livestock industries, number of vehicles, roads, industries and economic development, and these lead to huge increase in NH_3 and NO_x that adversely affects climate. Emission of NH_3 and NO_x should be measured to monitor their role at national level. The quantification of different sources of nitrogen and their relative contribution towards various sinks have been discussed in detail. This would pave the way for better management of the nitrogen cycle. Although some recent efforts to summarize the available knowledge in this area have been done, there is still a need to add more from the peer-reviewed literature with institutional publications, local reports and other available documents. There is a lack of comprehensive source for reliable data on various aspects of reactive nitrogen at the national level. Books such as the one under review will hopefully catalyse that process. Some rudimentary data are already available from localized surveys and estimates from many regions.

Section E describes the contribution of transport, energy and industry sector to reactive nitrogen emission, and implications of changing diets on reactive nitrogen. Coal and diesel contribute in large measure to nitrogen emission from fossil fuels in India, especially due to their poor quality. There seems to be a growing policy shift towards renewable energy sources, but it will take determined pursuit for over a decade to have an impact on the ground. For now, the overall nitrogen-use efficiency is quite low in India and an average of more than 80% of nitrogen is lost to the environment. Overall, this section underscores the need for a comprehensive assessment of reactive nitrogen emission from both natural and anthropogenic sources to understand the scale of anthropogenic damage for informed decisions and actions on the ground.

Section F consists of a single chapter on the managerial issues and policies for reactive nitrogen management in India. This chapter captures the growth trends of each of the major pollutants of reactive nitrogen such as nitrous oxide, NO_x from various sectors in a business-as-usual scenario, and the extent to which such trends can be moderated or reversed through various policy interventions. Some of these policies such as the mandatory neem-coating of urea and reduction of urea bag size are already under implementation, and have made a major impact in arresting the growth of urea consumption in the country. Some other such policy options either need adoption or effective implementation to see real results on the ground. Further determined efforts from policy-makers within the country are necessary in order to prevent and mitigate nitrogen losses to the environment.

Although the book covers all the sectors, the time period considered is not uniform for all of them. This could be due to the uneven research intensity or publication of primary data in different sectors. Hopefully this book will catalyse researchers to bring out updated information in sectors that need to catch up with frontline sectors such as the fertilizer sector, which has data up to 2016–17. References in all chapters are comprehensive, updated and given with full titles, making it a valuable sourcebook. The thousand entries in the index are excellent. An interesting aspect of the book is that each chapter ends with conclusions, which are helpful in understanding the overview of the topic discussed in them.

Overall, the first ever comprehensive Indian nitrogen assessment is an excellent and pioneering effort. As the publisher indicates on the cover, this is the first edition, and there is ample scope and need for updated revised editions of the book to be published every 3–5 years. This ensures regularly updated information for informed decisions towards sustainable development.

1. Abrol, Y. P., Raghuram, N. and Sachdev, M. S. (eds), *Agricultural Nitrogen Use and its Environmental Implications*, IK International, Delhi, 2007, p. 552.
2. Abrol, Y. P., Raghuram, N. and Hoysall, C., *Curr. Sci.*, 2008, **94**(11), 1343–1344.

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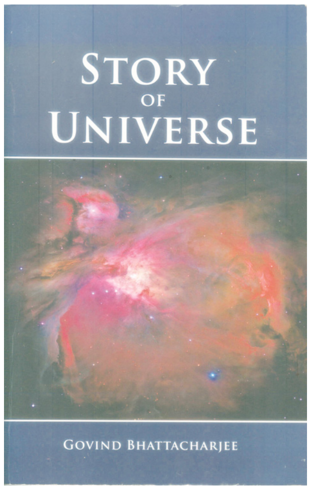

Story of Universe. Govind Bhattacharjee. Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida 201 309, 2017, xvi + 280 pages. Price: Rs 150.

'Cosmologists are often in error but never in doubt'

–Lev Landau

In this century cosmology has obtained a lot of very precise data, many of them with special satellites, heralding 'precision cosmology'. Cosmology, however, still continues to be speculative and controversial. In 1964, the discovery by Penzias and Wilson of the 'cosmic microwave background radiation' (CMBR), ushered in the dominance of 'Big bang cosmology', based on the work of Gamow and his collaborators, on formation of light elements in the early universe. The starting point of the application of general relativity to cosmology was the assumption of a homogeneous and isotropic universe, often called 'cosmological principle'. This led to the consideration of the Friedman–Robertson–Walker metric for description of the universe and for studying its expansion as observed by Hubble in 1917. The Hubble constant H relating the velocity of expansion to the distance and acceleration factor q the rate of change of H with time, were then identified as the key parameters to be fixed by observations. It took years to do this even approximately. The main difficulty was the need to know the absolute luminosity of the observed sources. In the 1990s, the supernovae 1a provided sources of known absolute luminosity, and led to the discovery of an accelerating universe and dark energy. The formation of structures in the universe like galaxies and their clusters, requires some inhomogeneities and anisotropies to be present in the early universe, and hence in CMBR to serve as seeds for the structures. In 1992, anisotropy was finally seen in CMBR at the level of one in a hundred thousand. This led to questions about the origin of anisotropies and isotropy itself. Even earlier, in the 1980s, questions began to be asked about the justification of the cosmological principle itself.

Guth, Linde, Satoh, Starobinsky and others came up with the idea, in early 1980s, of what is now called the inflationary paradigm for explaining these and related initial conditions[1]. Guth started with a grand unified theory (GUT) in the very early universe, and the subsequent breakings of GUT into strong and electroweak interactions. The accompanying phase transition would lead to expansions of the deSitter type, if there was supercooling of the earlier unified phase. The occurrence of exponential expansion, over a long-enough time, leads to homogeneity and isotropy. The observed universe now, was a very small homogeneous and isotropic volume at the beginning of the expansion. The idea led to an immediate success. The exponential (de-Sitter) expansion led to predictions of scale-free quantum fluctuations as required by the independent galaxy-formation studies of Harrison and Zeldovich. The quantum fluctuations can be both scalar and tensor in nature. The observation of tensor or gravitational fluctuations was supposed to confirm the idea of inflation.

However, there were several difficulties. The main problem was to stop the inflation and get the empty universe to produce particles and reheat the universe, to go back to the big bang model. It is like getting off the tiger that one is riding. Fine-tuning of the potential alone was not enough; additional inflaton fields had to be introduced. These problems are still largely unsolved. There is also the possibility of different parts of the universe growing into separate non-communicating universes. Further, the absence of proton decay made GUT-based arguments untenable. All this led to cosmologists being split, in favour and against the idea of inflationary universe by the end of last century.

Early in this century, WMAP (2006) and Planck (2013) satellites along with telescopes in the South Pole like Boomerang and BICEPS, were able to observe CMBR very precisely. They concluded that a small portion of the inflation potential was helpful in reproducing the anisotropy observed. The observed power spectrum (strength of multipoles of anisotropy) gives precise values for the scale of the spectrum, and the ratio of the strength of tensor to that of scalar fluctuations. Observations were able to put constraints on the form and strength of this part of the potential. The inflaton potential was able to accommodate these values by varying their parameters.

In 2013, the BICEPS experiment in the South Pole, suggested the presence of gravitational fluctuations. Immediately, there was talk of a Nobel Prize for the idea of inflation. Unfortunately, the findings of tensor or gravitational fluctuations were not confirmed by the Planck satellite in 2014. The BICEPS results were attributed to dust in the atmosphere[2]. No gravitational fluctuations have been seen to date.

Inflationary theory started with an attempt to explain unnatural initial conditions, but ended up with having to explain finely-tuned parameters. The ability to adjust their parameters to agree with observed anisotropies makes it phenomeonology and not a theory. The whole history of inflationary expansion is largely speculative and even gross details are unknown.

Meanwhile a Russian billionaire set up a large number of prizes with large amounts of money attached to them, called the 'Breakthrough Prizes'. These have been given in recent years to string theory as also for inflationary theory workers[3], in addition to other workers. The Nobel Prize committee, in Physics, waits for experimental confirmations before the awards. The Breakthrough Prizes seem to be given for mathematical beauty and excellence, and do not seem to require experimental confirmations. However, they do add to the credibility and acceptance of the theories among the public and even in the scientist's mind. Steinhardt, an early contributer to ideas of inflation, has in the last few years argued against the inflationary idea. He published an article in *Scientific American* in 2017, criticizing the inflationary theory and its improbability[4]. Later, Guth and collaborators published a rebuttal in the same journal[4]. It was supported by 33 well-known scientists, four of them Nobel laureates, who lauded the idea of inflation. There have also been accusations of giving up 'empirical testability' which, however, has been denied by Guth and others[4].

The author of this book is a civil servant, who wrote an earlier book on the evolution of the universe and life. He has now come up with two separate books on evolution, one of the universe (this book) and the other of life. The former, includes introductions to quantum mechanics, particle physics, astrophysics and cosmology, besides topics of DNA and cells from molecular biology. The author wishes to explain the version of science, and not that of faith and scriptures of religion. However, many quotations from the Vedas and other literary texts abound in the book. The chapter headings give no clue to the content. The chapter titled 'The formless acquire form' begins with a quotation from 'The Wisdom of Tao' by Lao Tse, has a description of CERN laboratory detectors, goes on to dark matter, cosmological constant, baryon asymmetry, parity violation, Higgs boson discovery and other things. It is written lucidly, and uses a conversational and casual style. The book gives a lot of information and is priced affordably even for students.

There are, however, some jarring inaccuracies and omissions. Some examples are: 'Positron was predicted independently by ….. Feynman' (p. 64); '….neutrinos are without mass…' (p. 80); '……Superconducting super collider… is being planned in the USA with a ring more than 80 kilometers..' (p. 95). (The partially built project, was abandoned in 1993). '…. (Yang and Lee) predicted that the weak interaction did not obey the *P*-symmetry,….. prediction

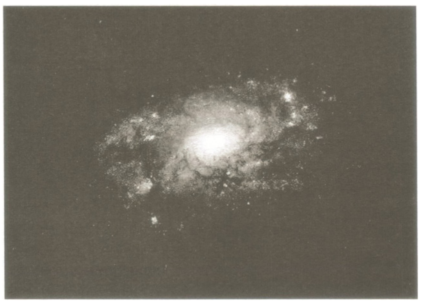

Image taken by Hubble Space Technology of NGC 3949, a spiral galaxy 50 million light years away from Earth, similar to size and shape to our own Milky Way. We can never see a similar picture of our galaxy, being inside it.

was …confirmed by Madam Wu…**all the three** shared the Nobel prize in 1957...' (p. 119). (Only Yang and Lee got the prize.) In the discussion of fermions and bosons (p. 86), it was disappointing to see no mention of either spin (bosons having integral spins and fermions having half-integral spins), or of Satyendra Nath Bose, the originator of Bose–Einstein statistics.

The book ends on the last page 261, celebrating the BICEPS claim of the discovery of gravitational fluctuations on 17 March 2014. Unfortunately, as mentioned above, BICEPS discovery was not confirmed by data from Planck satellite[2]. The book is published in 2017 and probably completed in 2016. But it has missed out on this important fact. It can be updated in the next edition, especially if gravitational fluctuations are seen by then. By that time it may have been decided if 'Inflationary Cosmology is theory or phenomenology'.

1. https://en.wikipedia.org/wiki/inflation_(cosmology (accessed on 12 December 2018).
2. Cowen, R., *Nature*, 2015, 16830; doi:10,1038. See also Keating, B., *Losing the Nobel Prize: A Story of Cosmology, Ambition, and the Perils of Science's Highest Honour*, W.W. Norton, 2018.
3. Dirac Medal of Salam ICTP (2002), Breakthrough Prize (2012), Kavli Prize (2014). See also ref. 1.
4. Steinhardt, P. J., *Sci. Am.*; Guth, A., *Sci. Am.*, 2017; https://physicstoday.scitation.org/do/10.1063/PT.6.3.20170605a/full (accessed on 12 December 2018).

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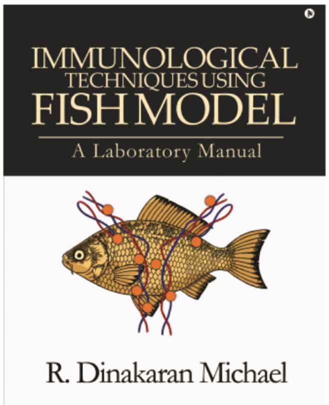

Immunological Techniques using Fish Model: A Laboratory Manual. R. Dinakaran Michael. Notion Press, 38/6, Mc Nichols Road, Chetpet, Chennai 600 031. 2018. xvi + 120 pages. Price: Rs 250 (student version – B/W); Rs 350 (Institutional Version – Colour).

This laboratory manual on immunology for teaching undergraduate and postgraduate life sciences, veterinary and fisheries courses has come at a time when there are restrictions on using several laboratory animal (mammalian) models and when no worthy immunology laboratory classes are conducted for lack of appropriate guidance and approved animal houses in most of the institutions in India.

The author Dinakaran Michael, trained as a fish immunologist by the doyen of immunology in the country, V. R. Muthukkaruppan (Madurai Kamaraj University) pioneered teaching and research in immunology, and developed and implemented the fish model for laboratory exercises. The manual fills the vacuum in teaching laboratory immunology in India. It is similar to Western efforts such as Nuffield curriculum, but this fish model is thoroughly indigenous, non-controversial for animal activists and enables students to perform experiments and learn by themselves. The experiments are compact, comprehensive and well-laid, covering the whole gamut of immunology starting from basic to applied. The manual is structured in 11 chapters and 120 pages covering basic phagocytosis, innate immunity, vaccination, agglutination, precipitation, CMI, immunochemistry and also DNA techniques such as identification of PCR genes and quantifying the gene expressions, i.e. expression profiling. The manual teaches step by step the preparation of solutions, experimentation and observing the results with suitable illustrations and references at the end of each chapter. It provides appropriate further readings (chapter 12), how to maintain fish in the laboratory, prepare the feed, procure the fish, preparation of solutions (chapter 13), and also a list of consultants and expertise from various parts of India trained by the author in these fish immunological techniques over a period of time, along with their postal address, e-mail and telephone/mobile numbers. The listing other experts is a rare gesture of a good teacher indeed. Should this be exercised in every field of the teaching and learning process, India would continue as a haven of knowledge.

The fish model is simple and easy to maintain in the laboratory by the students themselves, requiring less space. Also, it is easily available throughout the year and cheaper than maintaining an approved animal house. Michael has succeeded well in designing, experimenting and applying his ideas in teaching programmes. This manual is an outcome of his vast research experience in fish immunology. It is a handy, quality print with colour and B/W illustrations, affordably priced and also available through online resources though the price may be on the higher side for an average Indian science student. Video documentation of the procedures and making them available on YouTube will help teachers and students further in their teaching and learning process. I recommend that various universities and colleges in India and other developing countries make use of this manual in imparting hands-on training to students of immunology. Finally, I thank Michael for having written this useful manual for the teachers and students, and the future generations.

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