How Evolution Has Impacted the Human Body

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**Abstract**

This literature review explores how evolution has impacted the human body, specifically the positives and negatives of our anatomy as a result of evolution. The human body has evolved to be extremely complex. Not only is our body complex, but the diseases that form inside our bodies are extremely complex. With this complexity comes a few positives and negatives. The positives are that we have evolved to have a lot of protected as Shubin states in Your Inner Fish with the evolution of our cranial anatomy. The bones in other parts of our body also form in a protective way that saves our lives daily. Negatives of evolution of the human body mainly have to do with diseases and mutations (which in theory are one in the same). Even though evolution is not perfect, it should not be solely blamed though as environmental stressors could have a major impact on the development of diseases and mutations.

**Keywords: human evolution, anatomy, species evolution**

How Evolution Has Impacted the Human Body

**Introduction**

 Since the beginning of human existence, evolution has continued to impact our bodies. Is this impact positive, negative, or both? If evolution was perfect and we were truly a dominant species we wouldn’t get diseases, abnormalities, sicknesses, or death from the previously mentioned. How do we know that evolution has positively impacted our bodies when we endure these horrible causes of death? Are these diseases due to environmental stresses or evolutionary imperfections? Are we still evolving? In order to answer these questions, we must review basic evolution of the human body and broaden our horizons into evolutionary stressors we may not completely understand. When it comes to the topic of whether evolution has failed us, some would most readily agree that we are a dominant and superior species, after a careful review of the literature, it is shown that the positive and negative ways that evolution has impacted our bodies are closely numbered.

**How Have I Evolved?**

 Before we talk about how evolution has impacted the human body, we must talk about how we evolved to be the “superior” species we are today. When walking around a zoo, you see many different species of animals that look so different. These animals though are extremely similar to each other. Another animal in the zoo that may not be in an exhibit but is a very complex and interesting animal is…you! You may ask how we compare to the animals that are actually in the exhibits. In order to understand this, we have to look at our own evolution and compare it to another species’ evolution. The human body is an extremely complex thing. Neil Shubin says in his book “Your Inner Fish” that different parts of our bodies are extremely protected (Shubin 2009). Shubin gives the example of looking at our head anatomy (Shubin 2009) When looking at our head anatomy, you would have to saw through the cheek, forehead, and cranium in order to see these vessels and organs in the head (Shubin 2009). This protection is a positive of evolution of the human body. Without this evolved protection, our brains would be just hanging around in our heads. This fact is almost unsettling because if you were to hit your head, you’d almost directly be hitting brain tissue and causing extreme damage to the brain. Shubin connects this head and neck evolution to sharks (Figure 1.) (Shubin 2009). When looking at a human embryo and a shark embryo, there are bulges and indentations that look like gill slits in the throat regions (Shubin 2009). In some rare cases, gill slits fail to close and remain open as pouches or cysts (Shubin 2009). This cyst forms in an open pouch inside of the neck and is the failure of the third and fourth pouch (Shubin 2009). This cyst would end up as a failure of evolution. Another failure we also see rare cases of children born with an actual vestige of an ancient gill arch cartilage which is a little rod that represents a gill bar from the third arch (Shubin 2009). Shubin brings up that every animal from a shark to a human shares these four arches (Shubin 2009).

 Shubin continues on to explain how our bodies have evolved in a very precise way (Shubin 2009). We are assembled almost the same as fish, lizards, and cows where we each have bodies that are asymmetrical (Shubin 2009). We all have heads with organs and brains inside (Shubin 2009). We have a spinal cord that runs the length of our bodies along our back (Shubin 2009). Our anus is at the opposite end of the mouth, as is theirs (Shubin 2009). But how are we similarly assembled to be similar to a jellyfish? (Shubin 2009). To answer this question, Shubin’s colleagues Mark Martindale and John Finnerty compare our body plan set up to those of a jellyfish relative, sea anemones (Shubin 2009). They found that when you draw a line from the mouth to the base of the sea anemone, this line is similar to the head-to-anus axis present in our bodies (Shubin 2009). They then decided to look at the belly-to-back genes of humans and sea anemones (Shubin 2009). When looking at these two species, they found many belly-to-back genes in the sea anemone but the axis didn’t correlate with that of an adult animal’s organs and how they are out together (Shubin 2009). They found however, that if you cut a sea anemone in half, they found another axis of symmetry that defined two distinct sides of the species (Shubin 2009). Shubin compares animals to a cake recipe by says that all animals are the same but different (Shubin 2009).

 Now that we have a basic knowledge of how we have evolved and how our makeup is similar to almost every other species, we need to look at the positives and negatives of evolution.

**Has Evolution Failed Us?**

Perhaps the most common negative effect of evolution is shown in diseases and mutation. Dobson’s study in 1999 talks about how many human diseases are associated with protein misfolding events that result in the failure of cellular machinery (Dobson et al., 1999). Dobson gives the example of cystic fibrosis. With cystic fibrosis, mutations in the gene encoding a crucial transport protein result in the protein folding incorrectly which leads to the protein not being secreted in the quantity required for proper function (Dobson et al., 1999). Dobson also includes some types of familial emphysema, that come from mutations resulting in improper trafficking of proteins to the sites where they are needed (Dobson et al., 1999). Chen and his colleagues help us understand the future of protein misfolding. They talk about how the effect of the cellular environment on protein folding needs more research to design animal models of diseases affected by protein misfolding such as those mentioned in Dobson’s study along with multiple others (Chen et al., 2008).

As stated in the previously, evolution has a huge impact on different diseases. To give more life to this statement, Shankarrapa and his colleagues wanted to understand the increased changeability of the symptomless period between principal human immunodeficiency virus type 1 (HIV-1) infection and the development of AIDS (Shankarrapa et al., 1999). To do this, they studied the evolution of the C2-V5 region of the HIV-1 env gene and of T-cell branches in nine men with a average or slow rate of disease advancement (Shankarrapa et al., 1999). They found that in the individuals studied, the time between principal HIV-1 infection and AIDS could be separated into three states based on patterns of growing evolution over the C2-V5 region of env (Shankarrapa et al., 1999). These findings help us show that the evolution of genes can be extremely useful to figure out what is going wrong with diseases.

Another major disease affects by evolution and mutations is cancer. Pasculli’s findings show that cancer evolution at all stages is pushed by both epigenetic irregularities as well as genetic changes (Pasculli et al., 2018). It is also found that cancers evolve by a repeated process of clonal amplification, genetic diversification and clonal selection within the adaptive landscapes of tissue ecosystems, according to Maley (Maley et al., 2012).

Verma validates that cancer evolution is very complex because there are many things involved in this process (Verma et al., 2002). Ellis believes that epigenetic shifts including histone acetylation, histone methylation, and DNA methylation play critical roles in the outbreak and advancement of cancer in multiple tumor types” (Ellis et al., 2009). According to Varriale, examinations have been made that offer that environment can alter the epigenome of vertebrates by constructing immensely diverse methylation patterns that could show in phenotypic diversifications (Varriale et al., ). Sharma states, “epigenetic mechanisms, such as DNA methylation, are important for normal development and maintenance of tissue-specific gene expression patterns in mammals” (Sharma et al., 2010). Sharma also believes that dissemination of these epigenetic processes can lead to changed gene function and malignant cellular conversion (Sharma et al., 2010).

 To help provide more evidence to Sharma and Varriale’s findings, Jones shows in his paper that patterns of DNA methylation and chromatin structure are changed in cancer and show genome-wide destruction of, and regional advances in, DNA methylation (Jones et al., 2002). The epigenetic changes mentioned contribute to every step in tumor progression according to Jones (Jones et al., 2002). Rouhi went further to understand what other mechanisms can be alterned in cancer evolution. Through his findings, he concludes that “genome-wide epigenetic changes that occur in various cancers affect the transcription of many genes, therefore epigenetic changes brought on by transformation can potentially affect miRNA expression in both direct and indirect ways” (Rouhi et al., 2008).

Burrell reports that recent studies have shown great genetic diversity between and within tumors (Burrell et al., 2013). This affects important cancer pathways which pushes phenotypic variation, and proves a challenge to cancer medicine (Burrell et al., 2013). Burrell believes that a huge cause of genetic heterogeneity in cancer is genomic weakness which leads to a higher mutation rate and can shape the evolution of the cancer genome through an array of mechanisms. (Burrell et al., 2013).

According to the research by Casas-Selves, evolutionary theories are very important to understand cancer development in different ways (Casas-Selves et al., 2011). It also allows us to better understand why cancers mainly affect the elderly, and why specific circumstances correlate with certain cancers (Casas-Selves et al., 2011). Most importantly, Casas-Selves stresses that the use of evolutionary theory in cancer will enlighten new treatment ideas that may better control the disastrous disease that is cancer (Casas-Selves et al., 2011).

These diseases almost virtually come out of nowhere. With this fact we must think that if these diseases are still evolving and reeking havoc on our bodies, are we still evolving?

**Are Humans Still Evolving?**

Now that we’ve talked about the past, we must look at the present and ask ourselves if humans are still evolving. Jay Stock helps us find out the answer to this question in his paper from 2008. Stock talks about how many of the classic studies to demonstrate natural selection have been conducted under experimental conditions on fruit flies (short-lived and fast-reproducing species) rather than humans (long-lived and slow-reproducing species with generation times of about 20+ years) (Stock et al., 2008). Therefore, it is difficult to observe intergenerational genetic change as only two reproductive generations have passed since the discovery of the structure of DNA (Stock et al., 2008). Stock believes we need a modified approach to study evolution within our species (Stock et al., 2008). Stock makes another point that much of the genetic variation that we see in human populations today developed within the past 50,000 to 70,000 years, after the dispersal of Homo sapiens out of Africa (Stock et al., 2008). This dispersal could have caused variation that we see in species (Stock et al., 2008). With this being said, the variability that we see in that species might be non-adaptive, and could actually related to the pattern of human dispersal (Stock et al., 2008).

Stock provides examples of human evolution that occurred following the invention of agriculture, and that involve the co-evolution of cultural and genetic systems with changes in maintenance strategies (Stock et al., 2008). One example Stock provides is that “natural selection of heterozygous carriers of the sickle-cell gene to maintain sickle-cell anemia in populations that are exposed to malaria” (Stock et al., 2008). This natural selection is mainly visible in regions of central Africa where tropical forests have been deforested which has caused the rapid production of mosquitoes that transfer the malaria-causing Plasmodium parasite (Stock et al., 2008). Stock provides another more recent example of evolution within the human genome that shows evidence for strong natural selection on the gene that controls lactase production (Bersaglieri et al. 2004). More specifically, Stock provides that among populations with a long history of cattle herding and milk consumption, the ability to metabolize lactose is maintained into adulthood (Stock et al., 2008). Stock believes these are clear examples that natural selection has recently been shown in our species (Stock et al., 2008).

Conclusion/Future Directions

When it comes to the topic of whether evolution has failed us, some would most readily agree that we are a dominant species, after a careful review of the literature, it is shown that the positive and negative ways that evolution has impacted our bodies are closely numbered. In conclusion, we see that the human body has evolved to be extremely complex. Not only is our body complex, but the diseases that form inside our bodies are extremely complex. With this complexity comes a few positives and negatives. The positives are that we have evolved to have a lot of protection as Shubin stated previously with our cranial anatomy. Our bones in other parts of our body also form in a protective way that saves our lives daily. Negatives of evolution of the human body mainly have to do with diseases and mutations (which in theory are one in the same). Of course evolution is not perfect which is why humans and other species contract diseases and develop mutations. Evolution should not be solely blamed though as environmental stressors could have a major impact on the development of diseases and mutations. Shubin make an incredible point as he says that we weren’t designed rationally, we are products of a messy history (Shubin 2009).

With a review of our (as well as others’) evolutionary past and present, we have to ask the question, what is the future of the human body? Michael Murphy’s review postulates a possible answer. Humans have evolved in minor and major ways toward another important transition (Murphy, 1992). Murphy talks about how for certain types of extraordinary human development, there seems to be a third evolutionary supremacy (Murphy, 1992). With these certain types of human development, a new level of existence has appeared on earth (Murphy, 1992). This level of existence, Murphy describes as “one whose patterns cannot be specified by physics, biology, or mainstream social science” (Murphy, 1992). Murphy also talks about how as life developed from inorganic elements and humankind from its primate ancestors, a new evolutionary region is hesitantly rising in the human race, both spontaneously and by transformational ways (Murphy, 1992). Murphy says that when we have a spiritual happening that allows us to experience something we haven’t before and we say that "something came over us," that we were "carried away”, this recognition of ego-transcendent powers is reflected in religious terms and our common language (Murphy, 1992). This recognition of a “something beyond” and our lack of ability to explain how it effects us, points toward a new kind of human development as it is related to something inside of us, Murphy states (Murphy, 1992). Murphy believes that “the self-evident break with normal consciousness and behavior, the transcendence of certain needs, and the self-mastery of mind and flesh characteristic of metanormal functioning could create a new kind of life on this planet” (Murphy, 1992). This new life would begin to appear among larger groups, but appear but end up being dramatic enough that a new kind of evolution would come about (Murphy, 1992). Murphy believes this would in turn eventually show features and consistencies we cannot predict from the regular patterns of human behavior and existence (Murphy, 1992). With this being said, it seems the future of human evolution could be new life on earth or something as simple as new awakenings within ourselves.

As we are still evolving, there are many possibilities that have not been brought to our attention as to how we will evolve next. I believe that medicine will be an extremely important player in the future of human evolution as we are becoming more medically cultured. This could be a good or bad thing as we could be putting things into our bodies that may make us feel better but could have lasting impacts on our bodies.

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Figures



**Figure 1**. **Gill region of a shark embryo versus a human embryo.** When looking at a human embryo and a shark embryo, there are bulges and indentations that look like gill slits in the throat regions.