Ramachandran plot or a [φ,ψ] plot developed in 1963 by G. N. Ramachandran, C. Ramakrishnan, and V. Sasisekharan

# A. S. Paintal

(1925 – 2004)

"Compared to the dynamic first half of the 20th Century, the intellectuals of the second half look like `lotus eaters', interested in, and promoting, a comfortable existence, secure jobs with attractive perquisites and ostentatious lifestyles with no aim or desire to achieve anything in particular. .. We have given up self reliance as a driving force. We are back to subservience of a different kind - technological subservience... There is no question of self-help."
-A.S. Paintal (1985)

India's best known Physiologist, discovered the J-Receptors - a word he coined and researched in-depth. It was well known that the heart and lungs have a rich network of fibres which send signals following chemical or mechanical changes in the local environment. Paintal was the first to show that J-Receptors were responsible for the reflex action, which acted as a feedback mechanism to limit muscle activity during exercise. Such negative control was necessary for protecting the muscles from toxic damage caused during physical exercise. The discovery of J-Receptors was hailed world-wide.

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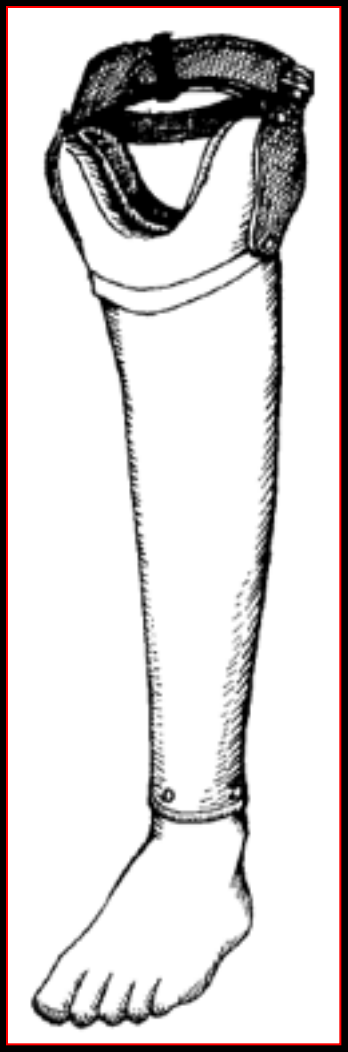
# P. K. Sethi
(1927 - 2008)



The Jaipur Foot was designed by an unusual team of a professional surgeon Dr. Pramod Karan Sethi - a fellow of Britain's Royal College of Surgeons and an unschooled master craftsman Ram Chandra Sharma. They both met in the corridors of the Sawai Madho Singh Hospital in Jaipur where Sethi was helping orthopaedic patients with crutches and Sharma was teaching leprosy patients to make handicrafts.

Jaipur in Rajasthan is famous as the birthplace of an extraordinary prosthesis, or artificial limb, known as the Jaipur Foot. This low-cost attachment has revolutionized life for millions of land-mine amputees

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# Monkombu Sambasivan Swaminathan

Indian geneticist and international administrator, renowned for his leading role in India's Green Revolution, a program under which high-yield varieties of wheat and rice seedlings were planted in the fields of poor farmers. Known as “Father of Green Revolution in India" for his leadership and success in introducing and developing high-yielding varieties of wheat in India

# Himmatrao Saluba Bawaskar

With just an old ECG, and at Mahad, a small town 175 km south of Mumbai, he carried out research on scorpion bite, which was a major health problem in the region

India's internationally acclaimed physician and an authority on scorpion sting

Bawaskar HS, Bawaskar PH. 1986 Prazosin in management of cardiovascular manifestations of scorpion sting. Lancet. Mar 1;1(8479):510-1

# Cytology/Cell Biology

- Schools of Cytology (mostly Karyotype studies) at Punjab University [Prof. G. P. Sharma (Zoology) and Prof. P. N. Mehra (Botany)]; Allahabad University [Prof. M. D. L. Srivastava, Zoology]; Banaras Hindu University [Prof. S. P. Ray-Chaudhuri, Prof. T. Sharma, Prof. J. P. Gupta]
- Cytology/Cell Biology at Delhi University [Zoology : Prof. B. R. Sheshachar, Prof. C. M. S. Dass, Prof. S. R. V. Rao, Prof. V. C. Shah]
- Cytology at Kalyani University [Prof. G. K. Manna, Zoology]
- Cancer Biology at Cancer Research Institute [Parel, Mumbai, fore-runner of current ACTREC at Navi Mumbai] – Dr. S. M. Sirsat, Dr. M. G. Deo, Dr. A. N. Bhisey, Dr. Rajani Bhisey
- Cell Biology Conferences started at Zoology Dept. of Delhi University: held every alternate years since 1965- leading to establishment of the Indian Society of Cell Biology in 1976

# Remarkable Academic Pedigree of the 'Fly' Community in India

TH MORGAN

AH STURTEVANT

HJ MULLER

C STERN

Th DOBZHANSKY

D POULSON

M DELBRUCK

G PONTECORVO

S BENZER

KS GILL
PUNJAB GROUP

O SIDDIQI
TIFR/NCBS GROUP

SP RAY-CHAUDHURI
KOLKATA & BHU
GROUPS

AS MUKHERJEE
KOLKATA GROUP

MR RAJASEKARSETTY
MYSORE GROUP

NB KRISHNAMURTHY

The *wingless* mutant discovered in Prof. RP Sharma's lab at IARI, New Delhi

Currently, there are 130+ Fly research groups in India

# Advent of ‘Modern Biology’

- Teaching and research in Biochemistry, one of the first ‘Modern Biology’ subjects, started in several Indian universities and research institutions in mid-1960s
- Teaching and research in more specialized domains of ‘modern biology’, like Molecular Biology, Biotechnology, Immunology, Cancer Biology, Developmental Biology, Molecular/ Human Genetics, etc, also started in 1970s. Later, Biotechnology and Bioinformatics became popular as PG and UG courses

Burma & Chakravorty (eds) 2010 Project of History of Science, Philosophy and Culture in Indian Civilization, Volume XIII Part 2: From Physiology and Chemistry to Biochemistry

# Remarkable expansion of research base in India during the past few decades

- Several new research institutes
- Enhanced funding for research
- Biology related courses at IITs and other institutes of Engineering/Technology
- IISERs
- Large number of young researchers
- Greater inter-disciplinary approach
- Competitive research output: increasing numbers of research publications in internationally leading journals

# Some negative features amidst the excitement

- 'Classical Biology' on a backseat or even left out
- UG and PG teaching: quality rapidly deteriorating
- Universities not the major contributors to basic research
- Weak Industry-Academia linkage
- Limited research of relevance to country's issues
- Non-existent post-doctoral culture in country
- Limited growth of research journals published in India

# ‘Classical Biology’

- Rush to ‘modernize’ Biology teaching: ignored teaching of ‘classical’ domains like Organismic Biology, Systematics, Physiology, Genetics, Evolution, Animal Behaviour, etc.
- Research in these areas also limited to only a few centers
- The enormous diversity of flora and fauna in the country remains unknown and largely un-exploited for research

It is significant to note that countries which are really leading in Biotechnology, do not offer such specialized teaching programs as we do in India. Yet, the state of local biotechnology industry is not laudable

Lakhotia: Over-emphasis on molecular biology has stunted biology (IndiaBioscience 2011)

Lakhotia: Are biotechnology degree courses relevant? Current Science 94: 1244-1245).

# Decline in teaching in Colleges and universities

- **Large Canvas of Biology: from the traditional descriptive morphology, anatomy, systematics etc to highly experimental physiology, genetics, cell and molecular biology etc**
- **Biology all pervasive in human affairs with emergence of genetic engineering, biotechnology, bioinformatics, and the various 'omics'**
- **Developments in nanotechnology opening yet new vistas**

**Such a wide and rapidly expanding canvas and the potential for their applications excite, confuse or even depress a student of biology about the present and the future**

**The learning process in class-rooms deeply affect the excited or confused state of young minds. *Unfortunately, the way biology is being taught in most places of learning seems to push the young minds more towards the confused or "lost" state***

**(Lakhotia: https://indiabioscience.org/columns/education/are-we-teaching-biology-well)**

# Poor state of research in universities

- Bifurcation of institutions of teaching and research and neglect of the university system (started in later decades of 20$^{th}$ century): spiraling decline in infrastructure and quality of teachers
- Quantity and quality of research in most universities is increasingly declining
- M.Sc. students do not prefer to continue for research in a university department
- New IISERs, IITs and central universities provided some good outlets
- Competent young faculty not willing to join the university system

<u>Improvements in the mainstream universities and colleges alone can cater to the requirements and aspirations of the increasing youth population- essential for the country to be 'knowledge power'</u>

S. C. LAKHOTIA (2005) India's ambitions to be a world leader in S & T depend upon a drastic overhaul of the university system. CURRENT SCIENCE (Commentary) 88: 1731-1735

# Weak Linkages between Academia & Industry

- Like the poor linkage between universities and research institutes, the Academia-Industry linkages remain weak
- Relative paucity of new technology and/ or products with origins in R&D activity in the country
- Uncertainty about success of the current emphasis on 'translational research'

S. C. Lakhotia (2015) Science research in India at cross-roads. (Editorial). *Proc. Ind. Natn. Sci. Acad.* 81: 337-338
S. C. Lakhotia (2015). New emphasis on privately funded applied research: Would it make India industrially sound and a knowledge economy? (Editorial) *Proc. Ind. Natn. Sci. Acad.* 81 1077-1079

# Limited research on issues that are relevant to country's needs

- Lack of 'science communication': masses not able to appreciate advances in basic research
- Basic research – we seem to follow questions/ directions developed in west (working on "3'-UTR of the problem rather than being at the promoter")
- Applied research – limited and often not in keeping with needs of the masses
- Basic or applied research: primarily on questions that may not have great relevance to issues with which the country's masses can relate

# Post-Doctoral Research

- Post-doctoral culture nearly absent in the country so that PDF/RA positions remain unoccupied
- Mis-placed emphasis on ‘exposure’ to research in a lab abroad – often considered ‘essential’ for recruitment in ‘elite’ institutions

# Research Journals in India

- Damaging impact of 'impact factor'
- Unwarranted distinction between 'national' and 'international' journals
- Mandatory requirement of a certain number of research publications, without any quality control, has promoted uncontrolled growth of 'predatory journals'
- Need for promoting internationally competitive journals published in India

## Publish good science <u>also</u> in journals published in the country

S. C. Lakhotia (2010) "Impact factor" and "we also ran" syndromes. Current Science 99: 411

S. C. Lakhotia (2017) What if you choose to ignore IF (impact factor)? Indiabioscience Interview. https://indiabioscience.org/columns/conversations/what-if-you-chose-o-ignore-if-impact-factor

# Blogs on Teaching & Research in Biology in India @IndiaBioscience

## https://indiabioscience.org/authors/SCLakhotia

- How to improve the quality of teaching and research in Indian universities? Posted on Oct 22, 2011 in TEACHING, RESEARCH
- Reductionist vs integrative approach in biology, Posted on Aug 30, 2011 in TEACHING, RESEARCH
- Do we always need “big money” for quality research?, Posted on Jul 11, 2011 in FUNDING, RESEARCH
- Over-emphasis on the so-called “Molecular Biology” has stunted Biology, Posted on Jun 01, 2011 in TEACHING, ADVICE, RESEARCH
- Advantages of working with organisms other than the model systems, Posted on May 04, 2011 in RESEARCH
- The damaging impact of “impact factor”, Posted on Apr 08, 2011 in RESEARCH
- Holistic science sans impact factor, Posted on Mar 15, 2011 in RESEARCH
- Are we teaching biology well?, Posted on Feb 05, 2011 in TEACHING
- Hype and the reality of biotechnology, Posted on Mar 31, 2010 in BIOTECHNOLOGY, RESEARCH

# What is needed?

- Minimizing disparity between ‘elite’ academic institutions and universities/colleges – general students also need good mentors to get excited
- Young investigators: move away from research themes pursued during PhD or post-doc research- carve your own niche
- Exploit the enormous biodiversity in the country instead of sticking to a few ‘model’ systems: some of the exotic organisms may become good models in future
- Shared utilization of existing facilities and creation of functional state-of-the-art facilities in different parts
- More collaboration and networking

# Some Research Areas that have promising future in India (my perspective)

- Natural History and Developmental biology of exotic plants and animals
- Non-coding RNAs (especially the lncRNAs)
- Research in health-related areas: need to focus on diseases prevalent in the country with a greater synergy with Medical practitioners
- Ayurvedic Biology

# Bright future for Biology in India

- Biology today is one of the most exciting and rapidly expanding fields for study
- Laboratory infrastructure, at least at many centers in the country, is fairly good
- Greater possibility for inter-disciplinary research
- Government claims more funding for science
- Many excited and competent Young Investigators in different institutions

Let your careers be as enjoyable as these creations of Nature

Thanks!