Chapter 3

Genetics, Plastic Surgery and Other Wonders of Ancient Indian Medicine

1. Introduction

As the title suggests, this chapter is about medical knowledge in ancient India. But it is more than that. It also proposes a plan for combating pseudohistory of science – a plan that has the potential to turn the mania for mythic history into an opportunity for learning.

Even a cursory look at news headlines will show that we are inundated these days with myths of our civilization's singular greatness. A narrative of Indic, or *dharmic,* exceptionalism is under construction which celebrates its spiritual and scientific riches. Not unlike American exceptionalism, Indic exceptionalism seeks to universalize itself, both at home and around the world.[1]

The myth of Indic exceptionalism is a myth wrapped in and around myths taken straight out of the *Mahabharata*, the *Ramayana* and the many *Puranas*, the traditional storehouses of mythology. The

1 *Dharmic* civilization is understood as the civilization that is native to the land of India. It subsumes Hinduism, Buddhism, Jainism and Sikhism. Its distinctive set of assumptions regarding "divinity, the cosmos and humanity" are seen as offering "an Indian challenge to Western Universalism," as the subtitle of a recent book by Rajiv Malhotra (2011) would have it. The point to note is that the Indic/dharmic tradition by definition excludes those Indian religious traditions with roots in the Judeo-Christian and Islamic traditions.

new myth-makers appropriate popular myths from this rich tradition, evacuate religious or spiritual meanings out of them, and retell them *as if* they are literally true accounts of scientific and technological achievements. The much beloved gods and goddesses that are imprinted in the collective psyche of Indian people remain – but now they serve the earthly ambitions of men and women.

A myth, according to the Oxford English Dictionary, is "a traditional story, especially one concerning the early history of a people or explaining a natural or social phenomenon, and typically involving supernatural beings or events: *ancient Celtic myths." Myth also means, according to OED again,* "A widely held but false belief or idea."

Both meanings of myth are at work in the public sphere in India today, with one important difference: rather than see myths for what they are – "traditional stories…..involving supernatural beings," or as "widely held false beliefs" – they are being served up as legitimate evidence of scientific achievements. Like fundamentalists everywhere who insist upon reading religious texts as literal accounts of the creation and evolution of the universe, in India too, the miraculous prowess of supernatural beings is being interpreted as if they provide a literally true account of the achievements of ancient "scientists" and "engineers."

This chapter will offer a creative way we can turn this fiasco into a teaching moment. The basic idea is simple: whenever our political leaders dish out myths and call them "science," we should take it upon ourselves to learn some *real* history of *real* science in the specific domain in question.[2] After we are done laughing at the absurdity of the tall-tales we are told, we should get down to the more sober task of educating ourselves with the actual history of science in India as a part of the global history of medicine, science and technology. This self-education requires that we arm ourselves with the best, the most reliable evidence available and approach it with a critical, or a scientific, spirit – that is, *be willing to rethink our preconceived ideas in the light of compelling evidence*.[3] This is what this chapter intends to do for history of medicine

2 I think of it as my "lemonade model," inspired by the old proverb, "when world gives you lemons, make lemonade."

3 Here Garrett Fagan, a critic of pseudo-archeology, is right on the mark: "a basic characteristic of genuine [as opposed to pseudo-] archeology, of whatever theoret-

(as the previous two chapters have tried to do for two landmarks in mathematics)

Such an exercise, carried out with rigor, honesty and a sturdy respect for historical evidence can yield rich dividends. Its usefulness for countering ideologically-driven pseudohistory of science is obvious. Less obvious, but perhaps more important, is how a dose of *real* history can save the ancient physicians, craftsmen-mathematicians from becoming civilizational icons (as in the Indocentric discourse), or from becoming totally invisible (as in the Eurocentric discourse). Understanding how the ancients grappled with the natural world armed with nothing more than their faculty to reason and the evidence of their senses, can save them from both glorification and condescension at the hands of their 21st century inheritors.

2. Mythologizing medicine

Scholarly study of myths has come a long way from the 19th century understanding of myths as proto-scientific explanations of nature. Throughout the 20th century, as scientific understanding of the natural world made progress, " the physical world was conceded to [modern] science," as Robert Segal, a leading theorist of myth put it, and myths were no longer seen as competing with science as explanations of nature; they were instead reconceived as symbolic narratives about the place of human beings in the world, their unconscious fears and fantasies, their sense of right or wrong.[4] As Sudhir Kakar, the pre-eminent interpreter of the "inner world" of Indians puts it, "myths… are individual psychology projected onto the outside world… myths can be read as a kind of collective historical conscience, instructions from the venerable ancestors on 'right' or 'wrong,' which serves to bind the members of a group to each other."[5]

ical bent, is the maintenance of conceptual flexibility – a willingness to re-examine favored conclusions in the face of… countervailing evidence, and to change those conclusions accordingly. *It is not unreasonable to brand such an intellectual stance as broadly "scientific" insofar as it accepts the capacity of the data to reshape interpretations*" (emphasis added), Fagan, 2006, p.25

4 Robert Segal, 2006, pp. 341-342.

5 Sudhir Kakar, 1981, p. 4.

In India of the 21st century we seem to be stuck in the 19th century: Myths continue to crop up in history of science *as if* they are literally true accounts of the physical world, or as literally true descriptions of technological artifacts. Existence of ancient Vedic-era space-ships capable of inter-galactic travel, the existence of nuclear weapons in the time of the *Mahabharata* and other such fantastic tales continue to be asserted by learned men and women in academic forums.

It is in this context that when the Prime Minister of India used mythology as evidence for the existence of advanced knowledge of genetics and surgery in ancient India, it made news not just in India, but around the world. One could not but read Mr. Modi's words as giving official blessings to the mythification of science that has been going on in the country for a long time, but which seems to intensified under his watch.

Speaking at the inauguration ceremony Sir H.N. Reliance Foundation Hospital and Research Center in Mumbai on October 25, 2014, Modi invoked familiar Hindu myths to exhort the audience to take pride in the medical achievements of our ancestors. The Hindi text of his speech is available on the official website of the Prime Minister's Office. Excerpts in English translation are reproduced here.

Karna in the *Mahabharata,* Modi suggested, could well have been a medical first; a baby born *in-vitro*. This is what he said: "We can feel proud of what our country achieved in medical science at one point of time. We all read about Karna in the *Mahabharata*. If we think a little more, we realize that the *Mahabharata* says Karna was not born from his mother's womb. This means that genetic science was present at that time. That is why Karna could be born outside his mother's womb."

Next, Modi invoked Lord Ganesh in the context of plastic surgery. "We worship Lord Ganesh. There must have been some plastic surgeon at that time who got an elephant's head on the body of a human being, and began the practice of plastic surgery."

The PM stopped at Ganesh. But following this line of thinking, many more medical firsts can be claimed. After all, we worship Hanuman, and so there must have been biophysicist who could make this member of higher primates fly. We worship gods and goddesses with

any number of fully-functional arms and heads and so there must have been neurosurgeons way back then. So on and so forth. The point is that if we are not going to respect any boundary between myth and science, then history of science simply collapses into mythology. Myths interpreted literally come to serve not just as evidence for rudimentary or proto-science, but for the most cutting-edge sciences that we have *today*.

No doubt this bit of myth-making at the hospital was done with best intentions of encouraging pursuit of science. As Modi explained, "What I mean to say is that we are the country which had these capabilities. We need to regain these."

One could well complain that we are making too much of these remarks. After all, don't all politicians, from the Left and the Right, go into a grandstanding mode time to time? This is what politicians do.

But Modi, as is well-known, is a product of the *shakha* culture of the RSS. Having joined the local *shakha* when he was barely eight-years old, the RSS "[has done] the most to shape him and his worldview, and to advance his political ambitions," to quote from Vinod Jose's biographical essay on the rise of Narendra Modi.[6] Fables about "scientific" achievements of our Hindu forefathers are as natural in the RSS culture as water is for fish. With the RSS in an unprecedented position of power, there is every reason to fear that this mythology will find a place in textbooks. This is one very good reason why we must take the PM's pronouncements seriously.[7]

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6 Vinod Jose, The *Caravan*, March 2012.

7 All signs are pointing to a massive push for the Saffronization of education. Earlier this year, the Ministry of Human Resource Development began its consultative process for a New Education Policy. It has invited input from grassroots movements regarding 33 topics related to school and higher education posted on its website http://mhrd.gov.in/. The RSS is a major player in the consultative process. According to the *Deccan Herald*, "Amid these initiatives and plans of the government, the Rashtriya Swayamsevak Sangh's (RSS) education wing is silently working to assist the government formulate the new policy. A Shiksha Niti Aayog (education policy commission), set up under the leadership of controversial educationist and former RSS pracharak Dinanath Batra, is holding parallel, nationwide deliberations to get suggestions from the "right-minded" citizens of the country. It has plans to hold at least 500 seminars across the country to "make people aware of the drawbacks of the current education system and get vital

This mythic history of medicine has implications for health policy as well. Under the Modi government, AYUSH, the government body that oversees traditional medical systems, has been elevated to a full-fledged ministry with an annual budget of 1,200 crore rupees. Even though the number of randomized control trials for Ayurveda can be counted on the "fingers of one hand," and even though homeopathy has been proven multiple times to be utterly ineffective in rigorous double-blind trials, resources are going to be diverted to these medical traditions which are more aptly described as alternatives *to* medicine, rather than as alternative medicine.[8]

The situation is ripe to put "the plan" into action, that is, turn every mystification into an opportunity to educate ourselves in real history of real science. Following the PM's mystification, the plan calls for looking up our ancient medical to find out what they actually have to say regarding "genetic science" and surgery. When we call them "scientific," what do we mean? If we really had made such advances in medicine in the past, why did we stop? Why has Ayurveda not made any real progress beyond whatever was put down in Charaka and Sushruta samhitas composed in the early centuries of the Common Era?

In this chapter, we will examine these issues in more details. We will first look into the question of "genetic science" in *Charaka Samhita*. The next section will examine the question of plastic surgery, focusing on the method of nose reconstruction in *Sushruta Samhita*. We will follow it up with a comparative history of anatomy where we will address the question why, despite the promising start in anatomy and surgery, we fell behind sister civilizations.

But we will start with a brief discussion of the dangers of anachronistic or "presentist" history. Delving into this problem with history

suggestions from them on how to make it relevant for the country." http://www.deccanherald.com/content/461641/education-policy-good-definitely-not.html

To understand why the leadership of Dinanath Batra should worry us, here is a gem from his book, *Bharatiya Shiksha kaa Swarup*: "Charaka explained blood circulation in 300 BC, while the credit is given to William Harvey." p. 50. Batra provides no evidence to back this astounding claim.

8 See Rukmini Shrinivasan, "Medicine Wars," *The Hindu*, April 26, 2015. AYUSH stands for Ayurveda, Yoga, Unani medicine, Siddha and homeopathy. The phrase "alternatives to medicine" was suggested by my friend, Vijayan.

writing may seem like a digression, but its relevance to the issue at hand will soon become evident.

3. Why anachronism is bad history of science

One of the first things all historians are taught to avoid is the "sin" of writing "Whig history", which consists of giving anachronistic or "presentist" accounts of the past.[9] Anachronistic history is simply reading the past in the vocabulary derived from our present knowledge, beliefs, or values. It is "unhistorical history writing" that "studies the past with one eye to the present", to use Butterfield's famous words. Put another way, it uses *now* as the prism through which it views *then*. Historians of science are *especially* wary of presentism for the potential it has to distort what scientists in the past were trying to achieve. The presentist distortion in history of science comes when historians "cast a particular theory, now deemed correct, as proven right from the start," or to put it another way, when they cast the "scientists" of earlier eras as working with the same conceptual and methodological framework as scientists today.[10]

The opposite of anachronistic history is the diachronic, or contextual, history of ideas in which the historian tries to become an observer *in* the past, not just *of* the past; in which the historian takes a fly-on-the-wall approach to writing history. This requires that the historian must

9 The term "Whig history" was made famous by Herbert Butterfield's 1931 classic titled *The Whig Interpretation of History*. By Whig history Butterfield was referring to the habit of British liberals to read the political history of Britain as one long continuous and inevitable march toward parliamentary democracy. This way of history writing worked by reading the contemporary political philosophy of liberalism back into the minds of actors in the past, who in reality may have had totally different motives and meanings for their actions.

10 The quotation is from Douglas Allchin, 2004, p. 182. Strictly speaking, there were no "scientists" before the term was coined by William Whewell in 1834 to describe the students of the knowledge of the material world collectively. By "scientist" he meant an analogue to "artist", as the term that could provide linguistic unity to those studying the various branches of the sciences. But, of course, human beings have been studying the material world from the very beginning of history. The correct name for pre-modern students of nature is "natural philosophers". See Sydney Ross, 1962. See also https://thonyc.wordpress.com/2014/07/10/the-history-of-scientist/

learn to *forget*, or at least learn to disregard, what she or he knows today when interpreting the past.

The reason is obvious: actors in the past did not have access to the conceptual framework that is available to actors living today. This is nowhere made clearer than in the work of Thomas Kuhn, the author of *The Structure of Scientific Revolutions*, a book that radically changed how we think of progress in science. According to Kuhn, "scientists" in the past lived in a different world: *they were not talking of the same things we do today, even when they were investigating the "same" object in the material world.* This creates problems:

> Scientists-historians and those who follow their lead impose contemporary scientific categories, concepts and standards on the past. Sometimes a specialty which they traced from antiquity had not existed as a recognized subject of study until a generation before they wrote. Nevertheless, knowing [from their current state of knowledge] what belonged to it, they [manage to] retrieve the current contents of the specialty from past texts, *not noticing that the tradition they had constructed in the process had never existed.* In addition, they usually treat concepts and theories of the past as imperfect approximations to those in current use, thus disguising the structure and integrity of the past scientific traditions. Inevitably, histories written in this way reinforce the impression that history of science is the triumph of sound method over error and superstition.[11]

The problem with this way of reading the past is that it turns history into a "hall of mirrors", where all we can see is an image of our own present.[12] This is a special problem of science as it turns the sciences of previous eras into *a precursor of, or an anticipation of, what we already know today.* In the process, it continuously updates – or "modernizes" – the achievements of the past. This is how presentism becomes a tool for constructing a glorious past of the nation whose "science" was always "modern".

A couple of examples will help illustrate the problem.

History of science in the West has its share of anachronisms. There is a kind of Hellenophilia among Western historians who think of modern science as a direct descendant of the natural philosophy of Aristotle and Plato. For example, by expressing Aristotle's law of motion in a mathematical equation, it is possible to make Aristotle look like the pre-

11 Thomas Kuhn, 1977, p. 149.

12 Carlos Spoerhase, 2008.

cursor of the modern laws of motion described by Newton's three laws, while in reality Newtonian physics could only emerge after Aristotle's natural philosophy was *discarded* root-and-branch.

For an Indian example, consider P.C. Ray's well-known history of "Hindu chemistry". Looking for some evidence that "the Hindus had a very large hand in the cultivation of experimental science", Ray turns to *rasayana* (alchemy) involving the use of mercury and mica that developed sometime between 13th and 14th centuries as part of a tantric practice, the intention of which was to achieve bodily immortality. Ray repeatedly uses "alchemy" and "chemistry" as synonyms, and does not distinguish between the mercury, sulphur and/or mica of the alchemists (who saw these elements as the "seeds" of Shiva and Parvathi respectively), from the modern conception of these elements.[13]

There is no doubt that alchemy involved hands-on work and laid the basis for laboratory techniques like distillation and sublimation that are still used in modern chemistry. But hands-on work by itself does not count as "science". There is no doubt that alchemy *was* the chemistry of middle ages, it was rational and empirical within its theoretical framework. However, that theoretical framework had to be completely *overturned* for chemistry as we know it to emerge.[14] The transition from alchemy to chemistry had already taken place by the close of the 18th century and yet, this break is hard to discern in Ray's work. Presentism allows Ray to celebrate the alchemists as the fathers of chemistry in medieval India, when they were anything but.

P.C. Ray is only the tip of the iceberg; presentism is practically the operating philosophy of modern Ayurveda. The examples are endless: the mysterious *ojas* are transformed into immunity and virility, *prāṇa* becomes "oxygen" and also "energy", while the lotus-like heart that

13 Ray, 1918/1992. For a similar critique of Ray, see Pratik Chakraborty, 2000.

14 The paradigm shift did not happen overnight and pioneers of chemistry like Robert Boyle and even the great Isaac Newton continued to practice alchemy. However, these admirers of Francis Bacon were doing alchemy in a scientific spirit, applying the Baconian method of experimentalism to alchemy, and unwittingly began the long process of questioning the idea that elements can be transmuted. Initial continuities gave way to discontinuities between alchemy and chemistry. Just as it is bad history of science to ignore the *continuities* between chemistry and alchemy, it is equally bad history to ignore the eventual *discontinuities*.

sleeps at night and wakes up in the morning become diastole and systole, and so on and so forth. The end result is a schizophrenic mindset which accepts fundamentally contradictory theories about the same subject matter at the same time.[15]

Whereas professional historians of science try their best to avoid presentism, nationalist historians in India have embraced it with a vengeance. Simply reading back whatever we know and value today – which, more often than not, has roots in the post-Enlightenment West – back into ancient times has been the hallmark of Hindu nationalist history. Straight lines of descent from "the Vedas" for everything from science and technology, secularism, democracy, ecological sensibility, etc., abound in this genre of history writing.

4. "Genetic science" in the time of *Mahabharata*

Mr. Modi's claim that "genetic science was present at that time of *Mahabharata*" is a textbook example of anachronistic history. The very idea of "genetic science" in the early centuries of the Common Era when the *Mahabharata* was put together makes no sense outside of the anachronistic history-writing described above.

The concept of a "gene" as a discrete unit of heredity was not known until the beginnings of the 20th century when the work of Gregor Mendel (1822-1884), a Christian monk who lived in what is now Czechoslovakia, was rediscovered. Even the great Charles Darwin (1809-1882), a somewhat older contemporary of Mendel, thought that traits are inherited through the blending of "gemmules" – tiny particles that are shed into the blood by all the cells in the body, which are then "blended" and eventually passed on to the progeny. For example, a tall and a short couple will have children with average height. A parent with blue eyes and a parent with hazel eyes will have children with greyish eyes. Mendel disproved this "blending" theory by meticulously crossing pea plants and

15 Wujastyk (2009) cites an interesting example of this schizophrenia. He reproduces a set of model papers from 1990s for the exam required for a degree in Ayurveda. One question is about the variety of "winds" that supposedly move in the blood vessels, while the very next question is about red blood cell counts; question about food getting cooked by *agni* in the stomach is followed by questions having to do with metabolic hormones.

observing how traits (such as color and texture) were passed down to the next generations. It was his tireless and patient work that taught us that genes are passed on as discrete units and do not blend. That these units of heredity sit on the chromosome; that the chromosome is made up of DNA, which has a double-helical structure – these are all later 20th century discoveries.[16]

Strictly speaking, there was no "genetic science" *anywhere* before the concept of genes was invented. That, of course, does not mean that people did not puzzle over *heredity* before they knew what genes were. Indeed, everywhere, in *all* civilizations that we know of, people have tried to understand the process through which some traits run in families; why children resemble their parents and siblings; etc. Just like every other people, ancient Indians pondered the mystery of heredity as well. Their most "scientific" theory – by the standards of that era – is recorded in *Caraka Saṃhitā* (henceforth, *CS*), the foundational text of Ayurveda.

According to Caraka, the birth of any living being involves not two, but *three* partners: the mother, the father, and the soul (the *atman*) attached to its subtle body (*sukshma sharira*), which is looking for a new body after death. Biological parents are necessary but not sufficient, as they only provide the material out of which a body is constructed. The individual soul is a particle of Brahman, the Cosmic Consciousness, which the parents cannot provide. The embryo is a "spirit-matter composite" and therefore ensouled from the moment of its conception.[17] This is how S.N. Dasgupta, the preeminent author of the multi-volume *History of Indian Philosophy* describes the process by which a fetus is formed:

> When a man dies, his soul, together with the subtle body (*sukshama sharira*) composed of the four elements (air, fire, water and earth) in a subtle state, and *manas*, passes invisibly into a particular womb on account of its *karma*, and

16 See James Schwartz (2008) for an interesting history of genetics.

17 As Julius Lipner (1989) correctly points out, because the embryo is considered ensouled from the moment of conception, abortion even at the earliest stages of pregnancy is seen as murder ("hatya") and condemned as a heinous crime at par with killing a Brahmin in the canonical Hindu literature. It is true that women have the right to abortion in modern India, but this law exists in contravention of Hindu ethics.

> then, when it comes in contact with the combined semen and blood of the father and the mother, the fetus begins to develop. The semen and the blood operate as causes …..only when they come in connection with the subtle body transferred from the body of a dying being.[18]

Now, this three-party arrangement is *perfectly rational and even necessary* within the classical Vedantic understanding of a human person and what happens at the time of death. In the Vedantic worldview, which *Caraka Saṃhitā* does not question, a human person is made up of gross body (*sthula sharira*), subtle body (*sukshama sharira*) and *atman-Brahman*.[19] The gross body disintegrates at the time of death. The subtle body, which carries all the imprints of deeds and thoughts of the previous life, does not die; it clings to the *atman* of the person who is dying, and together they exit from the gross body. The subtle body continues to live until salvation is achieved, and the *atman* merges with Brahman. Until that happens, it *has* to find a new body after every death.

This, then, is how the physicians who composed the Caraka Samhita understood the process of birth, and the passage of traits from the biological parents, plus the invisible and ethereal subtle body, riding the coat-tails of the eternal atman on its quest for the Brahman.

Though this explanation of conception and birth is coherent within the Vedantic worldview, can it be called "scientific" even within its own context, to say nothing of being scientific in the modern sense of the word? Can we, by any stretch of imagination, claim that "genetic science," or even the idea of heredity, was known to our ancestors?

The answer to both these questions has to be in the negative.

There is no doubt that the Ayurvedic physicians shared the ambitions and the goals of anyone who can be legitimately called a "scientist," insofar as they sought to understand and explain the state of health and disease. Like their modern counterparts they, too, sought to predict and control the course of disease. It is also true that CS encour-

18 Dasgupta, Volume II, p. 303. Dasgupta also provides a good description of what happens to the human person at the time of death.

19 The earlier generation of rationalists, notably Debi Prasad Chattopadhyaya, were too eager to find signs of hard empiricism in Ayurveda and claimed that all the Vedic elements (rebirth, e.g.) were later additions to originally materialistic texts. This view is no longer considered valid, as the Vedic elements are knitted into the fundamentals of Ayurvedic writings. See Engler (2003) for one of best critiques of a naïvely rationalist-materialist interpretation.

ages the physicians to use all their sensory faculties to make a proper diagnosis. Yet, empirical observations were made to arrive at conclusions that were untestable, even in theory. In the case of how conception takes place, empirical observations regarding the coming together of father's "seed" (*shukra*, or semen) and the mother's "field" (*sonita*, or blood) were of course made, but were used to simply illustrate the truth of a higher-level concept (the subtle body in search for an "appropriate" womb, for example). The higher-level concept, in turn, was deduced from a divinely sanctioned web of concepts which are seen as "eternally true" and therefore beyond reason and evidence. Independent evidence that may verify or falsify the higher-level concept was neither sought, nor considered proper to seek.[20]

Secondly, CS's argument that the subtle body is a necessary component of conception fails to explain what it sets out of explain – namely, heredity. Any model of heredity must explain how physical and mental traits are transmitted from biological parents to offspring.[21] But according to the long discussion of the process of conception and fetal development found in CS, "the self causes itself to be born by means of itself as an embryo" where self is the eternal soul, the atman. All higher functions which make us human – consciousness, self-knowledge, intelligence, memory, personal identity – are due to the atman that descends into the womb (parents only providing the stuff that the body is

20 It has become fashionable these days to argue that science is no different from any local tradition, or from religion and myth, because scientists also operate within a paradigm that they cannot question if they have to do any science at all. It is true that in modern science individual scientists or even communities of scientists at any given time do not challenge the matrix of theories, methods and metaphysical assumptions underlying the science they do; they merely solve puzzles for which they need to accept the assumptions and methods of their paradigm. But the reward structure in modern science has evolved in such a manner that a collective skepticism is encouraged so that the basic assumptions of any paradigm have been tested by the previous generation of scientists. So in science, paradigms do undergo revolutions; there is no guarantee that today's most cherished truths may not join the heap of rejected ideas in the future. Ayurveda on the other hand, "eternalizes" even those empirically tested claims by putting them in the mouth of gods, who passed on this knowledge to human sages, who passed it on to the vaidyas, and so on.

21 Oxford English Dictionary defines heredity as "The passing on of physical or mental characteristics genetically from one generation to another."

made of). The nature of the "mental faculty" of the embryo – whether it is *sattvic*, *rajasic* or *tamsic* – is determined not by biological parents, but by whichever of these traits was dominant in the previous life of the transmigrating soul.[22] It is thus safe to say that CS lacks a complete theory of heredity, as the term is universally understood.

Finally, while the transmigrating soul is a necessary component of ancient "science" of "heredity," it is entirely unnecessary to a modern understanding of genetics. In other words, the soul-stuff can be easily shaved off by Occam's razor with no effect whatsoever on the actual theory and practice on the science of genetics.

Occam's (or Ockhham's) razor is a form of reasoning attributed to William of Ockham, a 14th century Franciscan monk. It simply entreats us to "not multiply entities unnecessarily," where entities are our theoretical assumptions and premises. The rule of thumb that scientists follow is this: a scientific theory that recruits more assumptions, but can stand equally well with less, is needlessly complicated. If there are two theories in the same domain, scientists should accept the simpler one. The logic behind the preference for simpler theories is as follows:

> ..if we can remove the trimmings of unnecessary assumptions and premises without it impacting the quality of the conclusions, then the trimmings are unlikely to play a part in the explanation. As a consequence, they should be dropped as they play no part in the reasoning and thus have no consequence for the conclusion.[23]

To see how it works, ask any of the thousands of molecular biologists in India who continue to believe in karma and rebirth in their personal lives outside work, but do not invoke the soul-stuff in their scientific work. They may not put it these terms, but they are using Occam's razor in the lab, but not outside the lab. In other words, they live

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22 The mother is said to provide softer tissues like the skin, blood and internal organs, while the contribution of the father is limited to the harder stuff like bones, teeth, hair etc. See Wujastyk, 1998, pp. 95-100. In what amounts to a pathetic clutching at straws, this has been read as an anticipation of the modern human genetics in which the mother contributes the X-chromosomes and the father the Y-chromosomes! See Deb, 2015, p. 84.

23 Quoted from Jason Braithwaite's excellent exposition titled "Occam's Razor: The Principle of Parsimony, available at https://www.academia.edu/1742741/Occams_Razor_The_principle_of_Parsimony

compartmentalized lives; they are hard-core materialists and empiricists when they are scientists, yet unquestioningly accept the role that atman plays in matters of life and death in their everyday lives.[24]

To sum up this section: Our ancient medicine does contain a partial theory of heredity, but we did not have "genetic science." Our ancient theory of heredity is of no relevance to modern genetics. It has been shaved off using Occam's razor.

5. Plastic surgery in Ancient India

The Prime Minister's more astounding claim about ancient surgeons doing inter-species head-transplants (as in the case of Lord Ganesh) belongs to the realm of mythology in the sense of "a story … involving supernatural beings or events," as defined earlier. Such fables are beyond evidence, and for that reason alone should not be used as evidence for any kind of history. One should let such stories rest in the land of enchantment and imagination where they belong.

Yet, such statements amount to, in football parlance, self-goals by India First team, as they prevent us from seeing the promising beginnings made by ancient Indian physicians in surgery (this section) and human anatomy (next section).

Any inquiry into surgery and anatomy will naturally start with *Sushruta Saṃhitā* (*SS*) which provides a unique window into the world of surgeons and their techniques. The exact dates are hard to pin down, but the scholarly consensus is that the "kernel probably started some centuries BCE, in the form of a text mainly on surgery, but which was then heavily revised and added to in the centuries before 500 CE. This is the form in which we have received the work today."[25] The entire *Saṃhitā* is a work of many hands and contains many historical layers. The text is presented as the teachings of Dhanvantari (identified as the King of Benaras) to his pupil Sushruta.

When admirers refer to Sushruta as the "world's first plastic surgeon" they are not entirely wrong. Sushruta does describe surgical

24 See the first of its kind online survey of the worldview of Indian scientists available at http://commons.trincoll.edu/worldviewsofscientists/report/

25 Wujastyk, 1998, p. 105.

procedures for the reconstruction of the ear, nose and lip for defects; congenital, or acquired. There were ample chances for acquiring these defects, as cutting off someone's nose and/or ears was a common form of humiliation in ancient India, as it was in other ancient societies as well.[26] Apart from reconstructive surgery, there are also descriptions of "ophthalmic couching (dislodging of the lens of the eye), perineal lithotomy (cutting for stone in the bladder), removal of arrows and splinters, suturing, and much besides."[27]

The procedure for nose reconstruction developed by Sushruta is one of undisputable genius. It is described in chapter 16 of the first part of the *Saṃhitā*. The description is short and essentially consists of the following: The surgeon would take a leaf the same size as the person's deformed nose, and cut a flap of skin from the cheek which had the same measurements as the leaf. This flap would be laid on the tip of the nose, while it is was still attached to the cheek at the other end. Once the cheek flap was joined to the nose, two pipes (probably reeds) would be inserted which would serve as openings for nostrils. Once the skin had "taken" to the nose, its connection with the cheek would be cut. A similar procedure could be used for reconstruction of lips, according to *SS*. Simple and elegant![28]

There is no doubt that this is the first recorded method for reconstructive surgery in history. It eventually passed into European hands where it was developed further and became the basis of modern plastic surgery of the nose, or rhinoplasty.

But the history of this promising procedure at home in India is rather dismal. While Sushruta's words continued to be copied faithfully in later medical texts, translated into Arabic and reached China, there are no reliable records showing that nose reconstruction or any other surgical techniques described in *SS* continued to be practiced in India. The birth place of Sushruta had become bereft of anatomical knowledge and surgical practices, so much so that the French traveller Jean-

26 Remember what Lakshmana did to Surpanakha? This practice was widespread in ancient Egypt as well.

27 Wujastyk, 1998, p. 106.

28 For a complete description see Wujastyk, 1998, pp. 142-143.

Baptiste Tavernier could write in 1684 that the "natives of this country understand nothing of Chirurgery".[29]

All available evidence (or rather the lack of it) indicates a kind of stagnation which is described by Roy Porter thus:

> *Sushruta Saṃhitā* maintains that surgery is the oldest and the most useful of the eight branches of medical knowledge… However, there is little evidence to confirm that these practices persisted. A description of the couching operation for cataract exists in the ninth century *Kalyāṇakāraka* by Ugraditya, and texts based upon *Sushruta Saṃhitā* copy out the sections on surgery. But medical texts give no evidence of any continuous development of surgical thinking; no ancient or even medieval surgical instruments have survived;[30] nor is surgery described in literary or other sources. … the early sophistication of surgical knowledge seems to have been an isolated development..[31]

After centuries of complete silence, the Indian method of fixing broken noses was reported in a letter to the editor in the October 1794 edition of *Gentleman's Magazine*, published from London.[32] The letter, signed simply as "B.L." in part says the following:

> Mr. Urban,
>
> A friend has transmitted to me, from the East Indies, the following very curious, and, in Europe, I believe, a known chirurgical operation, which has long been practiced in India with success; namely, affixing a new nose on a man's face. The person represented in Plate 1 [reproduced below as figure 1] is now in Bombay.
>
> Cowasjee, a Mahratta of the caste of husbandman, was a bullock-driver with the English army in the War of 1792, and was made a prisoner of Tipu [Sultan] who cut off his nose and one of his hands. In the state of the Bombay army near Seringapatam is now a pensioner of Honorable East India Company. For about 12 months he has remained without a nose when he had a new one put on by a man of the brickmaker caste, near Puna. This operation is now common in India, and has been practiced from time memorial. Two medical gentlemen, Mr. Thomas Caruso and Mr. James Trindaley of the Bombay Presidency, have

29 From Wujastyk, 1998, p.108. Chirurgery is an archaic name for surgery.

30 The sketches of instruments – the lion, or crocodile face forceps, knives of various shapes, needles etc. – that abound in modern Ayurvedic books/texts are all artists reconstructions from the descriptions given in the Saṃhitās, and not copies of original and still existing instruments.

31 Porter, 1997, pp. 140-141.

32 *Gentleman's Magazine* started publishing in 1731 and continued to remain in print for the next 200 years. It was the first magazine in the modern sense and has been described as "the 18th century answer to Google". See http://www.otago.ac.nz/library/exhibitions/gentlemansmagazine/index.html

seen it performed as follows…." [A description of the procedure follows which is very similar to Sushruta's method described above].[33]

Figure 1. Illustration from the celebrated 1794 "Letter to Editor" responsible for the western spread of the "Indian Method" for total nasal reconstruction. (From B. L.: Letter to Editor. *Gentleman's Magazine*, October 1794).

33 The complete letter and the sketches are available at http://drnichter.com/impact-indian-methods-total-nasal-reconstruction/

The gist of the story is this: Tipu Sultan cut off the nose and a hand of a bullock-cart driver, Cowasjee, as punishment for working for the British army. He was given a new nose by someone from a "brickmaker" caste. The operation was observed by two surgeons in the British Army, Thomas Caruso and James Trindaley, whose eye-witness account "B.L" was describing in the letter he wrote with the sketch accompanying it.

In all likelihood, this letter to the editor was read by Joseph Carpue (1764–1840), an English surgeon at the York Hospital in Chelsea, who became the first European to practice the "Indian Method" of nasal reconstruction. After that, the method became routine in reconstructive surgery in the West.

The method had to wait for the British to discover it before any further advances could be made. In India itself, there are only hearsay stories of such procedure, but the scientific texts register no improvement over what Sushruta had written many centuries ago.

Why not? Why did medical science come to stagnate after showing so much promise in the beginning?

If we take the PM's call for "regaining" our lost capabilities in medicine, surgery and science in general, it is important to understand the nature of these obstacles to progress of science. Celebrations of ancient science, however well-meant, will not take us far unless we first grapple with what has kept us back all these centuries.

A clue lies in one fact that was noticed by the British observers: those performing this operation were not trained *vaidya*s, but artisan-craftsmen not professionally trained in medicine. In the famous case of Cowasjee reported above, the surgeon came from a family of brick-makers; in another case of cataract removal following Sushruta's method observed in the early 20th century, the surgeon was an illiterate Muslim.

Here we have a classic case of *hand-brain un-coordination*: the brick-maker surgeon and his working-class brethren were ignorant of what was written in Sanskrit texts, while the Sanskrit-trained *vaidya*s had forgotten how to wield a scalpel. Here is how M.S. Valiathan describes the problem:

> It is important to note that the procedure in Pune and Coimbatore were not done by Âyurvedic physicians but by illiterate men who had learnt the technique from an earlier generation. They did not understand the anatomical basis of the technique, nor could they explain the rationale for the sequential steps of the procedure. It was as if their brain was uncoupled from their hand movements, which ensured that there could never be innovation based on true understanding.[34]

We explore this split between book-learning and hands-on practice in more detail in the next section. We will see that this split, which largely took place on caste lines, held back progress not just of surgery, but of anatomy as well.

6. Human dissections and anatomy in ancient India

Like geometry (chapter 1) anatomy, too, had its start in Vedic rituals. It is well documented that animal sacrifice was an integral part of Vedic rituals. According to Kenneth Zysk, who has written extensively on healing practices of the Vedic and post-Buddhist eras, "the animals sacrificed were usually cows, but bulls, goats, rams and buffaloes were also offered."[35] The sacrifice of the horse (*Ashvamedha*), however, was considered specially significant and the entire procedure is detailed in the *Ṛg Veda* (1.162. 18-20). What is important for our purposes is this: *for the ritual to bring about the desired effect, every aspect of it had to be carried out with extreme precision*. Everything – from the construction of the altar, the recitation of the mantra, from the oblation of exact number of rice balls, to dismembering the sacrificial animal – had to be

34 Valiathan, 2006, p. 17.

35 Zysk, 1986. Charles Malamoud, a well-known French Indologist described the procedure for animal sacrifice thus: "first, the creature was strangled or suffocated; then the body was washed by the sacrifice's wife; a special cake was prepared and offered up [to whom?], the carver made an incision above the umbilicus and withdrew the omentum [abdominal membrane]; then he skewered the omentum and grilled it over fire; fragments of gold were inserted into the omentum; the officiants were given their fees; the victim was divided up and unclean parts were offered to demons; the heart was grilled; the other pieces were cooked in a pot; from each joint or portion produced by the division of the body, a small piece was removed for one of the divinities to whom the sacrifice was being offered, and the remainder was distributed to the participants." Quoted here from Wujastyk, 2009, pp. 193-194.

done exactly as laid out in the Brahmana texts. A great misfortune was supposed to befall those involved if the rules were not followed. Even though it was based on superstitious faith in the power of the ritual, the demand for precision led to a considerable knowledge of animal anatomy.[36]

By the time *Sushruta Saṃhitā* appears on the scene, sometime in early centuries of the Common Era, the science of anatomy and surgery had undergone a paradigm shift: it had shifted from the magical and religious rituals of the Vedas to rational-empirical investigation of human body for medical purposes. As M.S. Valiathan put it, in the fifteen centuries that lapsed between the magico-religious practices of *Atharvaveda* to the classical *Saṃhitā*s, the "practice of medicine changed from faith-based to reason-based."[37] One crucial sign of this paradigm-shift is *Sushruta Saṃhitā's* advice to aspiring physicians to "remove all doubts by direct observation" and to not rely entirely on the textbooks, or their guru's teachings. This is the beginning of a rational, evidence-based approach to medicine.

It is in this context that "dissections" of dead human bodies makes an appearance in the medical literature.[38] Sushruta recommends the following procedure: the body of a person who died a natural death and has all limbs intact is to be procured and thoroughly cleansed. It is then to be wrapped in a layer of grass and:

> ….placed in a cage or a net in a driving stream in a concealed spot. After seven nights, the completely putrid body should be removed and laid out. Thereupon, one should very gradually scrape off the layers of skin etc. by a whisk made of grass roots. At the same time, every part of the body, great or small, external or internal, beginning with the skin should be *examined with the eye,* one after the other, as it is disclosed in the process of scrubbing.[39] (Emphasis added)

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36 As Zysk, 1986, p. 689 puts it, "then animal was not cut up for the purpose of scientific observation, as was true in ancient Greece. The action was undertaken for a definite religious goal in mind, but the concern for precision and detail produced a scientific result: a very prudent knowledge of equine anatomy."

37 Valiathan, 2013, p. 5.

38 The conventional meaning of dissection in medicine is "cutting open a dead body into separate parts in order to study it." By this standard, ancient Indians did not dissect, because they did not cut open the bodies they studied.

39 S.S. III.5.50-56. Quoted here from Kutumbiah, 1967, p. 2.

The entire process can be summed up as "see, but don't touch". The eye was to do the examining, while the hand was never to come in direct contact with the decomposed body. A strictly visual examination is better than no examination at all, but it has serious limitations. Because the body is not probed adequately, many internal organs not directly exposed by scrubbing remained unknown to Indian physicians:

- The external and internal structure of the heart and its function was completely misunderstood. Externally, it was described as a "lotus bud" which closes during sleep and opens when awake. (This is interpreted by some as if Sushruta was describing the systole and diastole of the heart!). Internally, it was supposed to have a single cavity, like a tank holding water. There was no conception that the heart contracts; the pulsation in the "ducts" was supposed to be caused by *vāyu* (or air), and not by the heart.
- Virtually nothing was known about the brain and the spinal cord. Both Caraka and Sushruta held that the heart – and not the brain – was the center of sensation, intelligence and consciousness.
- The distinction between arteries and veins was unknown, as was the difference in arterial and venous blood. Since the role of the lungs and respiration was unknown, blood was supposed to acquire its red or bluish color becoming colored differently by different kinds of *rasa* (nutritive juice obtained from food) in the liver or the spleen. The various ducts (*dhamanī*s and *śirā*s etc.) were different only in the relative fineness or thickness and they were supposed to originate from the navel, not from the heart.[40]

7. Anatomy in a comparative perspective

Those who adulate ancient Indian medicine must explain the completely erroneous – *by the standards of that era* – understanding of human

40 Summarized from Kutumbiah, Engler, Wujastyk.

anatomy described above. Here, we are not comparing ancient Indian knowledge with what we know today, but instead to India's sister civilizations in the centuries spanning the close of the BCE era and the beginning of the Common Era. Once *Sushruta Saṃhitā* is placed in a comparative world perspective, it becomes clear that *Hindu beliefs in purity and pollution hampered the advancement of learning in ancient India.*

Let us look at the Greco-Roman biologists, anatomists, and medical doctors who had no qualms about cutting open and touching the dead bodies of animals, and for a brief period, human cadavers as well. We should start with Aristotle himself (384-322 BCE), the student of Plato (428-348 BCE), the teacher of Alexander the Great (356-323 BCE), and "The Philosopher" of Islamic and Christian theologians and schoolmen until he was dethroned by the Scientific Revolution in the 16th-18th centuries. Unlike in India where the materialists never got a fair hearing, Aristotle provided a perfect balance to the ideal of supersensory transcendental truths sought by Plato and the Pythagoreans. Growing up surrounded by the sea and marine life, this son of a physician began his career as a zoologist. About a fifth of Aristotle's writings that have survived describe some 540 zoological species. Based upon skillful dissections, he described in great detail the inner structure of species ranging from marine animals (dogfish, octopuses, squids), digestive system of ruminants, the eye structure of bees, for example. He is said to have observed the progress of chicken embryos by breaking one egg every day. Early on in the Greek civilization, Aristotle put the study of the living organisms on solid empirical foundations, although he never conducted any studies of the human body.[41]

This tradition of curiosity-driven observations of the natural world culminated in the great strides made in astronomy, geometry and medicine at the great Library and Museum in the City of Alexandria in Egypt. (The city was established by Aristotle's student, Alexander the Great, while the famous Library and the Museum was built by the later line of Ptolemy kings). It is in Alexandria that for a brief period of time, during the third century BCE, dissection of human cadavers was per-

41 See David Lindberg, 2007, chapter 3.

mitted. Ancient testimony is unanimous that two medical men, Herophilus of Chalcedon (330-260 BCE) and Erasistratus of Chios (330-255 BCE) undertook systematic dissections of human bodies. They made significant contributions to anatomy, many of which are taught to medical students *to this day*.

Herophilus investigated the anatomy of the brain and the nervous system – exactly those parts which had remained invisible to our "don't touch" anatomists. He is credited with identifying brain membranes (the Dura mater and Pia mater) and tracing the connections between the nerves, the spinal cord and the brain. His detailed description of the human eye has survived to the present day. That's not all: he also identified and described smaller, relatively obscure organs like the pancreas, the prostrate, and Fallopian tubes. He was the first to challenge earlier ideas about arteries carrying air and showed them to be conduits of blood, and also demonstrated that arteries have thicker walls than veins. Erasistratus followed Herophilus, and he is credited with describing the bicuspid and tricuspid valves of the heart, and the role they play in determining the one-way flow of blood. By the time Claudius Galenus, better known as Galen of Pergamon (130-200 CE) appeared as the physician to the Roman emperor Marcus Aurelius, human dissections again were banned. While examining the wounds of the gladiators under his care, Galen was given a chance to observe whatever he could inside the human body. Galen also carried out dissections of animals, including pigs, apes, and even the heart of an elephant. He made impressive gains in understanding heart and blood vessels, as well as the respiratory and nervous systems. (He extrapolated his findings from animals to humans and thus introduced some errors). These achievements remained unmatched until they were challenged over a thousand years later, first by the Arabic physician Ibn al-Nafis (1213-1288) who lived in what is now Syria, and later in 1543 when Andreas Vesalius published his masterpiece, *De Humanis Corporis Fabrica* (or *The Fabric of the Human Body*) based upon public dissections of human bodies in the University of Padua in Italy.[42] (More on him below).

42 David Lindberg 2007, Chapter 6. Also, Roy Porter 1997.

This brief foray into Greco-Roman medicine was undertaken for two purposes. The first is simply to set the record straight. As this book has emphasized repeatedly, when we in India make grandiose priority-claims, we have no choice but to place these claims in a comparative world history, otherwise they are mere boasts.

The other aim was to show how Hindu prejudice against pollution literally tied the hands of Indian doctors. After all, why was it that ancient India failed to produce anatomists of the caliber of their contemporaries, Herophilus, Erasistratus, and Galen, whose contributions have endured to the modern era? It is not as if the Greeks had access to superior technology, superior stock of medical knowledge, or superior intelligence. The most important difference was socio-religious; the Greco-Roman surgeons were not burdened with the stigma of being polluted in the sense that their Indian counterparts were. It is not that the Greco-Roman doctors were considered among the social elite, but they were not classified as polluted and unworthy of participating in the religious-cultural life of their society.

Throughout history, everywhere in the world, medical practitioners have occupied an ambiguous social status; their services were needed and even respected, but they have not always enjoyed high social status. In ancient Greece, for example, most medical men came from craft traditions which were held in low esteem by the social elite. In ancient India, the *Ṛg Veda* classified them between carpenters and Brahmins; *Taittirīya Saṃhitā* advised that "medicine is not to be practiced by a Brahman, for he, who is a physician, is impure, unfit for the sacrifice." Only after he had undergone a purification ritual, could a physician be allowed to participate in the *yagna*.[43]

If things were not so great for doctors in the Vedic era, they got progressively worse as time progressed. By the early centuries of the Com-

43 This injunction comes from the well-known myth of the Asvins who could put back the head of the sacrificed animal. The Asvins are commanded by the gods to replace the head, but they demand that they be first given a portion of *soma*. Since the gods needed their service, they agreed but only after first purifying the Asvins with *Bhaiṣpavamāna Stotra*. Following this myth, all physicians were to be purified before they could join in a *yagna*. Even though a purification ritual was required of all those participating in a *yagna*, the doctors were treated as a special case. See Zysk, 1998, Chapter 2.

mon Era, rules of purity and pollution got codified into *dharmaśāstra*s, and the stigma of being "impure" kept the medical men out not only from *yagna*s, but from everyday activities as well. According to the law books, dating around the same time as *Sushruta Saṃhitā*, the bearer who carried the corpse to the cremation ground – and by extension anyone who came in contact with a dead body – was deemed to be polluted for a period of three to ten days.[44] *Manusmriti*, the most influential of *dharmaśāstra*s, grouped doctors with those whose touch was polluting, and whose "food was pus".[45] The irony was that from this time onward, "medicine was included among the Hindu sciences and came under Brahminic religious influence", and *Atharvaveda*, the book most relevant to medicine, was given "full authority as an orthodox treatise, alongside other sacred texts of the priestly order and its inclusion served to authorize the medical tradition in the Hindu cultural and religious milieu."[46] Myths were reinterpreted and Vedic pedigrees were invented and superimposed on an already established body of medical knowledge, which actually contradicted many Vedic taboos (on meat eating, for example). Evidence for this Brahminic veneer has been well documented by historians and is now accepted by mainstream scholars who don't have pre-existing biases.[47]

The question necessarily arises: why did purity and pollution acquire such exceptional prominence in India? The answer is complex but not difficult to understand: *purity was the new, post-Buddhist legitima-*

44 *Manusmriti*, 5:65. For the exact chapters and verses for other *dharmasūtra*s and shastras including *Gautama*, *Baudhyāna*, *Āpastamba*, *Viṣṇu* and *Pāraskara Gṛhya sūtra*, see Zysk, 1986, p. 692.

45 "The food of a doctor is pus, the food of a woman who runs after men is semen, the food of a money-lender is excrement, the food of an arms-dealer is dirt." *Manusmriti*, 4:220. Doctors were classified with those whose food one must not eat: "hunters, cruel men, one who eats leftovers, a woman who has just given birth and one still within ten days of pollution due to death." *Manusmriti*, 4:212.

46 Zysk, 1998, p. 26.

47 As Kutumbiah (1969, p. i) says: "There was really no Veda called Ayurveda. Its existence is a myth. Sushruta calls it an *upāṅga* of *Atharvaveda*. It was raised to the level of a Veda and appended to the *Atharvaveda* to give the science of medicine the necessary sanctity and authority." The locus classic of unearthing the Hinduization of Ayurveda is Debi Prasad Chattopadhyaya's 1977 book, *Science and Society in Ancient India*.

tion of Brahminic power. The Vedic religion unapologetically saw both nature and society as engaged in a perpetual struggle for existence in which the strong devour the weak: "those that do not move are food for those who move, those that have no fangs are food for those with fangs… and cowards are the food of the brave."[48] Dominance, not purity, was their priority.

However, this civilization that openly celebrated might-is-right, was facing multiple challenges by the beginning of the Common Era: the efficacy of rituals was beginning to be questioned, heterodox seekers (*sramanas)* who no longer believed in the Vedas were growing in numbers. These seekers included Buddhists, Jains, Ajivikas, the Charvakas – and *also physicians and healers*. In response to these challenges the priestly caste began the slow process of co-opting or Hinduizing the ideals of *ahiṃsā* and vegetarianism which were first articulated by the world-renouncers as a way to break the chain between *karma* and rebirth. It is this process through which, to quote Wendy Doniger and Brian K. Smith,

> 'purity'...replaced sacrificial skills as the mainstay of the priest's ideological arsenal. Vegetarianism and non-violence became the principal signifiers of this 'purity' that jostled for power, [and became] the new yardstick for social ranking in the priestly reformation of Vedism.[49]

Given the codification of rules of purity and pollution that were to be followed in every aspect of everyday life from the cradle to the funeral pyre, it was bound to create problems for the *vaidya*s whose work by necessity involved contact with sick bodies. Indeed, it is a sign of their great thirst for knowledge that Indian surgeons did not give up entirely. Scrubbing-and-seeing was too crude a method to tell us much about human anatomy, but the fact that it was undertaken at all is a testimony to the ancient surgeons' thirst for knowledge.

All available evidence suggests that it is thanks to the rise of Buddhism that ancient doctors could come even this far. By now, it is well-established that "the foundations of classical Ayurveda were being laid at the time of early Buddhism in the Buddhist and other ascetic

48 *Manusmriti*, 5:29.

49 Doniger and Smith, 1991. 'Introduction' to their translation of *Manusmriti*, p. xxxvi.

communities."[50] The Vedic-age doctors, shunned and denigrated by the priestly class, found refuge in the heterodox communities of wandering ascetics – the *śramaṇas* – who had ceased to believe in the Vedas and were searching for a new path to liberation from the endless cycles of birth, death, and rebirth. One particular *śramaṇ*ic group, the Buddhists, not only emphasized empirical knowledge, but also made medical care a central part of their monastic life. The first hospitals in India, for example, were established in Buddhist monasteries. Initially, they were meant to care for monks who had no family to look after them. Later, medical care was extended to the lay public as well.[51]

Evidence strongly suggests that Sushruta's method of dissection of human bodies has Buddhist origins. For one, it was a part of Buddhist ascetic practices to contemplate upon decaying bodies to understand the impermanence of the world. *Dīghanikāya*, for example, instructs monks to "reflect upon a putrefying body, dead from one to three days, becoming bloated and decaying, being devoured by animals, until its bones became bleached and turned to powder."[52] Secondly, Buddhists had a custom of disposing the dead body by immersing it into flowing waterbodies. This practice is attested to both by the Chinese Buddhist pilgrim Hsuan-tsang (early 7th century) and by Alberuni (11th century).[53] It is entirely possible (and likely) that some *śramaṇa* physicians combined this contemplative discipline with an interest in medical knowledge, leading to the method described in *Sushruta Saṃhitā*.

50 Wujastyk, in Flood, p. 397. The Buddhist influence is accepted by M.S. Valiathan, the doyen of Ayurveda. "In the fifteen centuries which intervened between *Atharvaveda* and *Caraka Saṃhitā*, the stupendous event that transformed India was the advent of Buddhism. It overturned many old beliefs, effaced ancient customs, and subverted social institutions, revolutionized philosophy and enthroned a new species of compassion and brotherhood… Ayurvedic concepts and procedures flourished in Buddhist India, and Buddhists became their foremost exponents. The dominance of Buddhist ideas led to the erosion of Vedic charms and rituals in the management of illness, which became increasingly based on empiricism." (2013, pp. 5-6).

51 See Zysk's 1998 pioneering work.

52 Cited from Zysk, 1998, p. 35.

53 Zysk, 1998, p. 36.

8. The "Ayurvedic Anatomical Man"

Fast forward about a thousand years (give or take a century or two) to the 16th century. What do we find? We find the beginnings of the Scientific Revolution in Europe, while India is in a deep sleep.

Let us first look at India. The prime exhibit is the "Wellcome Ayurvedic Anatomical Man" (Plate 4). It is a work in ink and watercolor, about 2 by 1.5 feet in size, depicting the inside of the human body. This painting is literally one of a kind, as ayurvedic texts are not illustrated, as compared to medical texts from pre-modern China, Japan and Europe. According to Dominik Wujastyk, who has studied this painting in great detail:

> The Ayurvedic Man is an image painted no earlier than 1700, on which have been written extracts from the classic ayurvedic work called *Bhāvaprakāśa* (fl. ca. 1650-1690). The extracts are taken from chapter 3 of the work that deals with anatomy and embryology.[54]

Thanks to Wujastyk's research, we know that the Ayurvedic Man is basically a Nepalese-style diagram of a man, created sometime in the 18th century, with annotations from a 17th century Ayurvedic text called *Bhāvaprakāśa,* written by Bhava Mishra, son of Latakana, probably settled in Varanasi, where he was a renowned physician with 400 students.[55] We know nothing about who commissioned the painting, who the artist was, or who copied the text from *Bhāvaprakāśa* that accompanies the picture. All one can say with any degree of confidence is that it is a co-production between "a rich, perhaps royal patron who initiates the project; a physician who is also a scholar of Sanskrit and Ayurveda; one or more painters of the Citrakāra community, and finally a calligrapher or scribe." Wujastyk infers from his detailed, frame-by-frame and

54 Wujastyk, 2008, p. 209. The Wellcome library in London bought this painting in 1986 from an art dealer who specialized in Nepalese artifacts.

55 According to Wujastyk, 2008, p. 206, *Bhāvaprakāśa* "established itself as one of the more important Sanskrit medical texts ever written. Manuscript copies are abundant … printed editions began to appear from 1855, especially from presses in Bombay and Calcutta. The editions were often accompanied with Hindi, Bengali and Gujarati translations. At least sixteen editions were printed between 1855 and 1998…. This work has remained influential right up to the present time, when it forms part of the standard degree syllabus in Ayurvedic colleges across India." p. 206.

word-by-word analysis that "the scholar was not a great expert in Sanskrit texts, and the scribe was apparently ignorant of Sanskrit. Between them, they produced texts that are riddled with errors."[56]

What does the piece and its annotations tell us about the state of anatomical knowledge in medieval India?

The answer in one word: s*tagnation.*

The 16th century text used for annotations tells us nothing that Sushruta and Caraka would not have known in their time, at least a thousand years earlier. Take for example, what it says about the heart. Exactly what *Sushruta Saṃhitā* said in the early centuries of the Common Era, namely, that the "heart is similar to a lotus, facing downwards. On waking up, it blooms, on sleeping, it closes up. The heart is the resting place for the soul. It is the supreme location of consciousness." Lungs? They are as mysterious to the 16th century physician as they were in Sushruta's time. The left and the right lung have different names and "neither is involved in breathing". Kidneys? Well, they come from the "essence of fat and blood. They are said to provide nourishment for the fat in the belly." So on and so forth.[57]

Meanwhile, a revolution was brewing in Europe. In the year 1543 – around the same time when Bhava Mishra was writing his book in Varanasi – two books were published that would transform our knowledge of the heavens above and life here on earth.[58]

Nicholas Copernicus, a devout Catholic who managed a Cathedral in Poland, wrote his *De Revolutionibus Orbiusm Coelestium* (or "The Revolutions of Celestial Spheres"), in which he replaced the earth with the sun as the center of the universe, overthrowing at least two thousand years of Aristotelian-Ptolemaic astronomy. Andreas Vesalius, a medical doctor and professor at the University of Padua in Italy, came out with his magnificently illustrated *De Humani Corporis Fabrica* (or "the Fabric of the Human Body"), correcting many errors of anatomical knowledge that began in Alexandria and culminated in Galen.

56 Wujastyk, 2008, p. 208.

57 All quotations are from Wujastyk, 2008.

58 These are among the first generation of books that were *printed*, not hand-written.

De Humani Corporis Fabrica is a detailed, masterfully illustrated, 600-page book, which is a study of every bit of the human body, based upon dissections of dead bodies which were carried out by Vesalius himself. As the illustrations (plates 5-7) show, Vesalius minutely observed every part of the body – starting from the outer layers, to the muscles, the nervous and the arterial system, the internal organs including lungs, kidneys, the male and female reproductive organs, down to the bare bones of the skeleton. Whatever he exposed through dissection was sketched by the renowned artist, Jan Stephan van Calcar (or Kalkar) of the Netherlands, who had studied with Titian, one of the giants of Renaissance art in Italy. The drawings were carefully etched onto wooden blocks and copperplates – the name of the craftsman who did the engraving remains unknown. The etchings were transported to Basel, Switzerland, where one of the best known printers, Joannis Oporini, set them in print. As the illustarations (plates 5-7) show, apart from being a milestone in medical science, the *Corporis Fabrica* is also a notable example of science, art, and technology coming together.

Placing Vesalius in the larger story of the Scientific Revolution would take us too far from the subject at hand: namely, understanding the growth curve of traditional Indian medicine.[59] For our purpose, what is crucial is to understand the breakthrough that Vesalius made in methodology, which ultimately was made possible because he was prepared to break long-held social taboos.

Vesalius was not the first to dissect human cadavers in the early modern era. The Catholic Church had started allowing autopsies as far back as the 12th century. By the end of the 13th century, professors of medicine (notably, Mondino de Luzzi in University of Bologna in Italy), were using dissections to train medical students. These dissections were carried out in public, with religious and state officials present,

59 There is plenty of material on the period known as "medical Renaissance" which included, apart from Vesalius, the important figures of Leonardo da Vinci and Paracelsus. A good resource for history of medicine is Roy Porter's magisterial *Greatest Benefit to Mankind*. The website of the British Library offers a wonderful presentation and explanation of Vesalius's great work in a "virtual book" format, available at http://www.bl.uk/onlinegallery/ttp/vesalius/accessible/introduction.html

along with medical students and members of the general public. The unclaimed bodies of those dying in hospitals and the bodies of executed prisoners were used. As is also well documented, Leonardo da Vinci dissected and drew as many as 30 bodies, including one of a pregnant woman. As he did not have a license from the Church to do this, he was forced to work in secrecy (see plate 8).[60]

Vesalius' genius lay in a methodological innovation that would change medical science forever. Before Vesalius, standard procedure was that the learned professor would sit on a raised podium, read from the works of Galen, the second century Roman surgeon, which had been first translated from Greek into Arabic and later into Latin. Down below him, a lowly surgeon-barber would do the actual cutting and a tutor would point out the organs that the professor was reading about. The result was that even though bodies were being *observed,* they were being *seen* through Galen's book, to the point that what the students "saw" was not actually there.

Vesalius's revolutionary step was simply this: he came down from the podium, took the knife from the barber, and did the messy work of cutting open the body himself. Initially, he too saw what Galen had written – so powerful is the pull of a paradigm – but gradually, he began to see errors in Galen's anatomy, which he had derived from dissections of apes and other animals, not of human beings. Vesalius' innovation changed medicine forever: before Vesalius, medical learning took place through a book; after Vesalius, medical learning took place through the body.[61]

Sociologically speaking, this was unprecedented. Latin-knowing, University trained professors never dirtied their hands; that was left to the lowly surgeons who had the status of barbers. Because he was able

60 Da Vinci was assisting a doctor who had the permission from the Church. The doctor passed away while the work was still going on. Da Vinci continued to dissect and draw in secrecy. Toby Huff (2011) provides a good description of history of human dissections in a cross cultural context, including medicine in Islamic lands and in China.

61 I am grateful to Dr. Charleen Moore from the University of Texas Health Science Center for this formulation. It is taken from the lecture she delivered in December 2012 at IISER-Mohali titled "Teaching from the Body or from the Book: Vesalius versus the Establishment".

to bring the theoretical knowledge he had together with what he was observing, Vesalius was able to catch the errors of his predecessors, and in the process revolutionize the study of anatomy. This confirms what is known as "Zilsel's thesis" in history of science. This thesis, put forward by Edgar Zilsel, a socialist philosopher of science who was forced to flee his native Vienna for the United States under the Nazis, argues that the Scientific Revolution in Europe resulted from the lowering of social barriers between craftsmen and scholars.[62]

In light of this comparative history, one can confidently say that the cause of the difference between the growth trajectories of natural sciences in Europe and India was primarily sociological. In early modern Europe, the barriers between scholars and craftsmen were breached from both ends; the more literate amongst the craftsmen began to write in vernacular for their own guild members (and thanks to the printing press, they could do that with relative ease), while the university and seminary educated scholars began to take an interest in the stock of knowledge accumulated by the craftsmen.

In contrast, the lowering of the barrier between scholar and craftsman never happened in India – and it still hasn't to any significant extent. It was outside the realm of possibility that a learned, Sanskrit speaking Vaidya – take the above cited Bhava Mishra for example, who was probably a contemporary of Vesalius – would do what Vesalius did without losing his caste, being excommunicated, and having to undertake many rituals of atonement and purification.

Given what we know now, we can only conclude that the ancient Indians' obsession with pollution and purity killed off the spirit of empirical, evidence-based investigation of the natural world.

9. Conclusions

We do have lessons to learn from our ancient heritage. But these lessons don't have anything to do with what we actually knew, or how we went

62 See Zilsel (2000) for Edgar Zilsel's historic paper written in 1942. Zilsel's thesis has played an influential role in the history of science. It inspired Joseph Needham's classic history of science in China. It has inspired a host of recent books, including Clifford Conner's *A People's History of Science.*

about knowing what we knew. The real lesson of the history of medicine in India is negative; it tells us what stifled the development of medical and other empirical sciences in India. The history of medicine (indeed, history of all natural sciences in India) is less of a source of inspiration than a cautionary tale regarding the evils of social hierarchy legitimized by superstitions.

We cannot "regain" the "capabilities" which we never had to begin with. Yet, history of medicine – the real thing, not the fake one manufactured from myth and legend – is worth studying, for it can teach us what *not* to do if we are really serious about building real capabilities in medicine and science in general.