The Laboratory of Dr. Septimus Pretorius

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Submitted for your approval

Much has been written about the 1935 film, THE BRIDE OF FRANKENSTEIN, and for good reason. This film is considered the best example of cinema horror there is with the acting, atmosphere, set design, style, and production all top of the line. What has not received as much attention is the laboratory of Dr. Henry Frankenstein's nemesis, Dr. Septimus Pretorius. It is the visit to Pretorius' lab that ignited the scientific spark of curiosity in Henry Frankenstein. Maybe it was the chemical odors, the view of all those homunculi, or how the other elements of his lab were all organized and structured, that got his scientific curiosity juices flowing again. Then again, perhaps Pretorius' comment of "…a woman. That should be really interesting!" was enough to make Frankenstein wonder if maybe he could…just once more. So, let us take a closer look at Pretorius' lab and understand what he was doing and what he had available to work with. Was what he had enough to do the job at hand?

For Pretorius to do all the work implied in this film he would have to master many areas of biomedical science. The implied scientific disciplines necessary for Pretorius' to achieve his ultimate goal, namely, the creation of a fully functional female brain are anatomy, cell cultures, development biology, physiology, molecular biology, neuroanatomy and neuroscience. Only in the world of film can a cinemascientist be so talented. But, for the moment, let's keep the switch to our Jacob's ladder off as we focus on the immediate issue.

Septimus the man
Before we describe the lab we must first describe the man, Dr. Septimus Pretorius, himself. We first see him as he appears at Frankenstein's doorstep and insists he must see Baron Frankenstein. He says to the maid, "Tell him Dr. Pretorius is here, on a secret matter of graaave importance!" The maid escorts him to the Baron who further identifies himself as an old university acquaintance, a doctor of philosophy (and in his own words, also a doctor of medicine). In response to an unasked question, Pretorius further explains, "Booted out. Booted, my dear Baron, is the word…for knowing too much!" Knowing too much certainly has a sinister edge to it and based upon what happens later in the film one can speculate that knowing too much involved his alchemical work with homunculi.

Pretorius plays a renegade mad scientist to the hilt and his personality helped to define what it means to be a cinema mad scientist, especially during the 1930s. He has no morals and even less scruples with no regard for human life or ethics

and only seems to care about his own prestige and reputation. Bound up with his on screen persona is an undercurrent of homosexuality as well as a character not far removed from the homunculi devil all indicating that Pretorius and therefore, all that he does, is considered evil.

Pretorius is gleefully played with great panache and flamboyant style by Ernest Thesiger, a British actor who is 4th billed in the film's credits. He is a tall, thin and emaciated-looking actor with an unusually large nose and devilishly pointed ears and defines the mid-1930s role of the mad scientist. "You think I'm mad? Perhaps I am!" he says at one point to Dr. Frankenstein. (Perhaps his performance in the film THE MAN IN THE WHITE SUIT outdoes his flamboyant acting seen in BOF.) Pretorius is dressed as like a dark priest, complete with white collar and black skull cap hat. Overall, Pretorius is patterned after a real historical figure, Philippus Theophrastus Aureolus Bombastus von Hohenheim, better known simply as Paracelsus (1493-1541). Paracelsus was a Swiss alchemist and physician who has made a number of significant contributions to real science. On the other side of the coin, among other things, he claimed to have created homunculi from human seminal fluid and it is these illusions that are at the core of Pretorius' personality, his mad scientist persona. Paracelsus made homunculi from semen where Pretorius made his homunculi "from seed"; perhaps a nod to film censors at the time since using the word, 'semen' would have been forbidden. It should also be noted that Paracelsus himself is actually mentioned in Mary Shelly's original novel, *Frankenstein.* Paracelsus and his work were quite well known at the time and including an illusion of him and his work in the film brought in a small sense of verisimilitude reality to entice and tease the audience.

Though Pretorius and Frankenstein plot together the real driving motivation and push for the work is the fast talking and extortionist/kidnapper, Pretorius, who convinces Frankenstein that they should collaborate. As Pretorius says, "Now think. What a world astounding collaboration we should be. You and I, together! Leave the charnel house and follow the lead of nature, or of God if you like your Bible stories. Male and female created He them. Be fruitful and multiply. Create a race, a man-made race, upon the face of the Earth. Why not?" Though this did intrigue Frankenstein it wasn't quite enough so Pretorius resorted to extreme measures to insure Dr. Henry's cooperation, including extortion (revealing to the authorities that it was Dr. Henry who was responsible for the existence of the Monster and all his subsequent murders) and kidnapping (Henry's fiance, Elizabeth). In spite of this extra force to get Frankenstein to cooperate Pretorius really did not have that far to go to convince. Such enthusiastic responses as when Frankenstein says, "I must know!" shows that he is already there and essentially onboard with the idea. The passion and curiosity of a scientist is well demonstrated when Frankenstein said this line in the film (and it should also be noted that this curiousity seals his fate).

It is implied that Pretorius was a former teacher of Frankenstein while he was in medical school. During one exchange Pretorius says, “I was hoping that you and I together, no longer as master and pupil, but as fellow scientists...”. It is the ‘no longer master and pupil’ line that is the tell-tale remark. Since Frankenstein apparently was a former pupil of Pretorius the “master” sought out his student after learning that the Monster survived the burning windmill from the first film. It is tempting to speculate that Pretorius instilled the “giving life to the dead” experimental mentality in Frankenstein while he was a student under his tutelage. If so, then when during his school training did Frankenstein switch from Pretorius to Waldman? (Waldman was prominent in the original 1931 film, FRANKENSTEIN and was also a mentor of Frankenstein.) It is also tempting to speculate that Pretorius was “booted out” of his university position by assisting Frankenstein in his “unholy experiments” of bringing the dead back to life. With this master and pupil relationship then, as a student, how much did Frankenstein contribute to the basic homunculi techniques of Pretorius? Was Frankenstein the pupil a source of inspiration for Pretorius the teacher/experimenter?

While tempting Frankenstein to help him create a “mate” Pretorius wants Henry to build the female body with Pretorius supplying the brain grown “from seed”. Quite an interesting and effective collaboration between two scientists who both have something real to bring to the work at hand. Frankenstein would stitch together the parts for a female body, his particular surgical speciality, whereas Pretorius would prepare the brain, his speciality. This then brings up an intersting question of where did Pretorius grown the brain from seed? Did he do this in his lab and then transferred it to Frankenstein’s lab or was all the work done in Frankenstein’s lab? As Pretorius noted, his lab is not far from Frankenstein’s estate when they went there for the first time so the transport of a living brain may not have been that much of an issue.

For Pretorius’ opening arguments in trying to convince Frankenstein to join him in his work he says, “I was hoping that you and I together, no longer as master and pupil, but as fellow scientists, might probe the mysteries of life and death…to reach a goal undreamed of by science…but you and I have gone too far to stop [what does this mean? Gone too far implies a lot of science was done; who defines “too far”?]. Nor can it be stopped so easily. I also have continued with my experiments. That is why I am here, tonight. You must see my creation” (note: singular use of word). In response Frankenstein says, “Have you also succeeded in bringing life to the dead?” already showing his interest in what Pretorius has to say. Pretorius replies with, “After 20 years of secret scientific research and countless failures, I also have created life as we say, ‘in God’s own image’.” With his methods Pretorius has created life in a way that is quite different from both Dr. Henry and God by growing his humans from seeds. And a very effective way of showing how evil Pretorius really is. On the surface he seems to be on par with the work of Dr. Frankenstein in trying to re-animate dead tissue though there is room for interpretation of this.

The “20 years of secret scientific research” should have taught him much. Also, “countless failures” means that in addition to what he did learn he also learned ‘what not to do’ in his research. And if he was actually doing this work for 20 years then he was doing this work while as a mentor to medical student Henry Frankenstein as discussed above. Makes one wonder if Pretorius may have accidentally slipped some key knowledge to young Henry during his student days (“master and pupil”). And the converse may have been true in that young Henry could have told his mentor some information in confidence or perhaps in an off-hand manner that gave Pretorius some much needed insight. All this suggesting to Pretorius that maybe sometime in the future this bright young medical student may be of some use to him.

Also, where was the 20 years of secret scientific research done? Presumably this was done in Pretorius’ own lab since it is private and away from those who booted him out for knowing too much. He can do whatever he wanted without anyone scrutinizing his work in his private lab. Also, he could have moved from place to place during this 20 year period, maybe avoiding the authorities or perhaps nosey neighbors. His 20 years of work culminated in his homunculi but this was apparently not satisfactory since Pretorius dreamed of greater glory, namely the creation of a fully functional, normal-sized human female.

“Visiting my humble abode”
Our first look at the laboratory of Dr. Pretorius is when he and Frankenstein visit to formulate plans on working together. To begin their collaboration Pretorius gets a bottle of gin and says, “Gin. Its my only weakness” and toasts “To a new world of gods and monsters” and drinks. However, it should be noted that Frankenstein himself does not drink therefore invalidating the toast.

It appears the main focus of Pretorius’s lab work was the creation of his homunculi since no other useful items were seen or discussed. Therefore, was his lab layout satisfactory for the job at hand, namely homunculi creation? According to the alchemist, Paracelcus, sperm was needed as a necessary ingredient in the creation of his homunculi so, no doubt, Pretorius used a similar procedure (afterall, his work came “from seed”). Mixed in with the sperm seed were other ingredients, many of which were derived from distillates of various plants such as the mandrake root (a herb that has been intimately connected with humans and fertility since pre-historic times), a common component according to homunculi lore. All of these ‘procedures’ were part and parcel of the alchemist’s materials and methods. To make such distillates various types of glassware are needed. What is seen in Pretorius’ lab, mostly exotic looking glassware, large retorts, distillation columns, and other flasks and beakers, may be just the right stuff for him to carry out his “secret scientific research”.

Glassware is primarily used for work on small molecules in liquid form and the ingredients Pretorius would use for his homunculi would be a mixture of such small molecules. All in all it does make sense so based on what is shown in this scene the visible glassware does serve a function for the work at hand and is

useful for making the necessary reagents for homunculi creation, such as buffers, various solutions, protein extracts, and maybe “germ plasma”, “biological seed” (ie, DNA) extracts. However, since Pretorius is working with living animals (albeit, miniature humans) then he should also have vivarium capabilities, meaning some sort of functional housing (food, water, waste removal) to care for his homunculi. Presumably, this was all kept in a back room, maybe the same room where the homunculi box is kept.

Stating the obvious, from Pretorius’ lab we know what he has because we can see it. Visible are a variety of glassware, glass separation columns, shelves of books, work tables, reagents, apparatus, test tubes (with cotton plugs) & racks, rubber & copper tubes, heater, trunks, many flasks (erhlenmeyers & round bottom), an alcohol lamp (no Bunsen burner in sight), and a sink. As well as the proverbial human skeleton. All essential items for just about any lab and very typical for a mid-1930s cinema lab. In many contemporary films much of the bench bling is just that, bench items that look cool as eye-candy and interesting but have no real bearing on the work at hand. Not so with this film since what we see in Pretorius’ lab in very much in keeping with his presumed work.

A relatively small monocular microscope is briefly seen as Pretorius is describing his ballerina homunculus. The microscope, seen on a back bench and is slightly out of focus in the scene, is visible over Pretorius’ right shoulder. This microscope would have been inadequate for the initial work of growing cultures “from seed” since Pretorius would have needed more sophisticated optics with larger magnifications than what this small one could provide.

Retorts are used to help distill various types of liquids and since these uniquely looking glass vessels are used in the various alchemical procedures to create homunculi we see several of these in Pretorius’s lab. The largest one and the most prominent one on the film set, on a separate table, looks like it can accommodate all the fluids necessary for the homunculi that he created. This giant retort is used for distilling complex liquids to get evaporates (to make homunculi?), typically for distilling and separating small molecules; the large ehrlenmeyers are hooked up to the retort to receive the distillates. In the creation of homunculi there would be a lot of mixing of liquids and fluids. To make some of these fluids, such as salt buffers, a mortar & pestle (rare now) would be used to grind the large salt crystals into smaller pieces to easier dissolve. A thistle tube is attached to the top of the retort that is used to add additional solutions and fluids to the mix.

Throughout his lab are cast deep shadows with almost Caligari expressionist-like shading. In the very back of his elongated lab space is a small bed, presumably the one that Pretorius uses. On a back ceiling wood beam just above his bed is what seems to be a mold of a human hand seemingly tacked to the wood. Also, on the wall opposite his bed all by itself is a head form (plaster cast?). All in all, very modest accomodations.

“My trifiling experiments”
Right after his toast to new gods and monsters Pretorius proceeds to a back room to show Frankenstein the results of his work. In so doing Pretorius says, “The creation of life is enthralling. Distinctly enthralling, is it not? I cannot account precisely for all that I will show you…but perhaps you can.” Pretorius then goes into a back room and brings out a large oblong wood box that contains his homunculi. As a scientist I am uncomfortable with the comment of not being able to “account precisely” for his results. This is a troubling comment since any good scientist goes out of his way to account precisely for all that he does. Without knowing a precise mechanism then all his results can be considered phenonema observations without knowing or understanding what he did. In the real science world after a phenomena has been discovered or observed then the how and why will quickly follow. Giving Pretorius the benefit of doubt one interpretation is he was stuck on a particular scientific problem and sought the advice of a colleague to provide some insight or direction for future work (“perhaps you can”). On the other hand, he could have gotten very lucky and has no clue how he created his homunculi and thinking that maybe Frankenstein could help him figure it out.

Homunculus is a Latin word for “little man” (plural is homunculi) and refers to a type of artificial human created through alchemy. Typically, these tiny creatures are grown in jars and are vaguely human shaped, though that shape can vary considerably. According to the alchemists homunculi serve as a companion, helper, or possibly as a surrogate child. How the creature was made and the particular skill of the creator determines the type and shape of the homunculi. Also, some are able to speak but most are not and secondary characteristics such as wings, beaks, claws, and fur are possible. According to alchemy lore some of the homunculi can resemble, maybe in a grotesque way, their creator (“…or do I flatter myself?” says Pretorius when referring to his Devil homunculus). It is these homunculi that sets a dark tone for the film and certainly makes Pretorius appear as the proverbial “mad scientist”.

According to the lore, the alchemical methods needed to create homunculi vary greatly though all seem to use the same ingredients such as human semen and blood. Other ingredients have included the above mentioned mandrake root and other plant components and distillates. To make a homunculus retorts are filled with various herbs, animal parts, semen, and often incubated in baths of sand or manure. In alchemy literature often times the creator uses some sort of armature such as a metal wire or a clay effigy to cast the homunculus. One procedure even involved the injecting of semen into a hen’s egg and burying it in dung until it hatches. And in the world of Septimus Pretorius such man made creatures would not have a soul and therefore blasphemed since they are not in the image of God (“if you like your Bible stories”). Also, the creator often uses parts of himself (such as semen samples and/or blood) and therefore parts of him may be manifested in the resulting homunculi. With this in mind one can wonder how

much of Pretorius himself he used in the creation of his homuculi. (Stating the obvious, maybe he used too much of himself in the creation of the Devil homunculus.)

Given the existence of homunculi (they are a fantasy afterall) then certain questions can be asked. How long can homunculi survive? Do they have a shelf life (with an expiration date)? Pretorius keeps his homunculi in a box (like a coffin) with no apparent light source. As Pretorius removes the lid of the homunculi coffin box some tell tale, and quite interesting, tubes, glass items, and some small machinery (pumps?) can be seen. We can see the indentations of the 7 homunculi jar tops on the underside interior velvet lining, all notably, on one side. The other side of the box contains other jars, dials, and connecting tubes that presumably serve as life-support systems for the homunculi which would include food, water, and sanitation functions. These would be important to maintain not only oxygen and eliminate waste products, but also maintain nutrient levels in each of the homunculi jars. The ecology and necessary biological support for the mermaid would certainly be different than that of the others due to the aquatic environment. For example, how is the water oxygenated?

As mentioned above, Pretorius brought his homunculi box out from a back room. This immediately begs the question of what else was stored there. Perhaps more glassware and equipment necessary to actually create his homunculi such as an incubator, gas tanks, pumps, and various liquid processing units are kept there.

While removing the jars Pretorius says, “My experiments did not turn out quite like yours, Henry. But science, like love, has her little surprises, as you shall see...there is a pleasing variety about my experiments. My first experiment was so lovely that we made her a queen.” That one word, “we” implies that Pretorius had helpers. Were these helpers technicians or fellow scientists? Or perhaps someone far more sinister and unscrupulous like Pretorius (such as a partner in crime whom Pretorius may have unceremoniously dispatched for knowing too much). Also, his comment about his experiments not turning out quite like Frankenstein’s implies that Pretorius failed at making full sized humans. So, why were his creations so small (they all seem about 1/12th to 1/8th scale)?

The Seven Homunculi
To summarize, here are the seven homunculi that Pretorius created.
Queen: a label on the jar states: EXP λ GA178; on command she did a mechanical-like windup curtsy.
King: a label on the jar states: EXP Y VXY7; he seems to be patterned after Charles Laughton’s Henry VIII.
Archbishop: a label on the jar states: EXP λ PU8: he blows a whistle and rings a bell at the King’s amorous antics towards the Queen.
Devil: a label on the jar states: EXP λ 1403; as Pretorius comments, “There’s a certain resemblance to me, don’t you think? Or do I flatter myself?”

Ballerina: the jar label is not visible and Pretorius' comments that her talent "is charming but such a bore".
Mermaid: no jar label is visible. The mermaid is seen comfortably resting under water on a rock. She is combing her long hair with a seashell comb with undersea light dancing on her sequined tail. As Pretorius says, "You can never tell how these things will turn out. It was an experiment with seaweed." Itself an amazingly pregnant comment (for example, what about underwater ecology? Is the water sufficiently oxygenated for the mermaid to survive? What did he add to the seaweed to create his mermaid, a tadpole? Furthermore, "never tell how these things will turn out" is an unsatisfactory comment since it suggests that Pretorius had no control in his homunculi experiments and that the results are random. He should be able to have some control in the generation of his homunculi since he seems to have such with his other creations.)

Though not a part of the on screen six jars a seventh jar is also seen. Though not seen from the front a reverse shot shows this seventh homunculi jar with what appears to be a child on a high chair waving at the good doctors (the "child" is in reality little people actor, Billy Barty).

As this scene closes in the film the last we see of Pretorius's homunculi is in a reverse shot as he walks towards Frankenstein. Pretorius says, "Normal size has been my difficulty. You did achieve size [obvious since Frankenstein started with full size parts and not miniatures or seed]. I need to work that out with you. You did achieve results that I have missed." What is interesting about this comment is that Pretorius is freely admitting a shortcoming and a flaw in his own "20 years of secret scientific research" by saying in essence that 'size does matter' and he does not know how to do that. He has had 20 years of "countless failures" to learn from but apparently not enough to actually succeed. Again, Pretorius demonstrates that he is clearly in charge and telling Frankenstein the methods he is missing are those that his partner will contribute one way or another.

After seeing the homunculi an astonished Frankenstein says, "this isn't science, its more like black magic" and this statement deserves comment since there is more to it than meets the eye. This comment from Dr. Henry suggests, within the context of the film, that he does not think outside of the box. Dr Henry does not understand the biology necessary to create homunculi so to him it is indeed black magic. (I am reminded of the famous "third law" quote from Sir Arthur C. Clarke, the science ficton writer, who said, "Any sufficiently advanced technology is indistinguishable from magic." The advanced science technology of Pretorius seems as magic to Frankenstein and he reacted as such.) All in all quite out of character for Frankenstein since he can be considered the King of out-of-the-box thinking.

In creating his homunculi it should be pointed out that Pretorius also made miniature clothing (impressive bead work at that scale, not to mention the miniature jewelry!) as well as a miniature turkey leg for the King to munch on while pursuing the Queen. In addition, a minature whistle and hand bell were

made for the Bishop and miniature rock formations, not to mention that seashell comb, made for the mermaid. Perhaps Frankenstein was commenting on the homunculi couture and attire ("black magic") instead of the creatures themselves.

Grew then as nature does…from seed

In one verbal exchange with Frankenstein, Pretorius says, "While you were digging in your graves piecing together dead tissues I my dear pupil went for my material to the source of life. I grew my creatures like cultures, grew them as nature does…from seed. Leave the charnal house and follow the lead of nature." Based on these comments Pretorius claims to have grown all his homunculi from seed. And following the lead of Nature was a wise move since that is the ultimate 'gold standard' in much real scientific research. Lessons learned from Mother Nature are the best and it is indeed wise to try not to improve on Nature but, rather, try to equal the exquisite design and function that has taken countless millenia to optimize.

"Grew them as nature does…from seed" is a comment chock-a-block full of very interesting science and one of the most powerful comments ever said in any SF film. Much is implied in this comment so it deserves a closer look. A good place to start is Pretorius' comment of growing cultures. Initially, his homunculi would all start out as cultures but not perhaps what you may imagine. To properly explain this will require a little background in embryo and tissue development, the events that occur after an egg has been fertilized by a sperm cell.

Body growth is based on patterns and this includes organ development such as the brain. Nature is full of ordered patterns with some structures more complex than others. Higher organisms such as mammals, including man, have patterns of increasing complexity. All of this coordinated growth and development is genetically determined so biodesign, including brain development, is controlled by one's own DNA. The comment that "its all in the genes" is very apt here.

After fertilization, when mammalian sperm and egg cells combine ("grew them as Nature does"), the process of embryo growth or embryogenesis, quickly begins. The first few cells organize themselves into patterns of tissue architecture and as the embryo grows these patterns are of increasing complexity. Continued growth occurs as self-organization of cells and tissues into organs, including the brain begins. Self-organization is the process of spontaneous formation of ordered patterns and structures from elements that have no or minimal patterns, meaning different cell types non-randomly come together. Also, during development many of the cell types can radically change or morph into a completely different cell type. All are normal phases of normal growth.

Tissue self-organization can be classified into three categories: self-assembly (time evolving control of relative cell positions, such as the layered pattern in tissue development), self-patterning (spatiotemporal control of cell status, so that cells acquire heterogeneous properties from a homogeneous cell population like all the different types of brain cells that result from simple precursors), and self

morphogenesis (local growth and re-modeling such as seen with eye formation and some tissue mechanics); these processes are not necessarily independent of each other. Self-driven morphogenesis involves complex controls of tissue stiffness and viscosity. Local interactions are complex in tissue self-organization. Therefore, a change in a cell's state (such as in differentiation when one cell morphs into a different cell type) could simultaneously cause an alteration in the interacting rules meaning cellular development is not static but quite dynamic. Tissue scale, cell scale, and intracellular scale all play a role in brain development. All of these could be considered as a cyto-ecology of the developing brain meaning the environment of the developing brain does play a role in how all the cells are hooked together. One problem Pretorius had was to solve the ability to steer a multicellular population with complex behaviours into a dynamic, functional brain. His "grow from seed" comment is complex indeed.

During a natural life cycle the combination of sperm and egg, as mentioned above, result in an embryo that eventually develops into a fetus which subsequently comes full term upon delivery. This development is a continuous process and, this is the most important part, this process continues throughout life *after* birth. When a sperm cell combines with an egg cell this fertilized ovum is referred to as a zygote. It is this zygote that undergoes rapid development and growth. At this time certain cells become specialized such as the spine, internal organs, bones, and, of course, the brain. At this time the fetal brain rapidly grows both in size and in the number of neurons it has. It does indeed take some time for all the neurons to properly connect to each other.

Also, for proper embryogenesis to occur there must be some sort of fertilization process to occur. By fertilization is meant the fertilization of an egg and sperm cell that results in an embryo. With his homunculi lore Pretorius was able to bypass the fertilization step and able to directly stimulate his "seed" to undergo embryo and zygote growth. For humans the first 8 weeks is the most important since that is when all the early organ formation and specialization occurs. After the 8 week mark the growth of the fetus just adds more size and substance to the body. All of this is relevant for brain development in that the brain starts out with a small cluster of cells that rapidly, over a period of several months, develops into a functional brain with all the specialized cells. Please keep in mind that a new born brain, one that has undergone 9 months gestation, is still developing for many years yet to come. In this respect, a developing brain should be considered a work in progress. And this certainly applies to our Bride. Even newly born from mother electricity, that brain, grown from seed, still needs significant development, which could take years. The ability to respond to external stimuli such as sight, touch, hearing, taste, and smell, are learned experiences and something a couple hour old Bride would not have yet developed in so short a time span.

Brain Engineering

What would it actually take for Pretorius to grown a fully functional human brain from seed? We have to start somewhere so homunculi technology and know-how is a good place to start. Eventhough the creation of homunculi, as originally conceived by the alchemists, is pure fantasy we can nevertheless learn some interesting things from this exercise. Using homunculi procedures Pretorius would most likely start with human semen or 'seed' (whose? Pretorius himself or some other male?) and mix it with a variety of substances one of which would be blood (whose? Male or female?). It would be best to keep this mix warm, body temperature being the best, but a slightly higher degree may also be used such as that given by an alcohol lamp or perhaps a Bunsen burner. All of this mix is incubated, fed, nurtured, and pushed along during growth.

During brain development the nervous system is derived from the ectoderm cell layer, the outermost tissue layer, of the developing embryo. During the third week of development distinct patterns begin to form and one of them, the beginning nerve tissues, called the neuroectoderm, begins to appear and eventually forms the neural plate which becomes the neural tube, the source of the majority of nerve cells in an adult. Our brain and spinal cord come from this development. At this delicate stage any mutations and/or injuries that occur can lead to debilitating or lethal deformities. The closest part of the neural tube to the forming head, above the neck region, eventually becomes the brain. Newly formed and developing brain cells then further separate into neurons and glial cells, the main cellular components of the brain, as well as other anatomical regions such as the pons, hindbrain, and the various hormone-producing organs like the hypothalamus. These newly formed neurons move other parts of the developing brain to self-organize into the different brain structures all controlled by axons, dendrites, and nerve synapses. It is the connection and communication between these nerve synapses that control sensory and motor movements, all behavorial elements. All of this had to be carefully controlled by Pretorius and his alchemical methods.

Another consideration is how did Pretorius know the brain he grew from seed is a female brain and not a male brain? Afterall, using sperm seed cells as an ingredient in his procedure would suggest that both X (female) and Y (male) chromosome bearing sperm are present so he had a more or less equal chance of a male or female brain resulting. So, how did he know if it was male or female? Also, how many attempts did he make to grow the brain used? Did he start several seed cultures and took the one that looked the most promising?

For the developing brain many of the cell types change or morph into distinct cells with special functions. There are many types of brain cells and the challenge is to control the diffusible molecules, control circuits, and gene regulatory networks so cells know where they are and what their function is. Biomolecules called nerve growth factor and others like morphogens, which are diffusible molecules, help in controling developmental pattern formation, a key aspect of brain development, function, and physiology. These morphogens and

growth factors help steer different brain cells into their precise location much like a tugboat brings a larger ship to port. In this respect Pretorius had to do some cellular engineering in being able to get each cell located to its proper location. Brain cells like neurons, glial cells, Schwann cells, axons, and a myriad of others are all part of human brains and each must be in its proper location for proper function.

Also, Pretorius needed to address the issue of quality vs quantity. How many brain cells and how to interconnect them all? About 90% of the brain cells are glial cells that act as a sort of support for the other cells. Neurons send signals to and from to coordinate muscle movement and there are about 100 billion neurons in a brain (and many, many more glial cells!). This is important in determining the relative IQ of the brain. For Pretorius he can influence the brain's IQ my making sure enough morphogens can move enough cells into their proper location and make sure they are precisely interconnected. Many of these growth signals will accumulate over time. Furthermore, some brain cells are larger than others whereas some are more in numbers than others. In developing a human brain one wonders if certain errors can be fixed before they happen? Can they be fixed 'mid-stream'? How about post-maturation when the brain is transplanted into the Bride's cranium? For neurobiologists an important question is whether any brain cells can self-organize or do they need the help of morphogens? Can these cells be spatially self-organized? In culture can Pretorius determine how many cells migrate? Can he determine any cell positional sensing while the brain is growing? Complex indeed and Pretorius had to control all of this.

Neural development / neural network

With all that being said, let us take a little closer look at what processes are needed to generate and shape a functioning brain and nervous system. Could Pretorius control any of the processes of brain development? Could he have increased the number of neurons to make her a 'smarter brain'? Please keep in mind that not only did Pretorius have to grow a fully functional human brain but this brain also had to completely integrate itself with the nervous system of the Bride's sewn together body so all movements and processes are controlled and regulated. How much of the Bride's brain did Pretorius grow? How much of the hindbrain, pons, spinal column did he grow? The cellular basis of brain development requires a knowledge of neuroscience and developmental biology and Pretorius would definitely have to "know too much" to accomplish all this. Pretorius was ahead of his time in his ability to understand the cellular and molecular mechanisms to form a complex nervous system. Defects in neural development can lead to cognitive, motor, and intellectual disabilities and Pretorius seemed to have all these under control.

Without wanting to make this overly complicated it would be useful to dig a little deeper into brain development and growth so you gentle Scary Monster readers can better appreciate what Pretorius really accomplished. Frankly, Pretorius

climbed a much steeper mountain in growing a brain from seed than his partner, Dr. Henry, did in “piecing together dead tisues”. A proper developing brain (normal human brains continue to develop throughout the first 20 years of life) would be constantly developing various neurons, various precursor cells, migration of immature cells to their final positions, outgrowth of axons and dendrites from neurons, guidance of all the parts to their correct partners, postsynaptic partners, and finally all those synapses that give rise to learning and memory. These neurodevelopmental processes are of two types, active-independent and active-dependent. Active-independent processes are hardwired and genetically programmed by your DNA. Active-dependent processes are those of neural activity and sensory related experiences. Various environmental conditions can affect these processes meaning they are learned over time and not instinctively there. The Bride would therefore not have developed any active-dependent processes.

Along with this brain development is eye development that must also be coordinated. Within the developing brain is the optical vesicle that eventually becomes the optic nerve, retina, and iris of the eye. These nerve connections must be precisely controlled and placed for proper function. Were the Bride’s eyes also grown like seed, were they transplanted from a “donor” (another “police case”, says Fritz), or came with the original head?

Mixed within all these cell types are glial cells that help guide an estimated 90% of migrating neurons to their destinations. In very simple terms, during brain development there is significant cell migration with everything becoming interconnected in its proper way. As you can also imagine, it takes very little to offset this brain development homeostasis into a potentially severe neurological problem. So, Pretorius had to use extreme care in growing his brain. Easier said than done.

Synapse formation

Nerve cells communicate and they do this through small transmitter molecules called neurotransmitters, which are endogenous chemical signals transmitted from a neuron to its target cell, typically a muscle cell, across a synapse. One particular neurotransmitter, called acetylcholine, is a key component of the neuromuscular synapse response. A nerve impulse sends a signal down its length and releases small vesicles containing acetylcholine thereby stimulating a muscular response. These are the details of a synapse and a key element of proper brain function and all of the synapses would have to work in unison for the Bride to properly function.

Embryo brain

For humans, even after a normal 9-month gestation period the newborn brain is still a small size and continues to develop for the first 20 years. This makes the size of brain that Pretorius grew from seed of interest. How was Pretorius able to “super enahnce grow” brain development? Furthermore, did his brain snugly fit

into the cranium of the Bride? If it was a loose fit then her brain would have jostled around potentially causing some severe discomfort. Also, if it was a tight fit then potential brain trauma and headaches could occur. All in all, there is not much wiggle room for error. We should also keep in mind that any toxic exposure any time during brain development may not only be eventually debilitating but may result in birth defects, even death. These could be considered congenital malformations. Furthermore, a male brain is slightly larger than a female brain so a gender-specific snug fit is preferred.

Second view of Pretorius' lab

As Dr. Henry enters Pretorius' lab the second time we get a good view of the experimental work Pretorius is doing on the table he is seated at. Heated by a simple alcohol buring lamp is a large retort that is connected via a rubber tube to a large collecting ehrlenmeyer flask. The alcohol lamp provides a low though steady heat that would be necessary for a slow, careful distillation procedure. The flask is receiving the distillate from the retort suggesting Pretorius is trying to isolate some small soluble organic substance. Immediately in front of Pretorius is a mortar and pestle suggesting he has been grinding some salts in the preparation of a buffer. Also on this desk are other ehrlenmeyer flasks and other types of glassware, all indicative of isolating and preparing small organic molecules, perhaps something he needs to keep the brain alive or for his homunculi.

Head transplant vs brain transplant

The head/brain of the Bride deserves comment. Did Pretorius implant his brain into a detatched head which was then subsequently attached to the Bride's body or was the head already a part of the body and the brain was implanted into that? One possible interpretation is that an intact head/brain was already attached to a body Frankenstein had stitched together and as such the existing brain had to be removed prior to the brain implant (this raises the issue of why replace the brain if the original was OK? However, if the original brain was damaged then a replacement brain would be necessary). Based on the few visible sutures seen on the Bride's neck and jaw line then the brain most likely would have been transplanted in individually instead of an entire head. If the entire head were transplanted to the Bride's body then the neck sutures would have been more dramatic but since no such sutures are visible then this would support a brain transplant procedure instead of an entire head transplant. As such, this then supports the notion that Pretorius did indeed grow the brain using his own unique methods and Frankenstein did the actual transplant procedure with Pretorius assisting.

Birth of the Bride

During the last minute preparations for the soon-to-be-alive Bride Pretorius comments, "All the necessary preparations are made. My part in the experiment is complete. I have created by my method a perfect human brain. Already living but dormant. Everything is now ready for you and me to begin our supreme

collaboration." Then Pretorius goes on to say, "Lying here within this skull is an artificially developed human brain. Each cell, each convolution, ready, waiting, for life to come." Accepting the concept of an artificially developed brain the question now is how functional? Life's experiences imprint thoughts, concepts, ideas, and, most important, memories into the brain. These are the active-dependent processes mentioned above. Since her brain was "waiting for life to come" then, being newly minted, meant that there were no life experiences and no memory of anything. At this point all the Bride had were her active-independent processes that are hardwired and genetically programmed by her DNA. As such, then her reactions when fully revived/alive, with subsequent scream, are open to interpretation.

After Pretorius removes the bandages from the Bride's eyes we see her eyes focus, are moist, and appear to search surroundings. The Bride's first movement is her right hand. Then she lifts both arms straight out, her eyes close, and her head lowers and rests. This is followed by shaky, jerky head movements, side-to-side, then up (identifying a light source as the monster did in the original FRANKENSTEIN film?). Her eyes are straight and focused as she takes her first furtive steps and looks around at her surroundings (is she trying to get her bearings?). When she first sees the monster she tries to scream but just utters a choking sound (perhaps a vocal cord problem?). Finally, after some effort she lets out a good scream. She looks away from the monster towards Henry then she easily walks fast to a bench to sit down. All indicative of an active neuromuscular response with appropriate cognitive abilities suggesting the surgery and growing a brain "from seed" did indeed work in part since all this activity required a significant amount of mind-body-eye coordination.

Tabula rasa

Tabula rasa means blank slate in Latin (more accurately, "scraped tablet") which refers to the writing of Romans on a tabula or wax tablet, used for taking notes, which was subsequently heated and then smoothed (or 'blanked') to give it a 'tabula rasa' for new writing (perhaps an early version of an Etch-A-Sketch?). In psychiatric terms, people are born without built-in mental content so knowledge comes from experience and perception. In this interpretation nurture is favored over nature when it comes to personality, behavior, and intelligence. So, the bride was "born" with a tabula rasa brain that was devoid of personality, behavior, and intelligence. She had the nature but did not have any nurture.

Her reactions may not have been due to her first sight of the monster but more to a fundamental and hard-wired visceral reaction that any visual stimuli could have provided. Were her eyes and brain completely integrated into her spinal column and therefore the rest of her neuromuscular system? Keep in mind that it takes time to properly develop correct brain control of all body components. What about breathing? Endocrine issues? Was the bride a diabetic? She "screams", or rather hisses, and when was she trying to talk, actually scream, her tongue got stuck in her throat. Was this an asthmatic response, vocal cord problem, or

something else? She becomes petulant and refuses assistance in walking. Also, contextual, environmental, and interdependent coordination between cells is critical for proper structure and function and the newly born tabula rasa Bride did not have enough time to coordinate all of this. Interactions of cells evolve over time and space and not all may have been 100% functional at the time of her 'electrical birth'.

All of this being said, then her ability to walk must also be explained. She seems to be more stumbling and falling forward than actually walking so there may be some disconnect between neuromuscular coordination that is not yet fully developed. This makes sense actually since not all of the neuro-muscular connections are in place so there very well could be some misfiring of the nerve impulses or synapses to the muscles suggesting a lack of coordination. This could be something similar to muscular dystrophy (Lou Gherig's disease) in that the nerves are no longer properly coordinating muscle movement.

The fate of Pretorius is unknown and presumably the fate of his lab in his own home. In the end, the Monster realized that both he and Pretorius "belong dead" so the lab and them were presumably "blown to atoms" ("don't touch that lever!"). Henry and Elizabeth do escape ("You live!" exclaims the Monster on their behalf) and we know that the Monster survived for another sequel (SON OF FRANKENSTEIN) but we never do find out what happened to Pretorius (nor the Bride for that matter). Did he too escape to begin anew somewhere else under a new guise (ala, Neumann/Edleman from HOUSE OF FRANKENSTEIN)? And it is reasonable to suppose that the Bride was destroyed too (though if she too survived that would be a tale for another time: how about "THE DAUGHTER OF THE BRIDE OF FRANKENSTEIN"?; that could be, as Pretorius would say, "really interesting").

Summary

The laboratory of Dr. Pretorius is an important element of the film BOF since that is where the Bride's tabula rasa brain was presumably grown from seed. Pretorius' contribution to the Frankenstein mythos was in the creation of a (presumably) functional (female) brain whereas Frankenstein contributed his considerable surgical skills by stitching together her body. All of this work was accomplished because necessity is the mother of invention. The necessity motivation was two-fold: extortion (kidnapping Frankenstein's wife) and the search for science. In their collaboration, Dr Henry is "annoyed" whereas Pretorius is genuinely "mad" (anyone who uses extortion and kidnapping to achieve his ends should be considered mad). All of the homunculi apparatus and precedures that Pretorius had previously used in his lab helped to contribute to his creation of the Bride's brain and much of this was visible in his lab. The supporting glassware and overall layout of the lab are quite fitting for the work at hand, namely making different reagents, philters, and solutions for the creation of his homunculi. The homunculi scene essentially proves two things. First, that Pretorius does indeed know his science, as corrupted as it is, and second, he

has the know how and desire to complete his project, namely, the creation of a fully functional female mate for the Monster. It is assumed that he grew, from seed, the fully functional female brain for the Bride in his lab. Though the glassware seen would have been necessary for the early phase of his work he would need further sophisticated life-support machinery for the development of an intact, functional human brain (such as perhaps seen in the film, DONOVAN'S BRAIN). Lastly, the newly created brain would have to be carefully transported from Pretorius' lab to Frankenstein's lab (don't let Fritz do it since he may drop it…) and transplanted into the Bride's cranium with all 10 brain nerves properly interconnected and functional. The newly born Bride was still getting her bearings of sight, sound, and movement, when the lab was blown to atoms. Therefore, with the Bride destroyed we will never know how effective the brain transplant was since further development and experience were needed to see how effective her grown-from-seed brain really was.

Thank you for reading. It's back to the lab for me. Stay healthy and eat right.