Assignment 2

Question 6

By: Zina Scott

Kerri Finlay

Bio 265

November 30, 2012

The mammalian male reproductive system has components both inside and outside of the body. The epididymis and testicles are kept outside of the body in a protective pouch, the scrotum. This is because in order to produce sperm, the testicles must be kept a few degrees cooler than core body temperature (Kleisner et al. 2010). The way that the scrotum regulates temperature inside the testicles aside from having skin that is thin is through signals from the brain and nervous system that tell the cremasteric muscle to either contract or relax (Gallup 2009). When the body is too warm, the scrotum loosens and hangs further away from it in order to distance itself from heat. Contrarily when temperatures fall, the scrotum contracts to minimize heat loss. It is also hypothesized that this is the reason for asymmetrical hanging of the testicles, because the different heights create increased surface area for heat dissipation (Gallup 2009). But why does this temperature change make a difference? In other words, why is it that sperm need to be developed at cooler temperatures? And finally, does this rule apply to all mammals?

Spermatogenesis, or the production of sperm, is only successful at certain precise temperatures in mammals, because the enzymes that regulate sperm and testosterone production have temperature optimums at which they are most efficient. (Cornell 1999). For example, in humans, optimum temperature for spermatogenesis is 34◦C (Gallup 2009), however, human core body temperature is 37◦C, meaning that sperm production would be compromised or subject to higher rates of mutation (Gallup 2009) if the testes were held inside of the body. This is shown in human males who suffer from varicocele, a condition where enlarged scrotal veins disrupt temperature regulation of the testes, infertility often results (Cornell 1999).This disruption of sperm production at high temperatures has been demonstrated in many other mammals as well. In domestic rams for example, who have a tighter scrotum that is less able to hang further from the body, sterility occurs during the summer months when body temperature is too high for sperm to be produced (Gunderson 1976). Interestingly, studies have also shown that man-made objects such as heated car seats, hot tubs, or even tight pants can impair sperm production (Clark 2012). Further, in mammals that hibernate during the winter months, the testes approximate to the cold surroundings so that sperm production drops until spring when temperatures rise and animals wake from hibernation at optimum breeding condition (Gunderson 1976). The scrotum, allows for temperature in the testes to be 1-6◦C cooler than temperature in the body, so that sperm production or viability does not become compromised (Gunderson 1976).

As mentioned above, sperm are very sensitive to small temperature changes. To be more specific, when the temperature of surroundings rises, sperm experience a gradual decline in motility and viability (Appell 1977), but first, after immeditate temperature increase, sperm increase in motility until they use all of their energy (Bering 2009). This is known as the “activation hypothesis” (Gallup 2009). Sperm can swim faster, for up to 4 hours in increased temperatures, which is conveniently the average time taken by sperm to reach the female’s egg in mammals (Bering 2009). Therefore, sperm may also be kept at cooler temperatures not

only because it is optimum for their efficient production, but because that way, when they enter the higher temperatures of the vagina, they swim faster, increasing their chances of fertilizing the egg.

There are three categories of testes in mammals: scrotal testes as in the mammals mentioned previously, descended ascrotal testes as in seals and dolphins, and testes that remain in the body such as in elephants (Gallup 2009). Some mammals such as most rodents, have testes that remain in the body cavity except for during the breeding season when they descend into the scrotum, while others such as insectivores, bats, and whales do not have a scrotum at all, and elephants and rhinoceros keep the testes within the body permanently (Cockrum 1962). So how to these mammals regulate the temperature of sperm production? Marine mammals, although their methods for achieving this differ, all direct cooler blood closer to the body's surface to deeper areas within the body, effectively cooling the testes through unique vascular structures such as the venous plexus in the seal (Rommel 1998, Werderlin 1998). Animals that have testicles inside the body known as "testicond" animals have lower core body temperatures, where cooling of the testes is not necessary for optimum production (Werderlin 1998). One exception to the aforementioned is the elephant, with a core body temperature above 36◦C, and internal testes, for which much is unknown about how efficient spermatogenesis occurs.

As a **summary** and conclusion, sperm cannot be developed at core body types because the enzymes and testosterone through which they are produced operate most efficiently at temperatures that are below core body temperature. When exposed to higher temperatures, sperm temporarily increase their motility, making the higher temperatures inside the female body optimum for fertilization. While the use of scrotal muscles is the most common way that mammals regulate temperature in the testes, there are some exceptions such as vascular structures and lower core body temperature that some other mammals employ, as well as some mammals that do not require lower body temperature for unknown reasons.

Works Cited

Appell, R, Evans, P, Blandy, J. 1977. The Effect of Temperature on the Motility and Viability of Sperm. British Journal of Urology. **Vol. 49**: 1

Bering. 2009. Scientific American. http://blogs.scientificamerican.com/bering-in-mind/2009/11/19/why-do-human-testicles-hang-like-that/

Clark. 2010. Men's Health. http://www.menshealth.com/health/effect-heat-sperm-production

Cockrum, E. 1962. Pp- 67-68, *Introduction to Mammalogy.* The Ronald Press Company, New York.

Cornell University Wiell Medical College. 1999. http://www.maleinfertility.org/new-understanding.html

Gallup,G. 2009. On the origin of Descended Scrotal Testicles: The Activation Hypothesis. Evolutionary Psychology Journal. **Vol. 7**: 517-526.

Gunderson, H. 1976. Pp-220-221, *in* Fuller, M. and Licht, P. *Mammalogy*. McGraw-Hill Book Company, NewYork

Kleisner K, Ivell R, Flegr, J. 2010. Journal of Bioscience. **Vol. 35**: 27-37

Rommel, S, Pabst A, McLellan W, 1998. Reproductive Thermoregulation in Marine Mammals. American Scientist. **Vol 86**: 440-448.

Werdelin, L, Nilsonne A, 1998. The Evolution of the Scrotum and Testicular Descent in Mammals: a Phylogenetic View.