

## Comparative Medicine in Ancient Egypt: Origins of Early Biomedical Theories

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In introducing today's lecture let me repeat for any of you without medical backgrounds that epidemiology is the study of diseases in populations. It is the one diagnostic approach which is unique to the practice of medicine at herd or other population levels.

Of the 3 main facets of epidemiological diagnosis-- disease intelligence, medical ecology and quantitative analysis-- portions of the first two have often been referred to popularly as "disease sleuthing" or medical detective work. Many of you are familiar with the fascinating yet factual narratives about inquiries into the patterns and behavior of diseases new and old which were written over a many year period for the *New Yorker* magazine by Berton Rouché, a very talented reporter of science who died just a few weeks ago. Many of those narratives were also collected into several absorbing books about the work of epidemiologists as medical detectives.

I drew yesterday upon my long interests in more systematized information-gathering for disease control efforts to indicate how veterinary services delivery in Africa could prove the vital key to initiation and facilitation of successful development approaches among that continent's tens of millions of migratory pastoralists, peoples whose plights in the southern Sudan, Somalia, Ethiopia, Rwanda, the Sahel and elsewhere in Africa intrude upon our living room TV screens every now and again.

Today I am going to introduce aspects of a very different but interestingly related type of medical detective work which I have managed since the 1950s to "piggyback" logistically upon those other development-related activities in Africa. This sleuthing has drawn importantly not only upon an epidemiological outlook, but upon the prominence of a comparative or analogical approach to elucidating major medical unknowns throughout the entire episodic history of biomedical science, that is, the uses of animal research models and resort to observations in the vast natural laboratory of spontaneously occurring animal diseases. The question that remains today, as it has throughout medical history, is not as extreme animal rightists misleadingly imply, namely "what of importance

in medicine has ever been learned by animal studies that could not have been learned readily some other way?", but, rather, "what important biomedical discoveries through all of time have *not* involved at at least one crucial point observations possible initially only in some non-human animal?" The true answer to that latter is, of course, very very few.

So, when I joined the medical and public health faculties of the American University of Beirut during the 1950s I took advantage of our living then at the crossroads of Europe, Asia and Africa to begin to focus an already existing avocational interest in biomedical history upon its most ancient records, especially upon evidence for the beginning differentiation of rudiments of biomedical science from healing magic in the lower Nile valley civilization of Egypt. These medical sleuthing interests begun then have persisted and grown in importance ever since.

Almost all of the earliest and most important egyptological literature per se is concerned with differences between the "quick and the dead"-- between a living body and a dead body-- with the particular aims of extending the life of the pharaoh and assuring his eventual resurrection or rebirth as a god. Thus, the Egyptian priesthood was most concerned in its rituals and other activities with the ultimate forms of preventive and curative medicine.

But, especially striking to me as a veterinarian was the central importance in Egypt over an amazingly long period of time of cattle and of a broad and pervasive cattle imagery. To sketch a few aspects of this, one of the pharaoh's principal epithets for millennia was "Mighty Bull". At the base of his kilt the pharaoh wore a bull's tail and the legs of his throne were in the shape of those of a bull. The chief ritual proving the pharaoh's bravery and leadership prowess was his annual hunting of the wild aurochs bull ancestor of domestic cattle until it became extinct in Egypt during the Middle Kingdom. Later, leaping over the horns of domestic bulls was a way for daring young men to demonstrate their own skills and bravery. Surviving portrayals of the very first pharaoh Menes-Narmer show him smiting his enemies under the protecting gaze of the cow mother-goddess Hathor or as a bull goring them into submission. In later portrayals the pharaoh is shown kneeling beside and sucking directly from the teat of this cow goddess as representation of his own divine lineage.

The Egyptian people referred to themselves as the "cattle of Re", the sun god who, was reborn each day as a heavenly bull calf, would traverse the sky, reinseminate his mother,

the cow-goddess Hathor in the west, and be reborn in the east the following morning. In fact, abundant evidence suggests that not only such things as these, but Egyptians' conceptualization of kingship and other social organization-- of hierarchy and dominion-- were derived from their very early observations upon herds of wild cattle. Standing two meters at the shoulder, each wild bull controlled and protected an impressive harem. With powerful sweeping horns, he was the largest, strongest, most brave and libidinous animal the pre-dynastic Egyptians encountered, a magnificent beast their earliest chiefs admired greatly and attempted in every way to emulate.

In the Pyramid Texts and later religious literature, not only were the pharaoh and the sun likened to and called "bull", as were also other gods than Re, but over extended periods of Egyptian history several gods like Apis were reincarnated successions of bulls who were lavishly served by the priests as living gods. The colossal tombs and sarcophagi of these Apis bull gods comprise a great underground necropolis near the ancient Egyptian capital of Memphis.

But beyond such, a few scholars had directed attention to how pre-dynastic and early dynastic life in Egypt appeared to resemble in those and some other regards what anthropologists were then beginning to describe among black, Nilotic cattle-culture pastoralists such as the Sudanese Nuer and Dinka who still inhabit today the upper reaches of the Nile and are among the tens of millions of present-day African pastoralists concerning whose future welfare my lecture yesterday dealt. However, with the exception of one British physician-anthropologist named Charles Seligman, no egyptologist had attempted to pursue any of these often striking resemblances.

Operating from these premises that pre-dynastic Egypt not only exhibited characteristics of a present-day African "cattle-culture", but was a "fused" society in which significant disciplinary and institutional separations were not yet evident between such currently diverse notions as animal husbandry, religion and healing, and that important influences of these characteristics persisted throughout the entire dynastic period, two egyptologist collaborators and I have elucidated the origins for what appear to be the two earliest physiological theories devised by man, namely a basis for understanding the male's role in reproduction and, second, that flesh (i.e., muscle) contains an irritable, animating principle.

We believe that both of those theories were products of the frequent ritual sacrifice and dissection of bulls by Egyptian priests, an activity portrayed in detail in hundreds of surviving paintings and stone reliefs spanning a period of millennia. And those activities related closely to other religious duties concerned with these priests' preoccupation with the differences between life and death. The underlying biological observations which led to these theories' earliest at least implicit formulations in predynastic times, that is from the 4th millennium or earlier BC-- as well as to their eventually important religious and healing applications-- were possible because at least some Egyptian priests were healers of both people and cattle. In fact, in virtually all ancient healing traditions no distinction was at first made between human and veterinary practice and Greek medicine, for example, began to separate into its two branches only in the third century BC. That fusion as "one medicine" also remains true of most traditional medical systems throughout the world today.

This historical sleuthing into the beginnings of biomedical science became evermore exciting and assumed a more and more demanding use of some of my spare moments as years passed, so that by the mid-1970s I had proceeded far enough with understanding the Egyptians' very early explanation of the male's role in reproduction that I felt a strong need for some formal instruction in the hieroglyphic language. That was necessitated especially because that theory of the male's contribution to the birth process was seeming to explain the until then unknown origins of the very important Egyptian *ankh* symbol, as well as those of the two other most religiously and politically important Egyptian hieroglyphs and symbols. At that time I commenced my collaboration with an Indiana University student of the ancient Egyptian language, Professor Carlton Hodge, who was intrigued by my findings and hypotheses. After Hodge retired, I began more intensive interactions which have continued ever since with a Berkeley egyptologist, Andrew Gordon, who provided me with a working acquaintance with the rudiments of the Egyptian system of writing, its grammar and the main dictionaries and other research sources for working with Egyptian texts.

What Dr. Gordon and I have evolved since has been a new methodological approach to such historically intriguing but difficult to study problems-- a holistic epidemiology-like approach-- through complementary and closely coordinated egyptological, ethnological and biological investigations. We believe that this, as yet, uncommon juxtaposition of diverse disciplines for such studies can yield important findings in very early biomedical science unlikely to emerge through conventional historiographic and archeological routes

alone. Let me now outline this approach by indicating some of its results until now in terms of the second ancient biomedical theory we have elucidated about an animating principle in muscle tissue that persists in the bull even after his death and which can be stimulated to action post-mortem and therefore could-- so the Egyptians believed-- be passed on to the dead pharaoh.

In this case of rudimentary muscle physiology, our several immediate egyptological points of departure (largely ones not linked previously by egyptologists) were (1) very frequent portrayals of bull sacrifice and its invariable first stage, namely, the surgical excision of one of the bull's forelimbs; (2) varied portrayals indicating to us that this was done on a still living bull; (3) accompanying inscriptions in some instances indicating haste was important in removing this limb, for example some scenes showed an attendant running off with the severed forelimb before any other part of the bull was dissected and in others another attendant calling to the dissector "Hurry, they need the forelimb"; (4) the frequently portrayed ritual use of this severed forelimb (sometimes in considerable detail) for touching to the mouth of the deceased (pharaoh) in the very important funerary ceremony of the Opening-of-the-Mouth; (5) the also unexplained touching to the deceased's mouth in some such portrayals of an "adze" (a cutting tool with a blade perpendicular to its shaft, like a hoe), (6) the apparent Egyptian equation of bull's forelimb and adze elsewhere, as in the identity of both objects with the constellation *Ursa major*, the big dipper; (7) scenes of bull sacrifice and dissection being directed by priests, some of whom are identified as bearing the *swnw* (healer) title and (8) references in several medical papyri to a prescription ingredient "live flesh" or "flesh from a living bovine animal." Since, from prior biological knowledge, I postulated linkages between all eight of these situations, the initial historiographic and archeological searches were mostly to review available sources for these subjects and previous commentaries upon them.

Specially relevant findings were that several egyptologists had described and commented in some detail upon bull sacrifice as the central religious act over a period of millennia and the obviously key-- though unexplained-- importance of the bull's forelimb, except that it apparently could, for some reason unknown to egyptologists, "open" the deceased's mouth so his *ka* (often translated as his "double" or "soul" ) could then be fed and he could be revived. (Incidentally, for some reason unexplained by egyptologists, the word *ka* in Egyptian, besides that meaning of something in the body essential for life, also was their word for a "bull" itself. The hieroglyph for both meanings is a man's arms

extended above his head in imitation of a bull's horns). Meanwhile, Liselotte Buchheim, a medical historian, uniquely among discussants of the strange prescription ingredient "live flesh" in three different medical papyri, correctly distinguished this expression from simply "raw flesh" (which is written differently) and commented: "it is astounding that all investigators of the manuscripts read the words correctly and literally, but none of them dared interpret them literally." While she felt this flesh cut from a live bovine animal must have been believed to contain "life power," she did not suggest why the Egyptians would have believed this, what that "power" was or how it might have been manifested in this flesh. A physician and historian of wound surgery, Guido Majno, then came closest to linking some of these events by conjecturing in passing that Buchheim's literal conclusion about "live flesh" might be related to some late funerary scenes clearly showing a forelimb being cut from a live standing bull calf. He stated, therefore, that the Opening-of-the-Mouth ceremony must have been "precisely a matter of infusing life into mummies and statues," but, again, he failed to indicate why such flesh might have struck ancient Egyptian priests as possessing life's magic or power.

The egyptologist Serge Sauneron and physician-historian Paul Ghalioungui both had commented upon such religio-veterinary functions of priest-officiants at bull sacrifice as touching the beast's blood to their noses and saying "it is pure", that is, that the animal being sacrificed was one in good health. (The Greek traveler Herodotus had left a detailed description of the health examination still carried out on the live bulls intended for sacrifice in his time by Egyptian priests responsible for their care amongst the large temple herds). This selection of unblemished animals only was rather like a veterinarian's soundness examination of a horse today. Both Sauneron and Ghalioungui noted further that healer-priests of the goddess Sekhmet were also specifically stated in surviving texts to treat cattle as well as human patients. Beyond that, Ghalioungui and some other scholars had noted that Egyptian anatomical knowledge was largely of bovine origin, that is, that all anatomical hieroglyphs for internal organs and even some external structures, whether of man or animals, were pictures of the bovine not the human organ. For example, the hieroglyph for the human brow was the bovine poll with its attached horns. Beyond such, the only surviving Egyptian anatomical document per se was a list of organs and parts of bulls.

Similarly interesting were other pre-sacrifice portrayals show the casting and restraint of these bulls. As we still do today, a line tied to one front pastern was passed up over the animal's back and down and back between its hind legs. This line was pulled from

behind, raising the one front leg, while a second line tied to the animal's horns about the poll was pulled from the front, forcing the bull to lie down. All these cast bulls to be sacrificed then had both rear and one front pastern tied together with the animal in dorsal recumbancy. That is, the other front leg was left free. Many other scenes show this free limb being held taut by an attendant and severed by another with a knife stroke through the axilla. Numerous scenes also indicate clearly that this operation was being carried out on the live animal, that is, the bull's tongue is protruding and eyes bulging, its tail is shown thrashing about and some animals even are defecating. In some scenes, many such vivisected bulls are shown in a row with their freshly severed forelimbs resting upon their sternums.

Before our more detailed investigations into the Egyptians' evolution of the two physiological theories mentioned, I had hypothesized generally from some of this literary, artistic and other evidence, that rudimentary beginnings of biomedical science from healing magic-- that is, of an analogical (comparative medical, "animal model") approach to biomedical unknowns (so prominent in all periods of rapid medical progress ever since)-- could be discerned in ancient Egypt as outgrowths of associations with the central religious position there of cattle and other circumstances that position necessitated.

Once some of this pre-existing Egyptological knowledge about relevant points listed above became known to us, prior training and knowledge as a veterinarian and biomedical scientist caused me, almost "reflexively," to postulate explanations for certain of these important Egyptological unknowns, namely (1) the specific evidence of life Egyptian priests observed and were attempting to transfer from sacrificed cattle to the mouth of the deceased pharaoh, (2) why the bull's forelimb was removed first in sacrifice and used for that revivification purpose and (3) why there was an element of haste in this operation. That is, unlike Egyptologists (or most physician historians of medicine), I, in common with all other veterinarians, had on many occasions actually observed cattle and other livestock being killed and their bodies immediately and thereafter following death. One common circumstance was in the abattoir where veterinarians traditionally provide public health services, including detection of pathological conditions or other abnormalities in slaughter animals both ante- and post-mortem. It is also common practice for veterinarians trying to diagnose a disease among multiple animals in a herd to euthanize one or more sick animals in order to perform immediately a necropsy examination under the most favorable conditions.

From these and other practice circumstances, all veterinarians are aware that bundles of muscle fibers fasciolate spontaneously after an animal's slaughter (i.e., tremble or contract rapidly as in shivering) and that this is especially apparent, but not limited to, muscles that have been cut and in intact carcasses which have been flayed. Such spontaneous contractions are dramatic and may reoccur periodically, especially when the animal or part is disturbed, until the post-mortem changes known as rigor mortis occur. (Onset of rigor mortis thus explains the element of haste indicated in some Egyptian portrayals, for, as anyone who has read mystery stories knows, the higher the ambient temperature, the faster the chemical changes leading to rigor mortis occur, and Egypt is a warm country.) It would be obvious to any veterinarian who considered these egyptological problems that it would have been absolutely impossible for an Egyptian priest overseeing bull sacrifice not to have observed these very impressive spontaneous movements of flesh, which may persist even in pieces of flesh excised from the dead animal. It is logical that, since movement is the most obvious difference between a live body and a dead one-- between the quick and the dead-- that priests would regard these muscular movements as truly remarkable evidence of a "living" or animating principle still present after its death in a sacrificed bull's flesh.

However, the reasons for the prompt removal of an intact forelimb, and its specific use in the Opening-of-the-Mouth, become apparent only if one assumes further that, for some reason, the Egyptian priest wanted not just *any* piece of freshly excised muscle to demonstrate and transfer to the dead pharaoh this "magic of life" causing fasciolations, but a complete musculo-skeletal assemblage. In that case, anyone familiar with mammalian anatomy would note immediately that the mammal's forelimb is its only such assemblage that can be removed from the body quickly, that is without fairly difficult and time-consuming dissection involving either disarticulation of a joint or the cutting of bone.

The reason the priest might especially desire a whole musculo-skeletal assemblage like the forelimb in preference to *any* piece of muscle to demonstrate animating force would be most apparent to physiologists who recognise that intact muscles, even in such *in vitro* preparations, can be stimulated to cause *major muscle contractions with very dramatic movements of whole joints*. The routinely employed stimulus for such purposes today is an electric shock. Research in muscular, musculo-skeletal and neuro-muscular physiology has made extensive use of such preparations ever since the 18th century



Danish veterinarian Peter Abildgaard first demonstrated induction of cardiac muscle fibrillation and defibrillation in chickens by an electric current. Therefore, at that point in our studies, it became apparent that an experimental simulation of the Egyptian bull sacrifice was required to determine (1) whether percussive (mechanical) stimulation of the excised bovine forelimb also would cause major muscle contractions-joint flexions (as well as renewed fasciolations) and, if so, (2) how long these responses could be reinduced mechanically in the severed limb.

At that point also, an explanation for the adze's known associations with the bull's forelimb and the Opening-of-the-Mouth ritual suggested itself, namely the adze might have been the stimulating instrument the Egyptian priests employed in this Opening-of-the-Mouth ritual. This possibility was reinforced by our finding then that the Egyptian verb *stp*, "to cut up (an ox)" or "to cut off (limbs)" was actually written with the adze as its hieroglyphic determinative in Old Kingdom times. It was thus clear that, in addition to the commonly portrayed knife, an adze was also a bull dissection instrument, probably one used mostly to cut through joints (and possibly to crack bones to obtain their marrow).

To pursue those important questions, I, with the help of UCD muscle physiologist Robert Ashmore, carried out some experiments on bulls slaughtered in our campus' experimental abattoir. That is, immediately after a bull was humanely dispatched by captive bolt stunning pistol and severance of its carotid arteries, we quickly removed one entire forelimb. This "sacrifice reenactment" (but under modern conditions of humane slaughter) showed that stimulating this severed forelimb with an adze or a knife did, in fact, induce major joint contractions (i.e., work) of either the shoulder or knee joints, depending upon which muscles were so stimulated. One can imagine how dramatic and awe-inspiring such movements seemed to the early Egyptians. Moreover, local fasciolations of muscle bundles could be similarly induced even by prodding a muscle with the finger, and both of those responses could be elicited repeatedly for more than two hours post-mortem under the ambient Davis temperature of our experiment. Today, we realize, of course, that this animating principle observed in bull's muscles by us and the ancient Egyptian priests, and which they then attempted to transfer to the deceased pharaoh's jaws in the revivification ritual of Opening-of-the-Mouth, was, ultimately speaking, adenosine triphosphate, ATP. Thereby, they hoped to activate his jaws permitting the deceased's own *ka* to be fed with subsequently proffered food offerings. Today we know that ATP synthesis ceases and muscle ATP is depleted after death as

functions of prior muscle glycogen levels, as well as of ambient temperature and muscle pH. The higher the temperature, the faster the depletion of muscle glycogen. And, as glycogen is converted to ATP, lactic acid is formed as a byproduct and its levels eventually inactivate the enzymes involved. The result is that the contractile proteins in the muscle bond to one another, that is rigor mortis sets in and the body becomes, in the parlance of detective stories, a "stiff".

The third completely different, but also complementary, facet of our combined methodological approach to these ancient biomedical problems was an ethnological one. Ethnoarcheology is the use of current ethnological (i.e., cultural anthropological) studies among peoples inhabiting the same geographical area as ancient peoples to attempt to better understand the latter. It is a growing area for scholarship, yet one fraught with special uncertainties in interpretations of results. Thus Winifred Blackman studied the modern *fellahin* of Upper Egypt especially for evidence of survivals of beliefs and practices from pharaonic antiquity. But possibilities for survival among today's Egyptian peasants per se are complicated, of course, by strong Christian then Islamic cultural influences on the lower Nile during the long interval between ancient times and the present. However, Henri Frankfort, in referring to the apparent cattle-culture beginnings of ancient Egypt, to the many interpenetrations of solar and bovine imagery concerning life and death and the limitations of research dependent solely upon surviving ancient documents and portrayals, noted "the profound significance which cattle evidently possessed for the ancient Egyptians [which] allows us to bring an entirely fresh kind of evidence to bear on the problem. For some modern Africans, related to the ancient Nilotes, display a similar attitude toward cattle; and these living adherents to a point of view so utterly alien to us [can] open our eyes to possibilities which our own experience could never have suggested." Gordon Childe added that "it really looks as if among these tribes on the Upper Nile social development had been arrested at a stage that the Egyptians traversed before their history began" and Cyril Aldred opined similarly that "from the material remains of this first phase of pre-historic cultures, we are able to build up a picture of the early Egyptians... [which] can have differed little from the culture of the pagan tribes [like the Dinka and Nuer] of the Upper Nile today." In other words, among still pastoralist Nile-dwellers much less influenced by Christianity and Islam, these students of ancient Egypt suggested not so much disclosures of any actual survivals of beliefs or practices from antiquity, but the value of the improved perceptions which such studies might yield. It is that conservative objective that we have intended for our work.

Thus, two possibilities seem to exist for anthropological studies as complements to historiographic and archeological approaches to remote events. The most conservative is that stated by Frankfort and followed by us, namely that we may acquire thereby a new and more apt mind-set, one more resembling that of the ancients, and that these new perceptions may help us to interpret certain otherwise inexplicable findings from the past. A third possibility for ethnoarcheology has been suggested by some other scholars, namely that certain common ecological determinants may have stimulated similar human responses among peoples otherwise completely unconnected in space and/or time and that recognition of such determinants and their responses may have more generally applicable predictive values. Bruce Lincoln has employed that approach in arguing that ancient Indo-European cattle-culture peoples, that is, my ancestors and those of some of you, also developed the same forms of social organization as did such other presumably completely unrelated peoples as today's same cattle-culture Dinka and Nuer of the Upper Nile.

The confidence to pursue personally this ethnological research adjunct to elucidating ancient biomedical events resulted from (1) my more than 30 years' experience in health and food aspects of development among such pastoralists in the Middle East and northeastern Africa, including field research experience in epidemiology which followed some methodologies very similar to those of cultural anthropology, (2) other personal interests in cattle lore and traditional healing among such cattle-culture pastoralists as the Dinka, Turkana and Maasai, in relation to prospects for "appropriate economic development" of these peoples and (3) fortuitous circumstances which enabled this additional medical historical objective to be "piggy-backed" upon these other professional activities in so far as transportation, official contacts and other logistic support were concerned.

These ethnological pursuits exceeded our hopes. Results especially germane to our biomedical example of a beginning for muscle physiology in ancient Egypt were the finding among the southern Sudanese Dinka, of *Ring* (the Dinka word for "Flesh") (1) as an important manifestation among them of Divinity or "Spiritual Force," (2) its manifestation in sacrificed cattle after their death as spontaneous muscle fasciolations, (3) its manifestation also as uncontrollable muscular tremors in Dinka priests "possessed by *Ring*", that is, in Dinka priests who, prior to the bull sacrifice, worked themselves into a frenzy like dervishes do and (4) *Ring*'s periodic replenishment in these priests through

special communion sacrifices of bulls expressly to *Ring*. In their own bull sacrifices, these fasciolations of the sacrificial bull's muscles are taken as evidence by the Dinka that Spiritual Force is present and is eating or tugging at these muscles. The priest then cuts off and swallows some of this "living flesh" in an act of theophagic communion with the divine force, that is, "this is my body, this is my blood." Such ethnological observations, at the least, showed that present-day Nile Valley cattle-culture priests carrying out religious bull sacrifices resembling those of ancient Egypt, do still observe these muscle responses and have developed beliefs about them as an important representation of divine power.

Ultimately, as now seems likely, these observations on Dinka beliefs about this animating aspect of *Ring*, of "Spiritual Force" within bovine and human bodies, could offer an explanation of the nature of the Egyptian *ka*, according to them the body's "double" which the ritual of the Opening-of-the-Mouth was intended to permit being nurtured within the body of the deceased. In fact, aspects of these studies being pursued currently by Andy Gordon strongly suggest that Egyptian conceptions of *ka* were very similar to those of the Dinka about *Ring* and, further, that this principle seems to have been recognized even more widely in Africa.

Interestingly, too, this Flesh = *Ring* manifestation of the divine bares close resemblances in Dinka tradition to another personified form of the divine named Garang, who is regarded by Dinka as their "original father" and sometimes referred to as a bull in the heavens. More specifically Garang is described sometimes as a great weather, fertility bull in the sky. Thus "shining master," an epithet of Garang, who is said to come from the east, is also an epithet of *Ring*. Intriguing in that connection is that in the Egyptian Book of What is in the Netherworld, the deceased pharaoh enters the "Land of Sokaris, the Flesh, the body in its first manifestation," is drawn into the Cavern of Sokaris "to make the mysterious arrangements in the land which carries this divine flesh." It is stated further "his flesh shines" and refers to Sokaris "guarding the mysterious Flesh".

Our parallel studies on the Egyptians' theory of the role of males in reproduction have suggested a central religious and political importance, too, of their beliefs that the male's semen was produced in its bones as their marrow, especially by the bones of the spine whose cord they then regarded as marrow. They thought then, as also recorded explicitly in texts, that the male's semen, which they believed passed from the spinal "marrow" to the penis, produced the white portions of the fetus. Its red portions, they believed, came

from the female's menstrual blood. Interestingly, as every first year veterinary student learns, in the bull its penis *is* attached to the base of the spine by two white unstriated retractor penis muscles and this too had obviously been observed by Egyptian priests during their own bull dissections.

These findings, and a number of others we have made, indicated further that the pharaoh's most frequent and important epithet, written with the major symbols of divinity, *ankh*, *djed*, *w3s*, and translated "life, stability, dominion", represented pictorially this male reproductive system, the source of the pharaoh's bull-like powers. That is, we believe that the origin of the *ankh* symbol carried by gods and pharaohs is the thoracic vertebra of a bull (the specially important region where the bull's sacred forelimb "joins" its spine), that of the *djed* symbol (already identified by egyptologists as being especially, but inexplicably, associated with the spine of the god of afterlife Osiris) is the sacrum and last three lumbar vertebrae of the bull, while that of the *w3s* staff, also carried by gods and pharaohs, is the bull's more than meter long penis (an organ which when dried is like a fiber glass fishing pole and was used in antiquity, and still in some rural parts of the world today, as a strong, flexible whip or livestock goad.) Thus, the Egyptian deceased was commonly portrayed in a hunched fetal position upon the spine of a bull or actually being symbolically pulled through the bull's spinal cord by priests as another stage of the rituals of revivification. That is, the pharaoh, in his re-creation, traversed the same anatomical route semen does in procreation. Coincidentally, our words *sacrum* and *sacred* have a common Greek etymology.

Together, such findings also help make other facts from ancient Egypt more explicable for the first time. For example, that the important Egyptian institution called *Per Ankh*, "House of Life" was associated with such apparently totally disparate functions (in modern terms) as (1) a place where bulls were sacrificed for special ritual feasts by the living pharaoh, (2) as centers of learning where learned papyri were stored by priests and (3), in some other little known fashion, were institutions especially associated with healers and healing. Those activities assume a relationship to one another not only in terms of the ancient theories we have elucidated and their manner of derivation, but in the other previously unexplained fact that one of the two oldest surviving Egyptian medical papyri, the Kahun Veterinary Papyrus (which deals as a comparative medical document with diseases of cattle, dogs, birds and fish) is the only medical papyrus not written in the third person by a scribe. Rather, it is written in the first person by a priest-healer himself in the form of a religious document. He says "When I see a bull with such and such

disease, I do such and such." In fact the surviving fragments of the Kahun Veterinary Papyrus comprise a very modern sounding document in which a disease is identified by name, its symptoms listed, systemic and symptomatic treatments prescribed, a prognosis given, as well as advise on humane care of the patient if treatment proves unsuccessful. The German egyptologist Herman Grapow even suggested in passing, from his own reading of the Kahun and all other medical papyri, that it looked like much of the factual basis for human medicine in antiquity may have been derived originally from veterinary practices, rather than vice versa, but then quickly dismissed that heretical thought with the statement that such would be too preposterous to seriously consider.

We, however, believe now that Grapow may not have been off-base in his original reaction and interpretation. For a substantial body of biological evidence (illuminated by collateral information on the mindset, beliefs and practices of preliterate cattle-culture inhabitants still present in the Nile Valley today), supports a conclusion that rudiments of biomedical *science*, that is, real anatomical, physiological and other biomedical knowledge and methods of acquiring it, began to emerge from healing magic very early within ancient Egypt in connection with the maintaining in health of temple bulls, including some specific living bull gods, plus the ritual sacrifice and dissection of that same species to which pharaohs so likened themselves. Most specifically, two physiological theories seem to have been derived quite rationally from such comparative biomedical observations.

What I have attempted today is to give a rather unusual example of employment of a holistic epidemiological approach to an ancient and persistent problem of the dividing line between life and death and the essential characteristics and origins of the former. Medical science is still grappling with those problems, not only in their biological, but also in their humane, social, ethical and moral dimensions. Medical science's involvement in all this apparently began with these very early Egyptian formulations of theories of revivification, one of which presumed an active principle in bulls' muscles which enables them to respond post-mortem to *in vitro* stimuli (display irritability) by contracting. These startling post-mortem movements of parts of a dead body were probably first observed incidentally during the hunting of wild aurochs bulls and initially inspired hunting magic and awe. They then were routinely confirmed "experimentally" in the quickly severed domestic bull's forelimb and rationally applied to ritual revivification (the ultimate cure) of the pharaoh. Ultimately, as testified in three medical papyri, such "living flesh" was a medicine used also with some rational basis to treat

presumably life-threatening illnesses. We believe that we see here the beginnings, at least implicitly, of scientific method evolving from healing magic, including resort to analogy (from bull to man). Identification of such rules of evidence as analogy as key elements of scientific logic was first made explicit by Aristotle in his *Posterior Analytics*, though also resorted to repeatedly and implicitly in his other works on animals and also by other earlier Greek observers. Applications of G.E.R. Lloyd's criteria for claiming such prior *implicit* Greek evolution of some of these rudiments of scientific method during the two hundred years before Aristotle seem to possess similar validity when applied to these Egyptian findings more than a millenium earlier. Because of known intellectual contacts of Greece with Egypt, from at least the time of the first Greek philosopher Thales, including in medicine, these early events probably possess "mainstream" importance to the beginning evolution of Greek, hence of western medicine. In fact, both Plato in *Timeus* and Aristotle in *On Development* credit "the ancients" with stating that semen originates in bones.

Finally, these studies I have pursued partime for many years show how training to think epidemiologically about current medical problems can lead not only sometimes to their solutions, but to other important sources of career enjoyment and satisfaction. At least that has been my own personal experience and-- hopefully-- it could also prove some of yours.