Homi Bhabha Center for Science Education (TIFR)

Graduate Course: History of Science (Winter 2024)

Course Number: SCE104.2

Instructors: Ankush Gupta and Sathish C G

Credits: 2

Day & Time: Thursday (11 am to 1 pm)

Starting From: January 11, 2024

Course Objectives

On completing the course, the student will be able to:

1. appreciate history as a creative process undertaken by humans of present to visualize certain aspects of human past, with certain (possibly diverse) goals and processes leading to different histories.
2. recognize the relevance and appropriate ways of using history in science education.
3. know about different theories of light and vision which were used by natural philosophers in different historical eras, and evidences/observations which supported or refuted these theories.
4. know the ancient theories of matter including the five-element theory and the phlogiston theory and what developments led to establishment of modern atomic theory.
5. know some of the socio-political and economic developments related to colonial era which shaped modern discipline of biology.
6. appreciate how actual practice of scientific research cannot always be understood in terms of well-defined processes and black and white conclusions, which can have grey areas or controversial elements.
7. appreciate some of the non-European traditions of science and technology, and their contributions/non-alignments to the mainstream modern science.

This course aims at developing an appreciation of history as a tool that can enhance science education. In this course, we will try to understand the nature of history and how it can help us in understanding the nature of science. For example, the course would try to look at how historically people tried to understand vision and something related which they called as light. How they conceptualized the composition of matter at the minute (unseen) level, and the structure of the cosmos at the huge (unseen) level. We would also look briefly at an example

of how political dynamics (such a colonialism) shapes a field of science such as botany. At a conceptual level we would also try to understand the process of writing histories, and the relevance of studying history.

The course would involve various kinds of readings relating to a theme, which would be discussed during the classes. Broadly the themes and related readings are as follows. We may add/change some more reading depending on the interests of the students and the directions of classroom discussions.

1) Understanding the process of history: What goes into making of a history (list of facts of past as recollected or documented by some, narratives by historians, and interpretations in a certain framework). We will write some histories and then analyze histories written by us and others. We will also debate about history writing being similar to scientific process versus history being an unscientific discipline.
Reference: E. H. Carr (1961), *What is History?* Penguin Books.

2) **Case studies**:

a) Theories of Vision and Celestial Mechanics (***Seeing through the seeing***): In these we shall discuss various theories proposed in past to explain our vision, and the dynamics of celestial objects, which eventually laid foundation for what we know today as physics.

Reference: G. J. Holton and S. G. Brush (2001). *Physics- A human Adventure*. 3rd Ed. Rutgers University Press, New Brunswick.

b) The phlogiston Theory (***Rise and fall of a theory***): In this theme, we will discuss an alternate theory of matter which persisted for quite some time among scientific circles in Europe and explained many phenomena, before it got replaced by modern atomic theory of matter. We shall discuss how it can help students with a better understanding of the atomic theory.

Reference: Aaron J Idhe (1984), *The Development of Modern Chemistry*. Dover, New York.

Jaimie Wisniak (2004), *Phlogiston: the rise and fall of a theory*, Indian Journal of Chemical Technology, 11, 732-743.

c) Royal Botanical Gardens and development of agricultural science (***Institutionalization of modern science***). This example will reflect the political and economic forces that shaped the growth of scientific institutions and discipline such as biology in several regions of the world.

Reference: Lucile Brockway (1979), *Science and colonial expansion, the role of the British Botanical Gardens*. American Ethnologist, 6(3), Interdisciplinary Anthropology, 449-465.

Sir Albert Howard (1940). An Agricultural Testament, London.

d) Memory and Chemicals (***The nature of scientific research***): In this theme, we shall discuss a series of developments that tried to establish memory as a molecular phenomenon in the 20th century. This description will highlight insights about the actual science practice and show that sometimes celebrated research conclusions may not be unambiguous.

Reference: H. Collins and T. Pinch (2002). The Golem: *What you should know about science*. Cambridge University Press, Cambridge, UK.

3) Relevance of history in science education: We shall discuss the relevance of history in conceptual understanding, critical evaluation, contextualization of present knowledge; and ideas of historical evolution being similar to individual cognition. We shall try to understand some developments which led to organization of science content in the form we see in today's textbooks.

Reference: Michael R. Mathews (2015). *Science Teaching, The contribution of History and Philosophy of Science*. Routledge, New York.

John William Draper (1847). *A textbook of Natural Philosophy*, Harpers and Brothers, New York.

J. H. Wandersee, P. B. Griffard (2002). *The history of chemistry: Potential and actual contributions to chemical education*, Kluwer Academic Publishers.

4) Nature of historical materials: In this theme, we will discuss the diversity of historical materials which can help us in reconstructing our past. This material can range from original writings of scientists, contemporary writings/literature of that era, recollected and recreated writings by historians of a later age, and numerous other artifacts. Other modern forms also include animations, plays, recreated experimental videos, creative writing around history of science, and popular science writings.

References: *The chemical History of a candle*. Lectures by Michael Faraday,

Matt Ridely (1999). *Genome: The autobiography of a species in 23 chapters*. Fourth Estate, London.

Michael Frayn, The play *"Copenhagen"*.

Galileo Galilei (1610). *Siderus Nuncius*.

5) Developments in India, China, Latin-American and Arab world: In this theme, we will look at some developments in science and technology from these non-European cultures,

which independently (and sometimes interacting with each other) evolved and contributed to the global pool of knowledge.

References: D. M. Bose, S. N. Sen, and B. V. Subbarayappa (1971), *A concise history of science in India*, Indian National Science Academy, New Delhi (https://archive.org/details/in.ernet.dli.2015.502083)

James Poskett (2022), *Horizons: A global history of science*, Penguin, New York, USA.

Assignment and Evaluation:

There will be weekly reading assignments and writing assignments every 2 weeks, one mid-semester and one end-semester exam.