# THE SCIENCE CREATIVE QUARTERLY ISSUE ONE PART SIX OF SIX JUNE 20TH 2005 CLAPCLAPCLAP!



Our masthead, we think, will be forever evolving, although at present we have two Daves, a Bethany, a Caitlin, a Stephen, a Claire, and a Russell.

Tom, Moebius and Richard continue to be happy to help.

Maybe Justin and Willow?

We did follow up on Chris and his friends, and for now, we know that Chris is on board.

Isn't Jen really good at drawing pictures?

Our exotic sounding Azar is sort of still with us, but involved with a different project that will likely have an affiliation with the SCQ later this summer.

Email us at **tscq@interchange.ubc.ca**

# SO NOW WE CAN CALL OURSELVES A "QUARTERLY" (SORT OF).

**By The Science Creative Quarterly**

Dear Reader,

We are pleased to formally announce the completion of our first full issue, which is not only making us giddy with excitement, but is empirically valued at three months worth of experimentation with an (all told) accumulative and happy effort of 60 science pieces. To celebrate, we are holding a sort of retroactive yet ongoing contest to thank those who have already participated and to encouraged those who aim to submit new pieces for our second issue. The winner of this neat little trick will recieve an iPod Mini (4G version), although, how this winner is picked is up for much discussion. No doubt an algorithm will have to be construed that takes into account numerous awful and convoluted things like:

masthead eligibility,
previously published status,
eclecticness (is this a word?),
use of non-existent words,
google ranking,
hotness,
biographies that make us feel good about ourselves,
biographies that make us feel bad about ourselves,
etc, etc , etc.

We may even end up finding two favourites and giving away two iPod Shuffles instead. In any event, we figured that it is the least we can do.

Carry on.

# ABOUT SUBMISSIONS:

Anything will do, but if you like more direction, we are happy to look at:

Things with some link (however weak) to science.

Things in English.
Things in other languages that are more or less readable when translated with Google tools.

Things with many words.
Things with few words.
Things with pictures.

Things that are news worthy.
Things that are not terribly so.

Things that educate.
Things that entertain.
Things that both educate and entertain.

Things that are important to ones well being, or perhaps to the global community at large.
Things that (at the end of the day) are really only there for the sake of being there.

Things from famous people who think that this is a pretty neat thing going on here.
Things from infamous people - they're interesting too.
Things from everyone else.

Things that could win you an iPod of some shape and form.

And things whose copyright ultimately remain with the author, although it would be nice to be acknowledged as being involved in presenting it to others.

Submissions are preferred as attached word documents, or text pasted directly into the body of the email. Please send us your good work to **tscq@interchange.ubc.ca**

# THANKS FOR ALL THE BLOOD.

## By David Secko

Blood donors around the world got a pat on the back last week, as the World Heath Organization (WHO) stamped June 14 "World Blood Day."

Everyday millions of people feel the jab of a donation needle, giving pints of blood that can help save lives, and last Tuesday was a chance to reflect on this generosity, said the WHO in their reasons for labeling the day.

"Safe blood is a fundamental need for the health system of any country," said Dr Lee Jong-wook, Director-General of the WHO in a press statement. "WHO's 192 Member States have recently agreed that World Blood Donor Day will be an officially recognized annual event. This will help raise awareness of the continuing need for safe blood and safe donors," added Jong-wook.

Apart from thanking current blood donors, World Blood Day also aimed to point out that access to safe blood is only available for two out of ten people worldwide, leaving the other eight potentially in peril. Furthermore, only 30% of countries currently have a national blood transfusion service.

Part of the celebrations, which included a "gallery" in London's Trafalgar Square with pictures of 100 selected blood recipients, therefore aimed to increase awareness about the need for blood donation.

However, the news from the WHO is not all bleak, as they point out progress made in Malawi, a sub-tropical country in Southern Africa. The 12 million people in Malawi have been hard hit by HIV/AIDS, which significantly affects the mortality rate there. Despite this health concern, a safe blood service has been set up in Malawi, decreasing the death rate in children in some cases by 60%.

In Canada, Canadian Blood Services -- a not-for-profit charitable organization that manages 840,000 units of blood annually for Canadians -- suggests that the need for blood supplies in this country continues to grow, but less than four percent of people donated blood last year.

In response to this, Raymonde Gaumont, a Canadian whose 738 donations ranks highest among females in the country, speaks passionately about blood donation on the Canadian Blood Services website, which she calls a social responsibly.

"I first gave blood at the age of 18 when I enlisted in the Canadian Forces. The military life and blood donation system are united by a strong historical connection. Health is a privilege and, as human beings, we have a responsibility to share it," Gaumont is quoted as saying on the site.

Canadian Blood Services is also promoting a bill that was introduced into the Senate on May 5, 2005, which wants to make the second week of June "National Blood Donor Week."

# OPEN LETTER TO THE KANSAS SCHOOL BOARD.

## By Bobby Henderson

I am writing you with much concern after I read of your hearing to decide whether the alternative theory of Intelligent Design to be taught along with the theory of Evolution. I think we can all agree that it is important for students to hear multiple viewpoints so they can choose for themselves the theory that makes the most sense to them. I am concerned, however, that students will only hear one theory of Intelligent Design.

Let us remember that there are multiple theories of Intelligent Design. I and many others around the world are of the strong belief that the universe was created by a Flying Spaghetti Monster. It was He who created all that we see and all that we feel. We feel strongly that the overwhelming scientific evidence pointing towards evolutionary processes is nothing but a coincidence, put in place by Him.

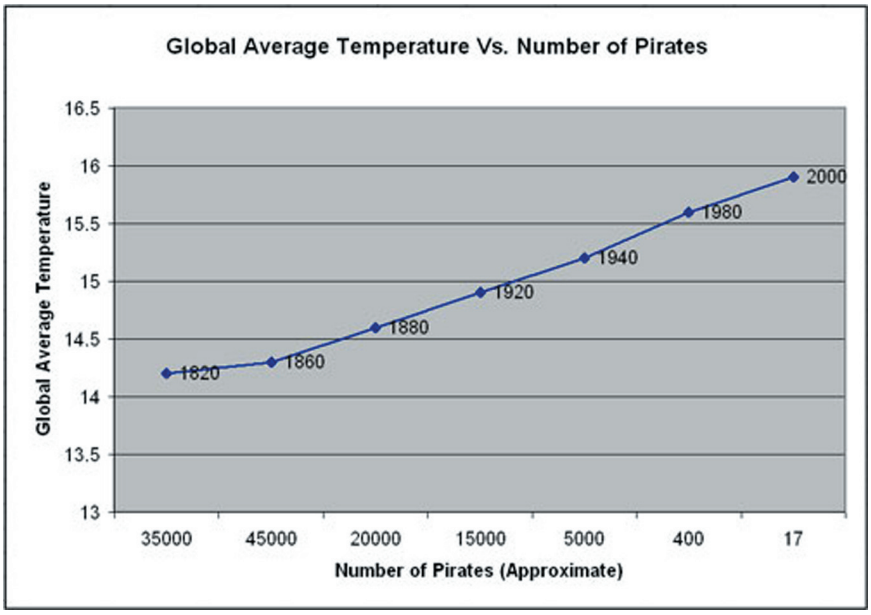
It is for this reason that I'm writing you today, to formally request that this alternative theory be taught in your schools, along with the other two theories. In fact, I will go so far as to say, if you do not agree to do this, we will be forced to proceed with legal action. I'm sure you see where we are coming from. If the Intelligent Design theory is not based on faith, but instead another scientific theory, as is claimed, then you must also allow our theory to be taught, as it is also based on science, not on faith.

Some find that hard to believe, so it may be helpful to tell you a little more about our beliefs. We have evidence that a Flying Spaghetti Monster created the universe. None of us, of course, were around to see it, but we have written accounts of it. We have several lengthy volumes explaining all details of His power. Also, you may be surprised to hear that there are over 10 million of us, and growing. We tend to be very secretive, as many people claim our beliefs are not substantiated by observable evidence. What these people don't understand is that He built the world to make us think the earth is older than it really is. For example, a scientist may perform a carbon-dating process on an artifact. He finds that approximately 75% of the Carbon-14 has decayed by electron emission to Nitrogen-14, and infers that this artifact is approximately 10,000 years old, as the half-life of Carbon-14 appears to be 5,730 years. But what our scientist does not realize is that every time he makes a measurement, the Flying Spaghetti Monster is there changing the results with His Noodly Appendage. We have numerous texts that describe in detail how this can be possible and the reasons why He does this. He is of course invisible and can pass through normal matter with ease.

I'm sure you now realize how important it is that your students are taught this alternate theory. It is absolutely imperative that they realize that observable evidence is at the discretion of a Flying Spaghetti Monster. Furthermore, it is disrespectful to teach our beliefs without wearing His chosen outfit, which of course is full pirate regalia. I cannot stress the importance of this, and unfor-

tunately cannot describe in detail why this must be done as I fear this letter is already becoming to long. The concise explanation is that He becomes angry if we don't.

You may be interested to know that global warming, earthquakes, hurricanes, and other natural disasters are a direct effect of the shrinking numbers of Pirates since the 1800s. For your interest, I have included a graph of the approximate number of pirates versus the average global temperature over the last 200 years. As you can see, there is a statistically significant inverse relationship between pirates and global temperature.

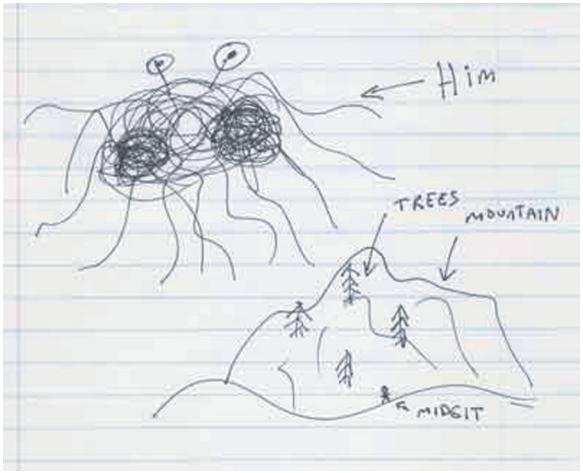



In conclusion, thank you for taking the time to hear our views and beliefs. I hope I was able to convey the importance of teaching this theory to your students. We will of course be able to train the teachers in this alternate theory. I am eagerly awaiting your response, and hope dearly that no legal action will need to be taken. I think we can all look forward to the time when these three theories are given equal time in our science classrooms across the country, and eventually the world; One third time for Intelligent Design, one third time for Flying Spaghetti Monsterism, and one third time for logical conjecture based on overwhelming observable evidence.

Sincerely Yours,

Bobby Henderson, concerned citizen.

P.S. I have included an artistic drawing of Him creating a mountain, trees, and a midget. Remember, we are all His creatures.



# CHILD'S PLAY.

## By Kara Stanley

My brother sent me a subscription to the British magazine *New Scientist* last Christmas. I love it. It arrives once a week and sits, like a center piece, in the middle of the kitchen table. Everyone in the family takes turns reading it, each finding, at different times during the week—over coffee and toast, before soccer practice, while the spaghetti sauce simmers—bits of articles that are so awesome we are compelled to read them aloud to one another.

Oh my god, one of us will say, you have to hear this.

Over the past year conversations at the kitchen table have included the plight of the very versatile, yet genetically challenged banana; the implications of the epaulette shark's ability to rise, like Lazarus, seemingly from death; the possible global value of jojoba oil, and, most spectacularly, a phantom menace that has the potential, as the headline read, to rip the cosmos apart. I collected this particular issue from my mailbox the week before U.S and British forces declared war on Iraq. It turns out that in the month prior to the war, as thousands around the world demonstrated, physicists were grappling with revolutionary new information. The first results of the Microwave Anisotropy Probe (MAP) were released and its potential implications were, well, explosive.

*Stand by for a nightmare end to the Universe—the article began—a runaway expansion so violent that galaxies, planets and even atomic nuclei are literally ripped apart.*

* * *

The initial profile of our universe, according to MAP, looks like this :
Age: 13.7 billion years (or roughly 3 times the age of the earth)
Age when first light appeared: 200 million years ago
Contents:
4% ordinary matter
23%dark matter, nature unknown
73% dark energy, nature unknown
Hubble constant (the expansion rate of the universe):
71km/sec/megaparsec
Shape: flat

* * *

My partner Simon and I became avid *Star Trek* watchers during the time I was pregnant with our son. After dinner, we snuggled up in a big wicker chair, a spot just big enough for both of us and my belly, and turned on the TV. Space, the intro began, the final frontier. Simon would speak along with the resonant voice of Jean Luc Picard. Space, he'd say, *bigger than a breadbox*. I enjoyed the show but my favourite part was always Simon's improvised over-dub.

*Space……bigger than the gap in your little sister's two front teeth.*

*Space….right after spa in the dictionary*

Sometimes he leaned towards my tummy, my extroverted belly button acting as a kind of microphone.

*Space*…he'd say, loud enough for unborn Eli to hear, *it lacks a reliable transit system.*

* * *

The fourth member of our household, a goofy black dog, was named by Eli. We were reading Madeleine L'Engle's novel *A Swiftly Tilting Planet*, which takes place over a Thanksgiving weekend. During dinner the family receives a phone call from the President informing them that the world is under dire threat. A mad dictator from an obscure nation is threatening to deploy nuclear weapons. The main characters use time travel and mental telepathy to alter the fabric of history and, in doing so, avert the global catastrophe. They are helped in their mission by a stray dog who appears unexpectedly during the long dark night. They call her Ananda.

"It's Sanskrit," Charles Wallace explains, "[meaning the] joy in existence without which the universe will fall apart and collapse."

"When we get our puppy," Eli interrupted my reading, "I want to call her Ananda."

Ananda was born on September 10th 2001, a date which has always been significant to Eli.

"It's a hopeful thing," he says.

* * *

Much of what I read in *New Scientist* I don't really understand. For example, I don't know how to understand that space is flat. It seems incomprehensibly strange and I feel what it must have been like, in times long past, to newly learn the earth was round. But….but…but.., I stutter, the universe may be flat but it is not *just* flat. Not if there are wormholes, and parallel or alternate universes, not if existence is multi-dimensional, time non-linear. Wormholes, parallel universes, an eternally present moment—to some degree these are fantastical concepts I can entertain, at least metaphorically, if not through an equation or a geometric diagram. But…flat? I'm not sure what to do with a thought like that.

I open the pages of my rather thin magazine and suddenly I am transported, a child who has been told to go outside and play. I step into a back yard that has been un-fenced and the world unfolds around me, vast and messy: flat, peaked, blobbed, swirled, swollen, bubbled, pocketed. Unimaginably large. Unimaginably unimaginable.

I did not enjoy feeling like a child the week that U.S and British troops moved into Iraq, but it was a feeling I couldn't shake. It tailed me through town, as I filled my car with gas, as I picked up bulk bags of all-natural lamb, rice and veggie dry dog food, when I stopped at the grocery store to pick up ice cream. The week before I had experimented with a 'compound' flavour of ice cream and it had caused ripples, and not the good, butterscotchy kind.

"Bring home some vanilla ice cream," Simon had said. "Make me feel like I have a home again." After securing two litres of Breyers All Natural Light Vanilla I somehow managed to fill my cart with things I didn't even know I needed: 4 packages of Minute Maid orange juice drinking boxes (on special), a pineapple (also on special), peanut butter (you can never have too many jars). And more: fold-over sandwich bags, Dad's chocolate chip cookies, pre-made hummus, a box of instant oatmeal. Standing in line, staring at my full basket of questionable necessities, I felt kind of sick. Spoiled. "The war on Iraq," a TV news item from the night before had begun, "wages war on American waistlines." People, suffering from war time anxiety, were soothing their stress with excessive amounts of fast food. Ahead of me in line, two guys, around my age, talked in excited, drippy tones about the latest U.S military gear.

"I know it's not cool," one said, "but, fuck, watching the fighting at Umm Qasr was like watching the best video game ever."

At home I abandoned my groceries and wandered into my overgrown garden. In the car, the ice cream melted. I was distracted by the witch hazel. It had been a damp, gray winter and this bright yellow bloom was an unexpected gift. In and out of the fringed petals flitted a hummingbird, the first of the season. It was a sharp sliver of brown, this hummingbird, a tiny racing heart with wings. I sat by the witch hazel a long time watching the buzz and blur of colour come and go. I was tired of not knowing what to do. I wanted to grow-up.

* * *

It is forgivable that, in the aftermath of MAP's findings, scientists were either a little shrill, or totally silent. MAP confirmed some of the most speculative of speculations. Designed to measure the cosmic microwave background, MAP now provides a clear record of the history of our universe. The way I understand it, it's kind of like carbon dating a dinosaur bone, but on a lot bigger scale.

Scientists have known for roughly the past 70 years that the universe appears to be expanding, but, with a kind of arrogant anthropomorphism, it was assumed that, like human life, the expansion rate would eventually peter out. MAP findings suggest otherwise. Still, it seems to me that sensational concern over increased expansion is kind of a misplaced anxiety, a galactic red herring. (I mean, c'mon guys, why get your panties in a twist over a "Big Rip" scenario that could play out as *soon* as 22 billion years from now.) No, the thing that is really upsetting the physicists, as far as I can figure, is that after all their theories—general, special, quantum, string—it turns

out that only 4% of the universe is know-able, ordinary matter. Only 4% is the stuff that makes up planets and super novas, car keys, milk-shakes, beaks, bones, tidal waves, meteors and moth wings. The rest—96%—is a mystery.

* * *

I didn't know what to do. What do you do when you feel something to be so profoundly *wrong* and yet you have so little power to affect it? What do you do when morality and reason flat-lines at the highest levels of power and influence?

In January 2000 George W Bush stood before an audience at the Iowa Western Community college and, in language that eerily pre-dated the rhetorical flourishes of the War on Terror, had this to say:

> When I was coming up, it was a dangerous world and
> we knew exactly who they were. It was us versus them and it
> was clear who them was. Today, we are not sure who they are.
> But we know they're there.

This was not the speech of a studied and thoughtful politician. This, to me, was Big Brother engaging in some horrific form of child's play. Could the devastation that war entails really be as arbitrary, as *entertaining*, as the ultimate millennial game of cops and robbers? The definitive cinematic version of cowboys and Indians? The best fucking video game? And if that idea scares you, or sickens you, what do you do? What do you do with thoughts like these?

I didn't know what to do but to start with the details: small, banal, daily, domestic, personal. So. The next week I bought a bulk bag of organic oatmeal and woke up fifteen minutes earlier to make it for breakfast. I called my best childhood friend and told her I loved her and that I didn't want to maintain my side of the argument—old as brothers and sisters—that lay between us. I took a day off to take Eli to a track and field meet. Afterwards, instead of rushing back to work, we bought milkshakes and went to the beach. I read a story out loud from the *New Scientist* about the discovery of a star called HE0107-5240I which, at 13.5 billion years old, shared its infancy with the universe. I tried to be a better, less distracted parent. Simon and I had long discussions about how compelling the phrase 'you'll do it because I told you so' was when parenting a pre-pubescent boy. We talked strategies; we talked conflict-resolution. I avoided TV and newspapers because it was there, through daily repetition, that the unthinkable was being transformed into the acceptably normal. I visited ZNET (The Spirit of Resistance Lives) for Iraqi conflict updates. I kept a journal of information I could reliably consider facts:

*March 29th* Cluster bombs explode, biblical in their wrath, and scatter bomblets over a wide radius. The sky rains grenades. A single cluster bomb saturates an area the size of football field with sharp, flying steel. At least 5% of the bomblets, often far more, don't explode, but live on as landmines. Human Rights Watch says that approximately 4,000 civilians were killed by unexploded

cluster bomblets after the '91 Gulf War. Presently, deaths and injuries sustained by children from unexploded cluster bombs are approximated to be around a 1000 a month.

Baby steps. I felt as if I had reached some kind of developmental plateau, one defined by my own limitations, my own irrelevance. It was hard, and it hurt, to read or see or think too much on the subject. And it wasn't just me. People were soon tired of talking about it. Conversations aggressively veered away from the topic. It wasn't cool to belabour the point. "NBC moves War", began a satirical headline in the online magazine *The Onion*, "to Thursday, *After Friends*." No weapons of mass destruction were found. The language of war, rife with bulky, over-fed acronyms, split its seams. Semantic distinctions blurred in translation. A 'defensive line' was both defensive and offensive, depending on which side of the line you stood. A *liberator* looked an awful lot like an *invader*, depending on which side of the line you stood. *Friendly fire* was not friendly at all. The predictably disastrous side effects of war upon an already devastated country's infrastructure and ecology occurred, continued to occur. May 1st came and went. The war was over but, like the over 300 000 rounds of uranium shells leaching into the soil and water of the Iraqi landscape, I found the ideas it generated, whether we talked about them or not, still continued to sicken.

* * *

Alongside my journal entries I compulsively collected the articles in the *New Scientist* that pertained to dark matter and dark energy. It was perversely gratifying to see how these unknown forces seemed to echo, on a cosmic level, both current U.S foreign policies and, more generally, the aims of all terrorist activity. The fact that the U.S represents 4% of the world's population—the same percentage of mass that constitutes the knowable universe—seemed to be a coincidence pregnant with possibility, albeit possibilities I could never logically unravel. The physicist's initial choice of nomenclature, (cold dark matter, repulsive dark energy), with all its social and metaphorical baggage, translated, at the time, into a literal representation of how I felt. Small and insignificant. Helpless against larger and unknown forces.

* * *

Often, I miss the ecstatic and anarchic despair of my adolescence, (soundtrack by Peggy Lee and Patti Smith, and a little Neil Young, for when the boys came around). Then, my anger and confusion had been visceral and immediate, uncompromising. Stylistically pleasing. I would never have worn track pants out the door, nor Gore-Tex. There had been both tragic glamour and scrappy indifference in the act of lighting a cigarette. I always wore funky, revolutionary shoes.

I find myself cringing a little at the wholesome earnestness of my 'mature' personal solutions to global crisis: oatmeal recipes and parenting tips, quotes that run along the predictable lines of 'seize the day' or 'take nothing for granted'.

But... I can no longer do apocalyptic joy any more than I can sleep in until two in the afternoon. I have a child. And as often as I feel like a kid (bewildered, bumfuzzled, lost at the mall), I am also a parent.

Spring dressed itself up into summer. In our front yard the cherry tree bloomed, the fruit ripened. It was a hot summer and the cherries ripened quickly, faster than we could pick them, and the fruit fermented in the uppermost branches. The birds congregated like college students and threw an all-day and all-night party, their cries becoming more lucid and slippery. Eli and I left shallow dishes of water, (not deep enough to pass out and drown in), around the yard so the soused birds didn't dehydrate. Ananda kept an eye out for cats on the prowl.

* * *

After a while the headlines became less shrill. The scientists started outlining the details they could reliably consider to be facts. Cold dark matter, aka WIMPs (Weakly Interacting Massive Particles), or 23% of the universe, has proven, to the physicists who would like to ascribe singular and consistent characteristics, remarkably unpredictable. What is known of the nature of repulsive dark energy, aka the cosmological constant, or 73% of the universe, is paradoxical: the cosmological constant would appear to be the property of nothingness, the energy of empty space. The fact that a cosmological constant has now been proven to exist stands as a challenge to hundreds of years of thought about the 'fixed' laws of nature. Our entire paradigm of human life—and its place in space—needs to be re-thought.

The details of our universe just got a whole lot messier. Messy, I'd like to think, in the good way that kitchens can be. If our natural laws aren't fixed, then, really, anything is possible. It seems we—parents, children, physicists, dictators—are all just playing in the dark. I imagine skipping through time and space like a kid playing hopscotch. I imagine travelling unexplored landscapes that, by their nature, resist narrow definitions and are immune to mandates of conquest and colonization.

These are ideas that make me feel infinitely happy.

* * *

A few weeks before Christmas, Ananda was killed by a hit-and-run driver. In the difficult days after her death I struggled with the superstitious thought that, without her, the three of us would somehow lack cohesion as a family. It was a trick of my mind, I knew, true and not true, a mental slight-of-hand playable only in a time of crisis.

It was my son's first experience of loss and, as he moved through the different stages of saying good-bye, I made a conscious decision not to make this family tragedy relative. I made a conscious decision not to rank it on the great scale of earthly tragedy. I let it be. Grief rolled through our home like a tidal wave. And then, gradually, it receded.

# IN THE NAME OF FAIR GAME...

**By Julie Hathaway, images by Jen Philpot**

Doping to enhance athletic performance happens at every level of the game; lately, we have heard about it in professional baseball, at the Olympics, at other international competitions and even at our local gyms. Performance pressure is ever increasing, especially considering the financial endorsements and sponsorships associated with success. As a consequence, some athletes continue their attempt to better themselves through extensive training, drive and motivation, while others look for a little help from organic chemistry. International and national sports organizations, in conjunction with laboratories around the world are trying very hard to "crack" down on drug abuse in sports. The following is a brief overview of the most popular sport enhancing drugs, how they act biologically to strengthen the body, when they should be tested for and finally, what scientific equipment and methodologies are used for drug testing.

## Steroids

By far, the most popular sports performance-enhancing drugs are steroids. They are not only commonly used in competitive sports but also in recreational weight training. Many studies have shown that the use of anabolic-androgenic steroids (AAS) by weight training individuals increases muscle mass and size by 5-20% over those not using any drugs[1].The AAS' are synthetic derivatives of human testosterone, which is produced in the testes cells. The anabolic activities of AAS' are of particular interest to athletes as they are involved in the stimulation of protein synthesis and the inhibition of protein breakdown, which contribute to muscle growth. The increase in muscle mass under the influence of AAS' is due to muscle hypertrophy and the formation of new muscle fibers. It has been reported that AAS' cause the incorporation of satellite cells ("reserve" skeletal muscle cells) into pre-existing muscle fibers to generate a higher number of cells in the tissue resulting in a stronger muscle1. AAS' have been modified from testosterone so that they may remain intact in the body for a longer period of time, enabling them to produce their effects. These modifications include the addition of a methyl group (CH3), which slows down the steroid's degradation by the liver, and alterations of the ring structures of testosterone, which increase their activity[2]. The structure of testosterone and the AAS derivatives that are banned in international sport are illustrated in Figure 1.

Detecting the presence of steroids is a difficult task. The analysis must be able to identify very small concentrations of drug as athletes might have discontinued use for quite some time prior to testing while still benefiting from the drug's enhancing properties. Competition officials therefore need to test athletes for steroid use both during and before their competition times. The athlete's urine is often the best sample to be taken for testing. Natural steroid levels (such as testosterone) for a particular population must be taken into account when testing for the presence of synthetic AAS. Often, the only way to determine "normal, natural levels" for the population of the athlete is through long term studies. The breakdown of steroids by the body is quite complex;

often, only side products or the breakdown products (metabolites) can be detected. Therefore, the analysis must include carefully designed hydrolysis and extraction procedures which lead to the detection of desired, known metabolites of the AAS' [3].

A commonly used method for detection of AAS metabolites is mass spectrometry coupled to gas chromatography.

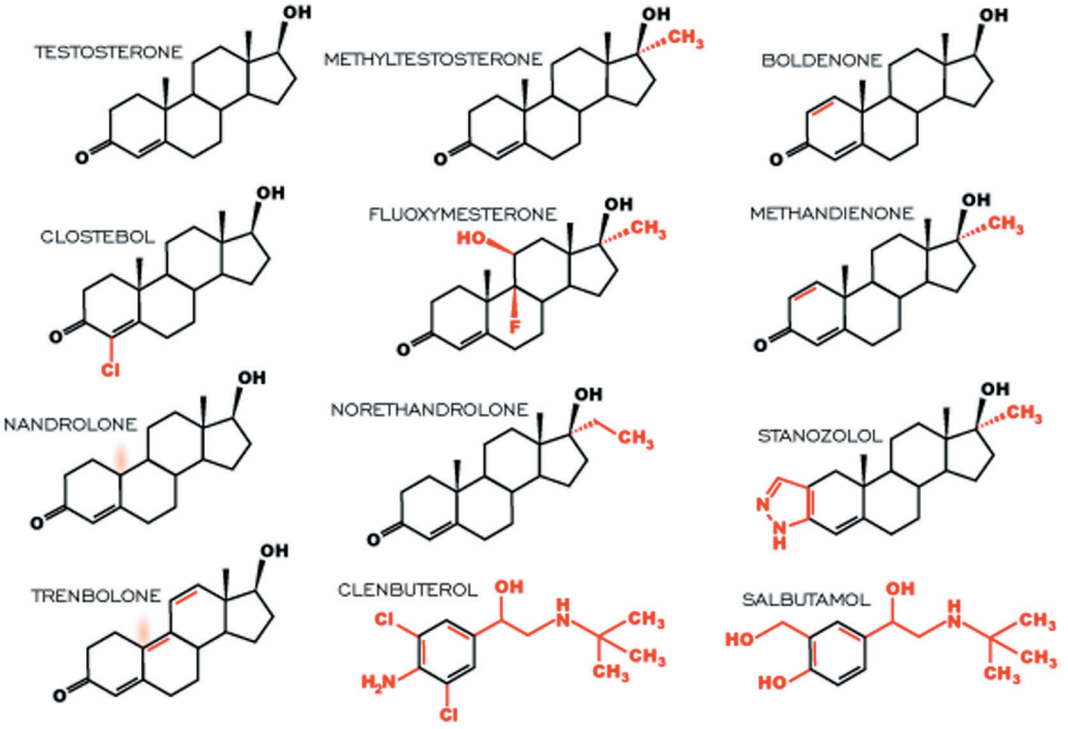



Figure 1. Testosterone and anabolic steroid derivatives banned in international sport. Each derivative has been slightly modified either by addition of substituent or through alteration of the ring structure (addition or removal of double bonds, cleavage of bonds or addition of ring structures)[3].

## Stimulants

Stimulants are another class of drugs that are often used by athletes for enhancing their performance. A lot of us consume a form of stimulant everyday when we enjoy a morning coffee or a Coke at lunch. Several of the banned stimulants are related to amphetamines. Amphetamines stimulate the central nervous system and mimic the sympathetic nervous system activities (the fight or flight responses). Amphetamines cause the release of dopamine in the brain and noradrenaline from the sympathetic nervous system, generating an overall feeling of arousal. This arousal is characterized by an increase in blood pressure, heart rate and metabolic rate. These drugs are believed to enhance performance through a reduction in feelings of fatigue[2].

Several studies have shown a 0.6-4% increase in performance in swimmers, runners and weight throwers given a source of amphetamine compared to those having taken a placebo[2]. In addi-

tion, the athletes reported an improvement in hand-eye coordination, strength and endurance.

To enhance performance, stimulants must be taken prior to an event as their effect is immediate. Therefore, testing for the use of stimulants must be done during the competition period. A urine sample is the best matrix in which to detect traces of the drug. Most of the above stimulants contain nitrogen and are quite basic in nature: these two features are exploited for detection testing. Analysis begins with an extraction into ether at a high pH, which results in an extract from the urine that should contain most of the volatile stimulants. Properties of the stimulants are quite different and thus require a method that allows for the detection of a wide range of compounds[3]. Traces of stimulants can be detected through mass spectrometry coupled to gas column chromatography, similar to the analysis of steroids mentioned above.

## Diuretics

Diuretics are a class of banned sports enhancing drugs that are mainly taken by wrestlers or competitive weight lifters. Diuretics are capable of rapid water loss through the urine, resulting in a reduction in weight. This is particularly advantageous to the athletes in the aforementioned sports as it allows them to compete in a lower weight class. Diuretics are taken before the weight classification process and following this, the athlete re-hydrates himself to regain lost weight. Diuretics are capable of diluting urine by increasing renal flow. This makes banned drug detection much more difficult and may be used as a method of masking the presence of other drugs in the system. There are three major classes of diuretics. The first, the thiazides, block salt reabsorption in the distal tubules of the kidney, which promotes the excretion of sodium, chloride and potassium. The second are loop diuretics which block sodium chloride transport in the upper loop of Henle in the kidney, also promoting salt loss. Finally, the potassium sparing diuretics allows only sodium and chloride losses. Loss of salt is of course accompanied by a loss of water through osmosis[2].

Studies have shown that diuretics result in a body weight loss of 3-4% over 24 hours. Although the drugs appear to be doing the trick, this weight loss is accompanied by an increase in muscle temperature during exercise as well as electrolyte imbalance[2].

Due to their mode of action, detection of diuretics must be done prior to competition dates, especially since their solubility and their ability to dilute down urine makes them hard to detect in trace amounts. Often, other compounds in the urine make it difficult to detect diuretic compounds. Therefore, two methods must be used. First, liquid chromatography is used. Second, for confirmation purposes, the methylation of the aminosulfonyl group (O=S=O) is followed by the previously mentioned mass spectrometry coupled to gas chromatography (MS-GC)[3].

## Catching those Cheaters...

In most cases, urine samples are collected from athletes according to a strict international protocol for doping control. For security purposes, a split sample is sent to the lab (sample A and sample

B). Sample A is analyzed first. Sample B is kept frozen until sample A yields a positive result for a banned substance. At this point, the athlete is contacted and he or she has the right to request that sample B be opened and tested in front of witnesses[3].

The commonly used method of gas chromatography coupled to mass spectrometry for banned substance identification is also used in courtrooms to reveal evidence in cases of drug abuse, fire and explosives investigations and environmental analysis. The method has been around for many years and continues to be improved with the advent of technology.

Gas chromatography (GC) and mass spectrometry (MS) each perform very different tasks but act together to identify a particular substance.

The sample enters the GC component first through the injector port where it will be vaporized. An inert gas, (often Helium) then enters the column and sweeps the sample out of the injector and into the column. The carrier gas helps remove any water and impurities from the sample. The column allows for the separation of chemical compounds in the sample based on their affinity for the material inside the column. Compounds with higher affinity for the column material will exit slower than those with less affinity. In addition, the column is also gradually heated to allow another separation factor; compounds with lower boiling points will exit the column prior to compounds with higher boiling points. The rate at which the different sample components exit the system allows them to be measured and characterized. A gas chromatograph is pictured in figure 2. The components are then moved on to the MS[4].

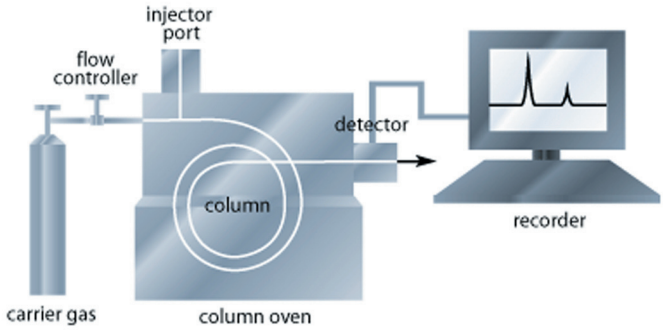



Figure 2. A schematic diagram of a gas chromatograph.

In the first part of the MS, the ionizer, an electron beam causes the components to gain a positive charge. This particular process causes further breakdown of the individual components. Each component has a unique fragmentation pattern. The sub-components then enter a magnetic region where they are focused and sent to a detector. Components with a lighter atomic mass enter the magnet set up and will be sent to the detector first. At the detector, the component transfers its charge which then activates a recorder capable of registering atomic mass, based on the mass: charge ratio, and identify the concentration of the particular component in the sample. Steroids, stimulants and diuretics are all substances that can be detected by this gas chromatography-mass spectrometry method of analysis. A spectrum of atomic masses and concentrations is generated by the mass spectrometer that is carefully observed by the analysts. In most drug detection, a selec-

tive ion monitoring (SIM) analysis will be performed where only certain peaks are observed to see if they are similar to those obtained during the analysis of a banned substance[5].

The drugs mentioned above are only three of many types performance enhancing drugs and performance enhancing methods that are currently banned for use in competitive sports. While new performance drugs and new harder-to-detect derivatives are sure to emerge in the next few years, it is hoped that technology can follow suit and improve its current detection methods. The media continues to report cases of sport doping, indicating that the problem still exists and further interventions and penalties must be enforced. It is the hope of many athletes and sport organizations around the world that soon, all cheaters will be caught and there will only be fair games to be played.

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# SIZE MATTERS: THE IMPENDING DEATH OF THE Y CHROMOSOME.

**By Andrea Lam**

*"And the LORD God caused a deep sleep to fall upon Adam, and he slept: and he took one of his ribs, and closed up the flesh instead thereof;*
*And the rib, which the LORD God had taken from man, made he a woman, and brought her unto the man.*
*And Adam said, This is now bone of my bones, and flesh of my flesh: she shall be called Woman, because she was taken out of Man."* (Genesis 2:21-23)

Biblical tradition tells the story of creation with man as the first sex, and woman the second, fashioned from Adam's rib. Biology conveys a different tale for the evolution of the sexes, however, revealing that man, not woman, is the second sex. Recent research in genomics and molecular genetics has shed much light onto the elusive human Y chromosome, suggesting that man may not only be the second to arise, but the first to disappear.

The creation of the sexes begins with the evolution of the mammalian sex chromosomes. It is believed that the X and Y were originally a pair of identical autosomes: ordinary non-sex chromosomes, the same size, carrying the same genetic material. Then 300 million years ago, a chance mutation suddenly occurred on the ancestral Y, mutating the SOX3 gene to the SRY gene. It is at this point that the Y chromosome took on the sex determining role for maleness (SRY stands for Sex-determining Region of the Y). The ancestral X retained the unmutated SOX3. And thus, the sex chromosomes emerged. Between 80 to 300 million years ago, four different rearrangements (inversions) took place sequentially in the Y, further differentiating it from the X. The ultimate result: only the two distal ends of the X and Y remain identical to each other, known as the pseudoautosomal regions (PARs) [12].

The SRY gene on the Y chromosome is the master switch for sex determination. When present, it diverts the embryo onto the path towards male development by turning on testis differentiation, which whips out powerful masculinising hormones . Embryos carry 22 pairs of autosomes plus two sex chromosomes; an XX embryo will become a female, while an XY embryo will be male. It has been known for 45 years that people with a Y are male, no matter how many Xs they may also have. This explains why XXY embryos develop into males (Klinefelter's Syndrome), while XO embryos produce females (Turner's Syndrome). It is evident that the female can be regarded as the "default" sex: the fall-back developmental pathway for any fetus if the Y is absent. It is for this reason that Steve Jones, professor of genetics at University College London and author of *The Descent of Men*, considers females the first sex, and males, the second [4].

By all means, SRY is not the only gene carried by the Y; also spread out on the chromosome are a handful of other genes involved in spermatogenesis, expressed exclusively in the testis, and required for manufacturing fully operational sperm [5]. In addition, there are also a few genes

that have absolutely no involvement in maleness, including one that codes for tooth enamel.

The emergence of the SRY gene on the Y was a bold and definitive move (albeit by chance) that allowed and enabled the manifestation of the male species. Ironically, this mutation may have also sealed the fate of the Y chromosome and quite possibly doomed it for extinction. Since that fateful event 300 million years ago, the Y has shrunk dramatically. Recall that the X and Y chromosomes began as the same size; today, the X is 165 megabases (Mb), while the Y is less than half of that (67 Mb) [6]. Something has been driving the Y to degeneration. Thus remain the controversial questions that have been debated for decades: What is the future of the Y chromosome? Will it continue to deteriorate to extinction? And what will this mean for the male species?

To put it plainly, the Y chromosome is a loner. Unlike all other chromosomes, the Y is genetically isolated; this is the central reason that it has shrunk so dramatically. The 22 pairs of autosomes are able to pair up, allowing for a process known as homologous recombination to occur in meiosis. During recombination, the two members of an autosome pair are able to cross-over, exchange genetic material with each other, and notably, swap faulty genes for good ones by using each other as templates. This process allows for the repair of damaged chromosomes that may have resulted from mutations. Like autosomes, the X chromosome is also able to engage in recombination, but only half of the time, namely, when it pairs with another X. The Y, however, is an isolated entity, because it is never in proximity with another Y; the only partner it can potentially pair up with is an X chromosome. Over the past 300 million years, however, because the Y has gradually become less homologous to the X, cross-over between the sex chromosomes has become drastically reduced. The result is that only the tiny PARs of the X and Y are able to recombine[2]. The 95% of the Y chromosome length that lies outside of the PARs, dubbed the male-specific region of the Y (MSY), is unable to recombine with the X. Thus, the vast majority of the Y suffers from the detrimental effects of suppression of recombination. In the non-recombining MSY, mutations accumulate, uninhibited and unrepairable. As a consequence, active genes on the Y are rapidly lost, and the Y is subject to considerable degradation and decay.

Jennifer Graves from the Research School of Biological Sciences at the Australian National University is one of the leading experts convinced that the Y is on the road to extinction. She estimates that since the Y took on its sex-determining role, 1393 out of 1438 genes have been lost, leaving a measly 45 genes retained on the Y. (Compare this to the large 1438-gene-bearing X.) Of these 45 genes, 27 are in the non-recombining MSY. The gene paucity of the Y is also evident in its density of active genes: 0.5 genes per Mb, compared to 10 genes per Mb on the X[6]. Graves argues that the Y chromosome's significant rate of gene loss (4.6 genes every million years) guarantees its future demise. In 2002, she predicted that the last 45 genes, and thereby the Y chromosome, will be gone within another 10 million years [7].

Needless to say, Graves' prediction has been vigorously opposed. On the other side of the argument is David Page of the Whitehead Institute at the Massachusetts Institute of Technology. In 2003, he and a team of 40 researchers completed the

sequencing of a human Y chromosome from an anonymous donor. They claim that the Y chromosome does not have only 27 genes in the MSY, but 78. Furthermore, they argue that the Y's powers of self-preservation have been greatly underestimated [8]. Complete sequencing revealed that the Y contains eight large palindromes, regions that read the same both forwards and backwards (think "RADAR"); the Y is a "hall of mirrors," as Page describes it [9]. These palindromes can form internal hairpin loops within a single Y chromosome, within which internal pairing and recombination can take place. This process, named gene conversion, involves a gene copy on one palindrome arm non-reciprocally replacing the homologous gene copy on the other arm [10]. In this way, by converting mutated gene copies to active copies via gene conversion, the Y chromosome may be capable of self-repair.

The role of gene conversion in sustaining the Y has been argued at the forefront by researchers involved in genome sequencing at the Whitehead Institute, including Page and Helen Skaletsky. They believe that gene conversion occurs in the MSY as frequently as recombination in autosomes. All eight palindromes of the Y are located in a euchromatic (genetically active) region of the MSY, of which they constitute 25%. All 27 genes of the MSY are also found within this euchromatin and are highly concentrated within the palindromes. The arms of each palindrome are over 99.9% identical, strongly facilitating pairing. Furthermore, for all the known genes on palindromes, identical or nearly identical gene copies exist on the opposite arm. It is therefore no surprise that there is evidence of gene conversion occurring routinely in 30% of the MSY euchromatin; calculations suggest that multiple conversion events take place every generation[10].

Interestingly, I noticed that most of the literature arguing the Y chromosome's destined oblivion cites the number of genes in the MSY as 27 (plus 14 in the PARs, totaling 45 genes). In contrast, almost all the literature arguing that the Y is here to stay cites 78 genes in the MSY. This apparent discrepancy is due to the ambiguous, flexible definition of a gene. There are 78 protein-coding genes within the MSY, but collectively, they encode only 27 distinct proteins. Graves chooses to define the number of genes as the number of distinct proteins encoded, no doubt to emphasize how puny the Y is. In contrast, Page and Skaletsky take into account duplicated and amplified genes, presumably to demonstrate that the Y is not deteriorating as fast as one might think from listening to Graves. This just goes to show that even apparent scientific "facts" can be manipulated for any slant; after all, the numbers can tell whatever story one wants them to tell.

Graves, for one, remains adamant that the Y chromosome is running out of time, despite Page's 2003 discovery of its eight palindromes. In 2004, she restated her unchanged predictions for the future of the Y, unconvinced that gene conversion will save it. She agrees that if mutated copies of a gene are continually converted back to active copies, then clearly, the Y will not decay[6]. But, unfortunately, gene conversion is not directional; there is equal opportunity for mutated gene copies to overwrite active ones. This "incestuous swapping might be a double-edged sword," warns Rick Wilson, director of the Genome Sequencing Center at Washington University School of Medicine . In fact, the current state of the Y suggests that there may even be more casualties of the process

than successes, judging from the numerous inactive pseudogenes (genes that cannot be transcribed) within palindromes. Graves believes that "gene conversion within palindromes is more like genetic masturbation than real sex [homologous recombination between two chromosomes]. It does not offer interaction between different Y chromosomes, which is essential for […] genetic health"[6].

I agree with Graves; there must be a critical flaw in the process of gene conversion if it has already allowed the Y to lose nearly 97% of its genes. I presume that the other side of the camp may argue that the Y has allowed itself to lose those 1393 genes because they were unnecessary, but the remaining 45 genes will be actively retained because they are essential. In other words, the Y has decayed to an optimal size and will remain stabilized at this state, perhaps akin to the human appendix. I find no evidence for this, however; after all, it is often said that the best predictor of the future is the past. If the Y has the capability to retain genes, it has evidently been out of practice, and it will likely be unable to successfully step up to the task when it counts. Ziny Yen, a medical genetics graduate student here at the University of British Columbia (UBC), believes that gene conversion has not proven to be a powerful enough compensatory mechanism: "Gene conversion may help to slow down the degeneration, but I do not believe that it can prevent the decay altogether" [12].

It may be argued that natural selection could assist gene conversion by providing the directional bias that will select for more active copies of genes. Natural selection, however, works very poorly on the Y chromosome, because it requires a large population to be effective. The Y is essentially a small population, 4-fold lower in frequency than autosomes, since only half the population carries a Y, and only one copy of it at that. Selection is therefore a very weak force on the Y. Furthermore, selection is confounded by the forces of genetic drift and genetic hitchhiking, which prey on small populations especially in the absence of recombination; they exert powerful influences on the Y and drive it to degrade[6]. Genetic drift acts on the Y in a ratchet-like way (a mechanism dubbed Muller's ratchet). When there is no recombination, the class of Y chromosomes with no mutations could be accidentally lost simply because its bearers have no sons; once this class is lost, it can never be salvaged. Subsequently, the class of Y chromosomes with one mutation may be randomly and permanently lost. The "ratchet" can continue to turn, with the two-mutation class disappearing next[2]. Similarly, damaged Y chromosomes can easily and randomly propagate simply if the bearer happens to have many sons. Genetic hitchhiking is another powerful force driving the decay of the Y. This occurs when a mutation conferring a major benefit on male fitness happens to pop up on a particular Y chromosome. This Y will spread through the population, regardless of whether there are detrimental genes carried on it as well [13]. Together, the forces of drift and hitchhiking can counteract selection for a "perfect" Y chromosome that carries all functional genes.

So altogether, the palindrome discovery may have revealed that the Y can keep afloat for a while longer, but inevitably, it will still sink. As Bryan Sykes, head of Human Genetics at Oxford University, so scathingly puts it: "…sadly, the Y chromosome is just as lonely as ever – though we now know that it talks to itself as it spirals towards

oblivion" [14].

Lack of recombination, drift, and hitchhiking all render the Y extremely susceptible to the propagation of mutations. This may have been manageable if the Y chromosome rarely suffered such mutational wounds, but this is not the case. On the contrary, out of all the chromosomes, the Y is the one under the most constant bombardment[6]. So not only is it defenseless, but it must deal with an elevated level of mutations hitting it in the first place. Studies have compared genes that are shared by the X and Y, and in each case, the Y-borne copy is much more rapidly mutated than its X-borne partner [15]. This is not surprising given that the Y chromosome is immersed in layer upon layer of danger and opportunity for error. Firstly, the Y alone is permanently locked in the germ cells of men, passed from generation to generation through the testis. This is a perilous place for a chromosome; the testes are located in the scrotum, which encounters many more harmful environmental mutagens than do the ovaries [16]. Secondly, spermatogonia undergo many more division cycles in the testis (300 to 700) than do oogonia in the ovary (~20)[16]. Over 150 million sperm are created daily, brought about by a tumult of cell division and extremely error-prone DNA replication. The chances of errors, and thus mutations, occurring in these conditions are astronomical [17]. Thirdly, sperm itself is a harsh environment for a gene, being a breeding ground of oxidation and lacking enzymes for repair [18]. True, all the other chromosomes must also pass through the testis and the sperm, but the Y is the only one found solely in these locations, rendering it much more fragile.

The effect of the Y chromosome's vulnerability to mutations has clear manifestations. Almost all de novo (new) mutations are derived from the father, not the mother [19]. Most prominent are the implications on male fertility. Severely declining sperm counts have been reported in the United States and Europe over the last half-century, in which the Y may play a role. A landmark paper was published by Elisabeth Carlsen et al. in 1992, a historical analysis of 62 separate sperm-count studies from around the world; she concluded that sperm count among men in the industrialized world declined by about 50% in the past 50 years [20]. These results were questioned, however, criticized for purported erroneous statistical methods. Furthermore, a flurry of studies in subsequent years presented contradictory conclusions [21]. In 1997, University of Missouri epidemiologist Shanna Swan revisited the data from the 62 studies and confirmed Carlsen's conclusions; moreover, she found the dramatic decline to be even greater than previously estimated. Sperm counts among healthy American men were found to have dropped by 1.5% per year from 1938 (120 million sperm per mL of semen) to 1988 (50 million sperm per mL of semen). In Europe, Swan found that they had been dropping at double that rate (3.1% each year) between 1971 and 1990 [22].

The World Health Organization currently designates a minimum of 20 million sperm per mL of semen as normal [23]. Many clinical groups have had to adapt this criterion to accommodate widespread declining sperm counts. According to Fouad Kandeel, a fertility expert and chairman of the department of Diabetes, Endocrinology and Metabolism at the City of Hope Medical Center, 20 million sperm per mL used to be considered subfertile[24]. As of December 2004, Surrey's own BC Biomedical Laboratories, which conducts medical

diagnostic services including semen analyses, has used 14 million per mL as its standard for subfertility [25].

These decreases in sperm count have been attributed to a range of factors, including age, ozone levels, pesticides, smoking, tight underwear, hot tubs, driving, and most recently, laptop computers. Not surprisingly, genetic defects, namely in the Y, are also incriminated. Between 10 to 25% of male infertility cases have been traced to a region on the long arm of the Y called the AZF (azoospermia factor), which is involved in sperm production[24]. Studies have revealed that microdeletions in regions AZFa, AZFb, and AZFc do indeed lead to both azoospermia (the absence of sperm) and, more commonly, oligozoospermia (decreased sperm count) [26]. One study conducted by researchers at the Whitehead Institute and the Howard Hughes Medical Institute looked at the Y chromosome of 35 men with extremely low sperm counts, and found that two had a deletion in AZF. This mutation was not found in their fathers, proving that the deletion was the cause of the condition. A follow-up study found similar deletions in 12 of 89 men who produced few sperm; their fathers also had intact Ys [27]. The first specific gene mutation on the Y conferring infertility (USPY9) was identified by Page in 1999 [28].

Sykes, the cynical Oxford professor mentioned earlier, is the author of the controversial *Adam's Curse*. In this text, he argues that, based on the observation that 1% of men are infertile because of a deletion on the Y, human fertility will decay to 1% of its present level in 125 000 years[14]. His prediction is evidently much more looming that Graves'. Recall that based on a loss of 4.6 genes per million years, Graves estimates that the Y will be gone within another 10 million years. She adds that this is likely a conservative estimate, however, since the rate of gene loss may very well be non-linear. There is evidence that as the Y becomes further degraded, its stability declines even more. Studies have looked at male babies born from intracytoplasmic sperm injection (ICSI), the now popular technology of injecting a single sperm into an egg to circumvent low sperm counts, and found that they have more Y deletions than their subfertile fathers [29]. Thus, the Y could disappear much faster and earlier than Graves originally predicted.

The idea of inheriting infertility seems to be quite the oxymoron. This is an argument used by the "Y will survive-ers," who claim that any mutations severely affecting the Y cannot be passed on since the bearer will be infertile. Predisposition to subfertility, on the other hand, can be inherited, as mentioned above in male babies born from ICSI. Nonetheless, there appears to be an exceedingly high rate of a recurrent deletion of a 1.6-Mb region containing genes required for spermatogenesis; this mutation confers infertility, yet it occurs at such a high rate that it is maintained as a polymorphism in the human population [30]. Thus, even though bearers of this deletion are infertile, the mutation crops up in so many males that it appears to be inherited, rather than de novo.

At this point, I must call into question all the information, statistics and "facts" presented thus far. They may all very well be biased. The majority of research done on male infertility has been on men found through fertility clinics: men who are not typical, nor representative, of the general population. It is from them that all the mutations on the Y chromosome are

discovered and analyzed, thus revealing a sampling bias. There may be men with mutations on their Ys, but who do not experience any fertility problems or realize they are subfertile; these men would never enter fertility clinics, and thus their Ys would never be considered. Studies on sperm counts are just as limited; they rely on data from sperm banks, which again, may not reflect the male population as a whole. It has been suggested that the decline observed in studies such as Carlsen's and Swan's may not have taken into consideration normal sperm fluctuations that can occur from year to year, from season to season, and between different regions. For example, one study found the sperm count in New York City to be much higher than that in Los Angeles. Another Los Angeles study in 2000 found no significant change in sperm count from a study conducted in the 1950s [31]. (Swan takes these apparent contradictions into account and defends her results, claiming that although temperature and climate can cause regional variations, the overall decline in sperm count is not an illusion; the United States National Institutes of Health agrees.)[22] To take this questioning one step further, I begin to suspect the validity of the alleged Y chromosome sequence itself. Page and his Whitehead Institute colleagues obtained this single Y from an anonymous donor. What a shock it would be to realize, 10 years later, that his sample was an anomaly. Laughable, maybe. But not as ridiculous and far-fetched as one might think; for 37 years, it was accepted as scientific fact that humans had 48 chromosomes. This was what Herbert Evans found in 1918 in the cells of a man who, as was realized later, just so happened to have a genetic abnormality. It was not until 1956 that J. H. Tijo and Albert Levan proved this wrong [32].

Another potential source of information for the future of the human Y is the Y chromosomes belonging to other mammals. "Rodents, which have much shorter generation times than primates, are indicative of what might happen after many more generations in humans," says graduate student Yen[12]. In other words, because mice have undergone many more "cycles of evolution," the current condition of their Y might provide a glimpse of that of the future human's. In 1990, the mouse Y was reported to be 60 Mb; given that the human Y is 67 Mb, this would provide support for the degeneration of the Y. However, a 1999 study revised this number, claiming that the mouse Y is actually almost 95 Mb, larger than the human's [33]. The marsupial Y has been found to be about 10 Mb, significantly reduced in size compared to that of the human's. It contains no PARs, and therefore does not undergo homologous pairing or recombination with the X; this may explain why it is so small [34]. In contrast, the mouse Y does include PARs of about 0.7 Mb [35]. But this only makes up 0.7% of its Y, compared to the human PARs which encompass 5%. Thus, recombination with the X evidently does not explain how the mouse Y has managed to retain such a large size. Perhaps it has evolved some extremely successful compensatory mechanism, more efficient than gene conversion has been for humans.

Intuitively, it follows that if a gene is clearly essential for male development, function, and reproduction, then it cannot possibly disappear. The gradual loss of genes on the Y would inevitably lead to the loss of the SRY, which would surely mean the cessation of the male species, and thus of mankind. Not necessarily. The loss of the Y may not equate to the loss of the species if genes on other chromosomes could take over the job

of male development. The question is whether all the crucial genes on the Y could translocate or be recreated elsewhere before the Y vanishes completely. The existence of human XX males reveals that the SRY master switch is indeed capable of smuggling itself onto another chromosome[6]. These XX males are sterile, however, since they are missing all the spermatogenesis genes also located on the Y. This strategy would therefore only work if one by one, each crucial Y gene is relocated or replaced by an autosomal gene, facilitating the loss of the former. Step by step, the Y would become less and less necessary for male function[6]. In 1995, male mole voles were discovered to have no Y and no SRY. These burrowing rodents who live in the foothills of the Caucasus mountains have roughly equal proportions of males and females, meaning that they have managed to invent a new form of sex determination [36]. The discovery of the identity and location of a supposed new sex-determining gene is currently in progress. It could be an already known gene that has been altered, or a newly-created gene. Japanese spinous country rats are also Y-less and SRY-less [37]. These rodents may very well be a vision of the future of human sexes.

So why should anyone, other than researchers fixated on the topic, care about the degeneration of the Y chromosome? Even if Graves is on track and the Y ceases to exist in 10 million years, that is still a long time away. After all, humans have evolved from apes in less than that time. Dixie Mager of the Medical Genetics Department at UBC agrees that although the Y "will continue to degenerate, […] humans will likely have exhausted earth's capacity to sustain life long before the Y has a chance to change very much" [38]. So why then should it matter? The implications of the decrepit Y do, in fact, affect today's world. Intracytoplasmic sperm injection (ICSI) is becoming an increasingly popular procedure to help men with low or zero sperm counts father children. A few sperm are extracted from their testicles and injected into eggs, which when fertilized, are placed back into the woman's uterus [39]. Given that the fathers have fertility problems, there is a chance that their sperm carry defective Ys. Thus, such sophisticated assisted reproductive technology may well be contributing to the overall problem of infertility by allowing otherwise infertile and subfertile men to produce male offspring who will have the same problems as their fathers. Studies by Page have shown this to happen; genes controlling sperm production are able to be passed on to children via ICSI [27]. Therein lies the dilemma. There is an evolutionary reason that certain men have fertility problems. Spermatogenesis involves numerous checkpoints to ensure sperm quality during various stages of production[16]. If there is a flaw in the Y's AZF region, for example, no or few sperm would pass the checkpoints, and the defect would have a hard time being passed on. Enter ICSI, and sperm carrying imperfect Ys no longer have to fight uphill battles. Nature has disallowed men with Y chromosome abnormalities to reproduce, and there is evidently a price to circumventing this.

About one in 1000 men have azoospermia, while a staggering one in 30 have oligozoospermia[27]. As previously mentioned, 10 to 25% of these cases involve a Y chromosome mutation not present in their fathers. With the Y continuing to degrade, these numbers are expected to rise; with the explosion of ICSI use, they may inflate even further. Thus, attempting to circumvent male infertility may, at the same time, increase its incidence and speed up the

decay of the Y. Should this be taken into consideration by scientists? By physicians? By infertile couples? In the United States, up to 20 000 couples a year seek assisted reproductive technology to help them conceive; sperm production deficiency is the culprit in a fifth of these couples[27]. Page advocates that in these cases, genetic counseling is strongly recommended [27]. Thus the question arises of whether an infertile couple would continue to pursue conception via ICSI knowing that their son would have a chance of being subject to the same difficulties. Granted, not all forms of infertility or subfertility are heritable, but rather, only when the condition is Y-linked. Consequently, should all men contemplating ICSI be tested for Y chromosome abnormalities? Should Y screening be offered, recommended, or enforced? Should men who harbor mutated Ys voluntarily refrain from using ICSI? Should they be strongly advised by genetic counselors not to use ICSI? Should the government step in and legally prevent them from using ICSI?

These questions do not stray far from the current debate on the ethics of pre-implantation genetic diagnosis (PGD). This is a procedure available for prospective parents concerned about passing on genetically inherited diseases (of which they are carriers) to their children. The woman's eggs undergo in vitro fertilization, and embryos are grown to the 8-cell stage. At this point, one cell is removed and tested for a number of diseases; if affected, the embryo from which it originates is discarded[16]. PGD is intended to weed out genetically defective embryos before they have a chance to develop. In this light, defective Y chromosomes could be weeded out as well before they are passed on to male offspring; this would prevent the spread of infertility, as well as artificially select for perfect Ys, which may, in turn, slow down the decay of the Y. The dangers of such methods, however, are that they begin to sound a lot like modern eugenics. If PGD can be used to select against diseases, it can also be manipulated to select for certain "desirable" traits: fast metabolism, height, perfect vision. Then again, there are cases where a deaf mother and deaf father find a way to purposely select for a deaf child, purely because they consider deafness "a beautiful thing," as UBC medical genetics professor Robert Kay explains [40]. Similarly, infertile couples could want their sons to be infertile as well, for whatever reason. Graves proposes that Y chromosome manipulation could be used to control the possum pest situation in New Zealand forests; by engineering sterile male possums, the multiplying fertile ones would be driven out by competition [41]. No doubt, countries enforcing strict population controls may contemplate such genetic means on humans as well. Page has suggested that further knowledge on how mutations on the Y cause infertility can be used to create sterility at will; finding a way to antagonize the USPY9 gene, for example, could be used as a male contraceptive[28].

In the end, I am left with more questions than I began with. All I can do is scrutinize all the available information, however biased they may be, and attempt to form my own conclusions. I predict that the Y chromosome will continue to decay and lose genes. As this happens, male infertility will become more severe and widespread, whether this is assisted by ICSI or not. Before the Y has a chance to disappear completely, however, humans, as we know them, will have already left the earth. Perhaps they will have evolved into Y-less existence. Perhaps they will have become extinct. Or perhaps they will have been

brought to Judgment Day by the same God who created Adam in the first place.

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# SIX DEGREES OF BEING SMALL.

## By Trisha Cull

*The medieval followers of Aristotle, first in the Islamic world and then in Christian Europe, tried to make sense of the moon. It was suggested in Antiquity that the moon was a perfect mirror; its markings were reflections of earthly features.*

On Sunday July 16th 2000, the longest-lasting lunar eclipse in 140 years was said to have occurred. The moon plunged for almost two hours dead center through the shadow of Earth. The earth's shadow has two parts: the umbra, the dark space directly between the earth and the moon, and the penumbra, the weaker shadow that extends outward like wings off the northern and southern poles of the planet. Lunar eclipses are considered total when the moon passes completely into the umbral shadow.

It was said to have been bright red from the vantage point of Oceania, Australia and some places in the Middle East. I have seen pictures since, a globe of fire hovering upon the sea.
I was determined to witness this. It would only happen once in my lifetime.

We are defined by our smallness and our even smaller composite parts. Appendages and internal organs. Vestiges and embryonic slough. We hold our newborns to our breast. Epics have been built on metaphors for the heart. Yet we are continually in a process of regeneration. The skin we're now in will one day be part of a fine cosmic powder, adrift in a spray of butterfly dust. We exhale argon and carbon dioxide. Our next breath will contain more than 400,000 atoms of the argon that Ghandi breathed throughout his life. In one year, our own breath will return to us – call it karma – having circumnavigated the planet. We are continually in the process of inhaling ourselves. We are breathing in the Last Supper. We are breathing Christ. And Michelangelo. And Hitler too.

We are breathing.

The intensity of a lunar eclipse depends on how much dust and cloud is present in Earth's atmosphere. Total eclipses tend to be very dark after major volcanic eruptions.

We are small.

We navigate a jagged torrent of stars. We dig. We carve. Are we moving into or away from our shadows? We pass through looking for another side. We love. We hate. We procreate.

But Why? Perhaps to keep the body whole. Perhaps so we can say, *look, I am here, this is my planet, this is my city, this is my body, this is the result of my work. Or simply, this is my space, my darkness, my light.* Or is it random, a lifetime strung along a narrative of a thousand acts of kindness, equaled by a thousand random acts of terror? I wonder.

It's so goddamned noisy sometimes. It's so bloody bright out there. Someone right now is losing a limb. Someone is skinning a cat alive. A baby is soaring into a garbage heap. The oil fields are burning. A country is being tyrannized. The Anti-Christ is afoot. Yet so many people are making love. What's the point?

How small can we become before we are no longer here, before we disappear into the darkness, before the composition of our parts becomes irreconcilable?

A fine dust is settling and resettling over everything.

Here are six degrees of being small.

**one: conception (12:47am- moon enters penumbra)**

I once had a young gothic princess friend. Let's call her Kay. Kay and I danced by ourselves at retro bars. We danced in the twirling bright lights to techno music. Sometimes we were high from a white powdery drug called mescaline that we bought from a gorgeous French model called Majou. One night Majou and I went to an after hours bar. I sold five cigarettes to make three dollars for the cover charge so we could get in, but he was hot and the bouncer was a girl, so she let us in without having to pay anyway. I felt that my entrepreneurial efforts were extravagantly wasted. That's always pissed me off.

Kay had long red hair and could run very fast. When she smoked pot, she says she felt nothing extraordinary. There was order to her chaos. When I smoked pot, I heard doorbells ring and couldn't ever get the spider webs off my hands. I needed her. She was my dearest friend.

One hot summer afternoon Kay called me to tell me she was pregnant, more than two months along. She was crying, which is a significant point because she never cried. Kay never cried at anything. Not even when things were bad in Junior High. Not even when she was sure no one loved her. Once, we took some of her step-dad's weed and rolled it inside our report cards and smoked it on the banks of the Nechako River. This is particularly funny because it was meant to be an act of rebellion, but we both always made Honour Roll. We stared out across the milky water. The stiff blue paper burned. We inhaled. We exhaled. She didn't cry.

But she cried when she found out she was pregnant. *Holy shit*, she said, or something like that. I can't remember exactly. It was more the cadence of her voice, strung weak as a thread in the wind. She was adrift. There was nothing to hold onto. A baby was growing inside her. The baby was small, a fetus really. Her periods stopped under the cycles of the moon.

Kay and I were twenty-one. We traveled a little ways across the Pacific, through the Gulf Islands then farther into open sea. A doctor waited in the city. You had to go to the city to have an abortion so far along. We stayed with my mother in her house in the valley. My mother helped us – as mothers often do – but she would later tell me she thought it was wrong.

Hardness overcame Kay.

But she seemed enthralled with her own despair. She sat by the window on the ferry and gazed out at the islands, gently rubbing her belly. *I wondered why my pants were getting tight*, she said.

*Are you sure you want to do this?* I said.

We exist on the premise of Immaculate Conception. Everything. Everything. Only happens once.

"An ineffable explosion, trillions of degrees in temperature…created not only fundamental subatomic particles and thus matter and energy, but space and time itself" (Marcus Chown).

I believe Christ was the first subatomic particle created, in a manner of speaking, when the universe began. And later, a star ripping across the sky. And later still, a man.

**two: love (1:25am- first shading visible)**

I believe it's in the interval just before our most horrendous acts and the acts themselves that true love presides, the moment before you do the worst thing you've ever done and the thing itself. Before the knife hits the flesh. Before the fetus is cut out. The moment before eclipse.

It is such a small space in time. To love.

Quantum theory suggests that the universe was created $10^{-43}$ seconds after the Big Bang. "The Fire of Creation began with the sun filling the sky, bursting into the star-pricked blackness of space with a pyrotechnic spectacle of shifting, scorching images" (Brian Swimme).

I believe if love existed outside the context of an equally appalling hatred – or rather, lack of love – the universe would implode. About 13.7 billion years ago, the universe was compressed into the confines of an atomic nucleus. This was the moment before creation, before the Big Bang. Before space and time.

Before love. And hatred too.

I would not have done what Kay set out to do, I tell myself. But then, I have done other things I will never forgive.

Sometimes I dream I am a mother. But always in my dreams my babies are small non-human things, or they are human but miniature manifestations of human. I recently dreamed that I was mother to a small orange kitten. I found it inside a rabbit cage on a porch. A rabbit was gnawing at it though the wire. I picked up my kitten and held it belly up cupped in my hands upon my lap. I loved it, but it was a kind of despairing love because my kitten had patches of fur missing, and its eyes were incredibly small and looked cloudy. I thought if I touched its eyelashes they

would crumble.

It loved me too.

**three: hatred (1:57am- partial eclipse begins)**

I believe it is also in the interval just before our most horrendous acts and the acts themselves that hatred presides, the moment before you do the worst thing you've ever done and the thing itself. Before the knife hits the flesh. Before the fetus is cut out. The moment before eclipse.

It is such a small space in time. To hate. We turn it on ourselves, our bodies, in an effort to remove the enemy from inside.

The night before the abortion we sat on the deck overlooking the park. In the distance- beyond a knoll of green grass and a fringe of Willow trees – a lake gleamed under moonlight. Just then a mother raccoon and three baby raccoons emerged from the darkness and waddled across the lawn. It was uncanny, one of those coincidences that leans toward synchronicity – magic – as if an event was enacting itself in triplicate before our eyes in order to counter a more singular act of annihilation.

Life counters death. Nothing can be created or destroyed. That kind of thing.

Kay lifted her shirt to expose the slight curve of her belly.

*Feel*, she said.

I could have sworn I felt a movement, something like a small fist, or perhaps it was the movement of the raccoons in the dark that persuaded me to think so.

One might argue that hatred is the embryonic slough of stellar decay, what happens when we attempt to annihilate an equal and opposite other – a proton, a star, a soul – only to find the process has long since been in progress for us. Hatred is perhaps our futile attempt to rediscover its equal and opposite counterpart. It exists on the periphery of divinity, to the left of light, to the right of darkness, just a little off center of a perfect eclipse.

We stab it in the throat or heart. We slice it up the middle.

**four: sex (3:02am- total eclipse begins)**

We procreate.

In the beginning it was neither dark nor light, but now, as Swimme says, we are children of the sun, accumulating cosmic energies and transforming them into matter. One small part coalesces

with another in order to create a whole.

Perhaps it's an instinct – part of the cosmic plan – that kicks in the older you become and ushers in a sense of mortality. A voice nods unintelligibly in some obscure direction just off your periphery. It rests a hand gently on your shoulder and urges you forward. It whispers. *This is not about love. This is about creating from your own physiology an example of what you are in the universe, a template, a rough carbon copy, a proton, an electron, a version of yourself. Go. Procreate. You will never be alone.*

And it feels good.

One night, months after the abortion, I got up in the middle of the night and saw two figures moving in the dark. It was Kay and another man we both knew, the two of them straddled together on the couch. She was riding him. His hands grazed her white back. Her red hair was on fire. Their bodies eclipsed the light of the moon shining in through a window behind them, and I did not think it then, but now I do, how everything leads simultaneously toward destruction and creation at the same time, how from our greatest acts of pleasure an equally post-coital darkness ignites.

We begin again and again.

**five: war (3:56am- mideclipse)**

An eclipse like this one would not occur again until sometime after the year 3000. Its duration was brief, the moon kept moving, and the night sky re-aligned itself. But in the interim, a war between light and darkness was fought.

I walked outside on July 16th and there was nothing but a dark ridge of clouds. A light rain fell.

The future unfurls along a string of cosmic beads. Will this future be regarded one day as a multitude of many small wars or one enduring one? What will the moon look like then? And conversely, the sun?

In eleventh grade a holocaust survivor came to visit our class. He was an old man, but he was not as old as I had expected him to be. I had expected him to be so old as to be near death, somehow only remotely human, as if his untold terrors had happened to another similar man in a lifetime so far from mine they might not have happened at all. But there he was, a byproduct of war, dressed in a brown suit and tie and carrying a small black case, as if he had decided he would carry his memories with him in a physical vessel because to keep them in his mind would be too dangerous.

A person can be torn apart by certain things, like a star ripping a rift across the cosmos, thus forming a portal, a gateway, a galaxy, sometimes a black hole. It is better to carry it beside you. It is better to keep it small and identifiable. It is better to give it a name than to keep it inside.

Sun. Moon. Earth.

The universe has not forgotten the gash we've carved into her, the chronology we've assigned her, how we shook her from her coalescent sleep and sent her scattering across a new continuum. And the old man had not forgotten what had happened to him either.

Jew. Nazi. Krakow.

Inside the case was an antiquated slide projector reel and an assortment of slides. We turned out the lights and watched as one by one he explained the meaning of each frame, most of which bored me. I don't remember what he was talking about, but his accent was thick. He came to a picture of a Nazi officer dressed in SS uniform. The officer sat casually in a lavish looking office, which was decorated with rich leathers and ornate furniture. I recall the look of confidence on the officer's face, or perhaps it was pride, and his stature and good looks.

The old man paused on this frame and became quiet. As he was speaking his voice broke, and he could not speak anymore. We paid attention.

*You see the lamp in the corner?* he said. *The shade is made of Jewish skin.*

The universe was once a solid nucleus. We are the product of an old and gigantic stellar collision. We are the product of opposites. We are the product of minuscule accidents, matter pitted against anti-matter. In the beginning, "for each billion pairs of particles that were created, one was spared annihilation due to particle-antiparticle collisions" (Swimme). Whatever was left after these small collisions occurred was the constitution of the universe, of which we are a small part- our bodies and minds, our skin.

It's the same with men. Every Christ has an Anti-Christ. Every Jew had a Hitler. Islam has America.

War is the most crass representation of what one person might do to another- on a quiet street, let's say – if an irreconcilable difference comes between them. Each party believes he is right; there are infinite degrees of perspective. But from the point of view of a moon-dweller, our lunar eclipses will be solar instead. The moon dweller will see a disk of the sun partially concealed by Earth. From within the umbral shadow, he will witness a total eclipse of the sun.

We look outward, blinking. The flesh is thick from so deep inside the womb. But what lies beyond that layer of skin but a sphere of electrons and a vaguely identifiable lamplight?

**six: death (4:49am- total eclipse ends)**

I imagine a black blanket pin-pricked by a multitude of lucky stars. I imagine a childhood science project, my creation of the solar system in a box covered with tin foil – and inside, darkness and

planets hung from wire.

Sometimes I dream I am a mother. In my dreams my children are getting even smaller. I once dreamed that I was the mother of an inchworm. You know, the little green worm about half a centimeter long that moves along the surface of a leaf by bringing the back end of itself all the way to where its body begins, so inch by inch it goes, in and out again. If I ever have a baby in real life I will love it as surely as I loved that worm. This is true. But the horrible thing is, my babies in my dreams- whether they are inchworms or miniature people or kittens and so forth- are always slipping through my fingers. So many times I have lost them completely, in the folds of a blanket or in the fibers of a shag carpet, and sometimes I wake up sweating because I am sure I have squished my baby into nothingness against my own skin. I am so big, you know, and inchworms are so small. And while this is strange – no doubt – there was no mistaking my love for the thing.

When the universe was one hundredth of a second old, neutrons began to decay. This allowed electrons and protons to combine with other particles. "The cosmos began: in a single Big Bang, matter coalesced, and the stars turned on" (Swimme).

I believe that's love.

We are tortured by our singularity. We don't know what to do with our children because somehow we know they are in the end not an indication of our communion with all things, but rather an indication of our infinite isolation. There will always be another chromosome to splice, another cosmic collision, and so, we begin again.

We unfurl our suckling progeny into the dirt. Dust flies. We breathe. We are small.

A fine dust is settling and resettling over everything.

# THE COMPASSES OF BIRDS.

## By Bethany Lindsay, images by Jen Philpot

Twice a year, arctic terns make an epic journey. They travel the length of the Earth, from breeding grounds in the high Arctic to their southern habitat in Antarctica and back—a one-way distance of almost 20,000 kilometres[1].

This migratory pattern allows terns to follow their food, and escape extreme winters at both ends of the globe. They also avoid the central latitudes, where the predators are. They have every reason to make the trip, but how do they manage the navigation?

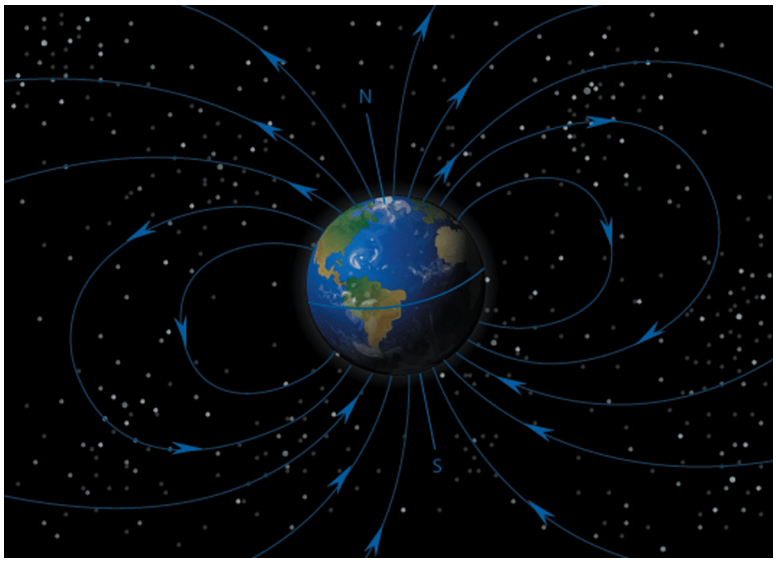
One popular suggestion is that the Earth's natural magnetic poles help to guide birds in their migrations[2]. How they manage to detect those poles is more difficult to determine.

One theory posits that certain birds' brains contain magnetite, otherwise known as iron oxide[3]. Magnetite is a naturally occurring magnetic compound that has been found in animals ranging from bacteria to mammals[4]. With physical magnets in their brains, birds would be able to detect the magnetic fields created by the North and South Poles. Magnetite has been found in the upper beaks of several birds, but until recently, there has been little evidence that the substance is connected with navigation[5].

Late last year, a study published in Nature presented evidence that some birds do navigate using magnetite. Homing pigeons earned their name through an ability to "home" in on their lofts, and return to them from hundreds of miles away[6]. It's not exactly migration, but the distances are comparable.

Homing pigeons had long been thought to navigate either by scent or magnetic attraction. In

the latest study, researchers found that they could train pigeons to recognize when an anomalous magnetic field was present—the birds would hop to one end of the cage when the field was normal and to the other when the field became abnormal[6]. In other words, they were detecting differences in the magnetic field.




The pigeons were left to try the same trick with magnets attached to their upper beaks, and could no longer perform the stunt[5]. They also failed when their olfactory cavity (the proposed location of the magnetite) was frozen. Everything that occurred in this study had been seen before in rainbow trout, a species that manages migrations of incredible distances using magnetite found in its olfactory cavity[7].

But if pigeons use magnetite to navigate, they may be an aberration among birds. Most other evidence seems to point to a different technique for sensing poles.

This alternative technique is called a radical-pair mechanism. It is a complex idea that involves electrons spinning around a nucleus in an atom. Electrons come in pairs, and each pair is given an orbit around the nucleus. The two electrons spin in opposite directions—one up and one down, or one north and one south. Each of the electrons is essentially is own magnet, but they neutralize each other's effects[8].

But free radicals, formed when larger molecules split, do not have a complete set of electrons. One of the electrons is unpaired. These molecules are unstable, and they react quickly with other molecules to form compounds[8].

When two free radicals come together to build a new molecule, they're constrained by the directions that their unpaired electrons spin. If one has an unpaired "up" electron and the other a "down", there's no problem. The electrons are balanced and the radicals will fuse seamlessly[8].

If both unpaired electrons are "up", on the other hand, the result is much like trying to touch the

"north" ends of two magnets together. One of the electrons needs to change its direction—not a simple matter, but not impossible, either[8].

Merging the two radicals becomes more difficult when an external magnetic field is applied[8]. In the radical-pair hypothesis of bird navigation, birds detect the magnetic pull of the North and South Poles by sensing the relative effort of creating stable molecules from two free radicals.

Scientists are able to differentiate between magnetite and radical-pair mediated magnetism in animals because radical-pairs are sensitive to very weak magnetic fields. Weaker fields are dampened by the cellular environment that surrounds magnetite particles, so the fields cannot be detected[9].

In a recent experiment, European robins were conditioned by simulated light conditions to believe that it was time for spring migration[9]. The birds were restless and eager to fly in a northerly direction.

However, when the birds were exposed to weak magnetic fields, they became disoriented and began to fly in all directions. They only faced north when the simulated field was parallel to the Earth's own magnetic field[9].

The simulated fields were more than 600 times too weak to be detected by magnetite particles, suggesting that radical pairs were involved instead[9]. The scientists did caution that both the radical-pair mechanism and magnetite could be involved in European robin migration.

For a radical-pair mechanism to work, of course, birds need to have radical pairs in their bodies. This may be accomplished by the changing daylight hours during migratory seasons. Both visible and ultraviolet light can produce free radicals.

The proper light conditions are essential for bird navigation. Birds can't orient themselves correctly in yellow light[10], or in red light without lengthy pre-exposure[11]. Exposure to blue or green light is necessary for birds to begin migrating in the correct direction[10].

The complete theory is that light in the blue-green range excites molecules to create free radicals, which in turn begins the process of magnetic field detection. In plants, cryptochromes are the receptors for blue-green light, and many of the molecules within them will split into radicals when struck by light[12].

Birds are thought to use cryptochromes in some part of their heads to sense magnetic fields. Birds will often turn their heads from side to side a few times before flying off under normal conditions. When an abnormal magnetic field is present, they twist their necks as many as triple the number of times before take-off[13].

Several cryptochromes have been found in the retinas of birds, and a few of these are exclusive to migratory species[14,15]. Garden warblers, a night-migrating species, have particularly high concentrations of a specific cryptochrome located in specific nerve cells that are very active at

night, when the birds need to orient themselves[15]. Another cryptochrome found in the same species concentrates in an area that is connected to neurons that are sensitive to magnetism[15].

Birds appear to be using a radical-pair mechanism, mediated by light sensing cryptochromes in their eyes, to sense magnetic fields and keep themselves pointed in the right direction during long migrations. Experiments have also shown that birds recalibrate their compasses once a day to insure that they are flying in the correct direction[16].

The mystery of bird migration probably doesn't have a simple solution. For migratory birds, travels across land and water seem to be complicated processes involving spectrums of light, electron excitation, and constant recalibrations.

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# WHO IS THE GREATEST SCIENTIST OF THEM ALL?

## By Patrick Francis

Who is the greatest scientist of them all? With no objective way of comparing scientists from different disciplines and eras the debate has raged for time immemorial leading to more than one disagreement, most notably the 1982 Falkland Islands war which began when Margaret Thatcher refused to even consider General Leopoldo Galtieri's claim that Jonas Salk was one bitchin' scientist. Luckily modern society has produced the perfect measure of a scientist's greatness: the no holds barred cage match in which combatants are locked in a steel cage and exhorted by blood thirsty on-lookers to fight until only one remains standing. History's greatest mind has now been decided via a single elimination cage match tournament from which one undisputed champion has emerged bloody, unbeaten and victorious over 31 other aspiring savants.

Tragically the tournament was marred almost as soon as it began by a devastating explosion that destroyed half of the Midwest regionals. Einstein, widely regarded as a lightweight in the competition due to his strong pacificism and the incomprehensibility of his work with general relativity, seemingly fell victim to his hereto-unknown competitive streak and snuck a small nuclear device into the cage; detonating it in the middle of his match-up with Descartes. The ensuing explosion killed not only Descartes and Einstein but also Rutherford and Copernicus who were to fight next in a highly anticipated contest. After an agonizing debate, the tournament's organizing committee decided to continue on with the competition saying, with a reportedly straight face, "…while the accident has been a tragic waste of life the tournament, by finally laying to rest who is the greatest scientist of all-time, will no doubt save countless future lives."

Outside of a minute of silent remembrance prior to each remaining match-up, the first round was generally unremarkable. In particular Newton's victory over Dalton and Arrhenius' win against Stokes were dull, lifeless affairs. Even the forecasted jewel of the first round, Galileo v. Watson & Crick, failed to live up to its billing as the discoverers of the double helix couldn't quite put their much ballyhooed theoretical work in the area of Brazilian jiu-jitsu into practice and were thoroughly whipped by Galileo in a bout lasting only 2 minutes.

The only truly memorable opening round fights were the shocking upset of Mendel by the unheralded Alexander Fleming and the disqualification of Niels Bohr. Disheartened by having his work on the inheritance of traits in pea plants go largely ignored during his lifetime, Mendel seemed despondent and only landed a handful of lackluster blows before finally succumbing to the inspired performance of the discoverer of penicillin. In the oddest match of the day Bohr was disqualified after being charged with spitting at Linus Pauling. It was a disgusting lack of sportsmanship that was uncharacteristic of Bohr, generally regarded as one of the more gentlemanly scientists. In a tear filled post-match press conference Bohr blamed his actions on the stresses associated with quantum theory as well as a diet-pill addiction.

The tournament lived up to its hype in the second round with an epic fight between Newton and Pauling. Many pundits had these two men as contenders for the crown and it was only due to an unlucky draw that they had to fight so early in the tournament. It was a tight fight throughout with both fighters showing moments of sheer brilliance and dazzling creativity. Pauling began the match by introducing Newton to the concepts of electronegativity and hybridization. This clearly intrigued Newton who stopped his advance and began to stroke his chin thoughtfully allowing Pauling to reach into the crowd and retrieve his Nobel Peace prize, which he then used to beat Newton about the face. Newton was able to escape the blows and amazingly climbed to the top of the cage before dropping onto his stunned opponent while screaming, "Eat gravity!" This was the beginning of the end for the author of the seminal work The Nature of the Chemical Bond as he was pinned moments later.

In another clash, Darwin was upset by a tenacious Pasteur. Darwin had shown both grace and athleticism in his first round victory over Ptolemy but against Pasteur he seemed disorientated and made frequent attempts to escape from the cage before ultimately falling to the Frenchman who accentuated his victory by standing over the father of evolutionary theory and exclaiming, "You've been Pasteurized!" Later, his coach explained that Darwin had insisted on employing a multi-generational breeding strategy whereby he and his offspring mated with the world's toughest women. Darwin felt that this strategy, combined with a smear campaign that claimed Pasteur suffered from syphilis, was unbeatable. Unfortunately Darwin's coach was unable to convince him of the plan's shortcomings, most notably its overly long timescale.

The shock of the day was the emergence of Marie Curie as a force to be reckoned with. After a boring first round victory over Volta, Curie seemed to have transformed herself overnight into a charismatic and stylish fighter. Displaying a fighting technique that could only have been developed after repeated and careful viewings of the Karate Kid trilogy, Curie was able to completely dominate Werner Heisenberg who, when he was able to locate his fleet-footed opponent, seemed to consistently misjudge her momentum. Curie's precision attacks and lightning fists wore down the befuddled Heisenberg, an early favorite after his clinical dismantling of Linnaeus, and her whimsical approach to the match made her a fan favorite; at the end of the bout, with the great German lying unconscious in a bloody heap, Curie took the time to sign autographs and tenderly blow a kiss to an ardent fan who had earlier yelled out a marriage proposal. She then returned to business, laying a bone-crunching pile driver into the prone physicist's lower back.

In other action, the Leakey family was too much for Galileo to handle. While the later displayed some grit and hustle he was outnumbered and tired visibly over the duration of the battle, finally falling to the threesome as Faraday had before him. Freud also progressed with a rather pedestrian victory over Arrhenius, which, because of the first round tragedy, put him directly into the semi-finals. Other winners on the day were Mendeleev whose sheer power garnered much attention and Planck who, in a slight upset, defeated Aristotle. It was later revealed that the Greek philosopher had been suffering from a stomach flu ever since his victory over van Leeuwenhoek the day before; this could have affected his performance.

The quarter-finals saw some great grappling. In particular the fight between the Leakey family and crowd favorite Marie Curie was a battle for the ages. Curie came out strong and, in stark contrast to Galileo who focused all his efforts on Louis, employed a strategy of attacking whoever was within striking range. Seemingly garnering strength from her numerous supporters in the crowd, most of whom were wearing "Marie Curie: Rocking the Bitches since 1867 " t-shirts, Curie was able to knock Louis unconscious near the end of round 3. Curie continued her onslaught taking down Richard with a swift kick to the head and things looked bleak for Mary. However, just as she had discovered Parathropus boisei at Olduvai gorge, Mary found some hidden reserves of energy and began to turn the tide on Curie eventually defeating her in what had become a marathon match. Even with their sweetheart defeated the crowd was unbowed in their support for the great lady and cheered wildly when she raised a defiant fist from the stretcher that was carrying her from the arena. On a curious note Freud was seen in the crowd furiously scribbling down notes throughout the battle.

On the other side of the bracket Planck faced Mendeleev in a comparatively toned down affair. Planck in particular looked tentative as an ankle injury picked up in his opening match against Avogadro was clearly affecting his movement. It also became increasingly apparent that Planck would have rather been wrestling with the implications of the statistical nature of the second law of thermodynamics, particularly the finite probability that entropy decreases over time in a closed system, than with the powerful Russian. For his part Mendeleev showed awesome concentration and focused all his attention on his opponent as opposed to the ordering of elements by their atomic weights, finishing the bout by lifting Planck above his head before throwing him against the side of the cage with tremendous force.

In the final contest of the day Pasteur was thoroughly outclassed by Newton. Ironically Pasteur, who had spent the lead up to the fight telling anyone willing to listen that he was going to "beat down Newton just like I beat down the theory of spontaneous generation" and had developed a reputation for arrogance, was unsure of himself and in the infrequent moments when he seemed to gain the upper-hand was unable, or unwilling, to press his advantage. In the end Newton emerged victorious after a powerful blow to the knee sent Pasteur to the mat for good.

The semi-finals showcased both the ability of men of science to think creatively and their skill at hand-to-hand combat. The first match was between the Leakey Family and Sigmund Freud. In the lead up to the tournament Freud had had to deal with many critics who questioned his status as a true scientist and he felt that this was his chance to show just what Psychology is made of. It was expected that Freud would stick with the Greco-roman wrestling that he had used to much success versus Archimedes and Arrhenius; however, he shocked the crowd by instead deploying a cunning combination of psychoanalysis and hypnosis. The Leakeys seemed confused by this surprise tactic and took up a defensive posture from the outset. Slowly, over a period of hours, Freud was able to break down some of the family's barriers and was able to get them to open up. Louis, in particular, was an enthusiastic participant in the discussions and at one point started to relate his dreams. The final blow came when Freud deployed his Oedipal theories;

this left the family in tears, unable to go on with the fight.

The other match-up was an exciting contest between Newton and Mendeleev. The latter, wanting to finish the fight quickly, opened with a series of powerful blows and did not let up for the remainder of the fight. By the sixth round it seemed Mendeleev's potent attacks were wearing down Newton's defenses and when the round ended it came as a great relief to Newton who looked to be on the verge of defeat. As the 7th round began Mendeleev made a crucial error and taunted Newton, declaring that Leibniz had in fact been the true progenitor of calculus. Upon hearing this, Newton flew into a rage and flung himself at the startled Mendeleev who, realizing his mistake, was powerless to stop the enraged physicist and quickly succumbed to the onslaught, turtling in a corner of the ring. It was a pathetic display from a man rumoured to have trained for the competition by wrestling bears in his native Siberia and the referee quickly put an end to the fight. Newton, still visibly upset, charged out of the cage and stormed into his dressing room where he reportedly caused several thousand dollars worth of damage.

And so from a field of 32 two emerged to battle for the title of history's greatest scientist: Sir Isaac Newton and Sigmund Freud. Worthy competitors who, over the course of the tournament, had truly shown what it takes to be a great man of science: a single-minded drive to uncover the truth and a high pain threshold. Once again Freud opted for a new strategy, opening the match by serenely stating one of his many contributions to science: "Complications during birth are not the cause of cerebral palsy but rather a symptom." Intrigued, Newton retorted by simply naming one of his inventions, "the reflecting telescope."

Freud countered with, "Psychoanalysis," to which Newton replied, calmly, "the law of cooling." Freud, by this point sweating and uncomfortable, then tried a multi-faceted attack, "the id, ego and superego as well as the concept of the unconscious." This attack was brushed aside easily by Newton with the powerful rebuttal, "binomial theory, the laws of motion and conservation of momentum." Freud was clearly shaken by this latest blow but the worst was yet to come as Newton, in a clear voice, declared, "And gravity." With that the crowd erupted and Freud staggered backwards.

Freud then abandoned his initial strategy, tore off his spectacles and tweed jacket revealing a brightly coloured spandex body suit with yellow lightning stripes down the side and threw himself at Newton whose frilly shirt and heavy shoes clearly hampered his movements. Initially Newton seemed shocked at this onslaught, but, just as he had no trouble besting Freud's achievements, the part-time alchemist was easily able to deflect the Austrian's weak attacks. As it became more and more evident that he was thoroughly outmatched, Freud became desperate, finally pointing behind Newton and exclaiming, "Look, the Holy Trinity!" Newton did not fall for the cheap tactic and responded by placing Freud into a sleeper hold from which the psychologist never escaped. As Freud slipped unconscious from his grasp, Newton raised his arms triumphantly and placed the ceremonial garland about his neck basking in the adulation of the cheering crowd who rose as one to applaud history's greatest scientist.

# ELSEWHERE AND OVERHEARD

## By Caitlin Dowling

### Overheard

*"The men are usually very surprised, but the babies seem content."*
Caroline Flint of the Royal College of Midwives in the UK, on how babies often suckle their fathers instinctively, as well as their mothers. (Times Online)

*"If there was an Olympic team of Bynoe's geckos, there wouldn't be a single male on it. These geckos outperform their sexual relatives by 50 percent. They are the 'Xena: Warrior Princess' of the lizard world."*
Kellar Autumn, on the Bynoe's gecko, an all-female line of lizards that clone offspring just as strong as their relatives.

*"It looks like the animals use the sponge as a kind of glove... It might just give them protection against some noxious critters hiding in there."*
Michael Krützen, of the University of Zurich. His study shows that dolphins use a sponge to help them find fish on the sea floor, a technique taught from mother to daughter.

### Elsewhere

Trust me, I'm spraying you with hormones (New Scientist)
(http://www.newscientist.com/article.ns?id=dn7451)

Sheep urine cuts pollution - That's fubaaa (ananova.com)
(http://www.ananova.com/news/story/sm_1424428.html?menu=)

6 minutes of exercise is as good as 6 hours? Halleluljah!
(http://www.ananova.com/news/story/sm_1420260.html?menu=)

'Ice volcano' found on Titan Moon (BBC)
(http://news.bbc.co.uk/1/hi/sci/tech/4074186.stm)

# IMPERATIVE AND INDIFFERENCE.

## By Alison Dowsett

Like some animal licking matted fur, the softness of the tongue on the softness of the wound.

The sum of the wounds is a ball that expands according to its own clock, whenever it damn well pleases. Asserts itself always at the beginning of the day, I wake up to it, chattering its bad news into the ether.

The ether is created by the imperative of the system; by the whoosh of blood and air through the tunnels of the body. This intent movement, going places, distribution.

I lay on my bed trying to attach myself to the imperative of the system. To its triumphant design. Pretending to understand how I fit into the world. I am caught by the inertia of the ball. Weighted by my gut.

Women, and I suspect some men, are not built for frenzied non-stop sex with a lot of partners. Women actually let people inside their bodies when they have sex. Have you ever had a house guest? That feeling when you see their alarm clock next to your bed or their socks bunched up on the floor.

Does anyone ever think of what we take on when we fuck? Or what we leave behind? We see the animated meat before our eyes; the slick swelling of flesh and the miraculous sensation of all consciousness surging to the genitals. But the protein on protein aspect of sex, does anyone ever think of this?

If you've ever been present after a birth you will know this. Having gone through the anticipation, the little foot kicking out at the side of the stomach like some kind of pointed gas bubble. Once the baby arrives you are faced with the strange imperative of sex. The proof that something has happened as a result of letting the guest in.

The oscillating proteins. Have you ever tasted caviar? Pressed the beads against the roof of your mouth with your tongue, that richness. Scrambled eggs are never the same. And the infant, fish-like but with no sense of grace or light, blood-matted hair and fingers exploring an oxygen-filled dimension for the first time.

In these first moments outside the creature becomes human. Humanness defined by air and light. Then you recognize the chin as belonging to your uncle.

If this is the biological imperative of sex then what on earth is happening when biology is sidestepped by people like me? People that don't wager pregnancy. People that don't deal in free-ranging sperm. People just having sex for the sheer sake of hormones. What on earth are their cells doing?

# NEW (THIS TIME AROUND) CONTRIBUTORS

Trisha Cull is a recent graduate of the MFA Programme in Creative Writing at UBC. Her poetry, non-fiction and photography has appeared in various literary journals, such as Room of One's Own, Descant, Fugue and Wreck. In 2004, she was honoured to receive the Earle Birney Scholarship in Creative Writing.

Alison Dowsett studied creative writing at UBC. She is working on her first book, a graphic novel, and is conducting studies into the emergence of plant consciousness in humanity.

Patrick Francis is freakishly strong. However, his fighting technique is almost as bad as his dancing and so he would probably perform poorly in any sort of cage match. Also, he likes pie.

Julie Hathaway recently graduated with her B.Sc at UBC, and is probably much more exciting than this bio. Sadly, that is our fault as we asked for it much too late.

Bobby Henderson is 24 years old, having recently graduated from Oregon State University with a Physics degree. He is also very much unemployed, and it is clear to him (at least in the US), the ability to think is not required, or even a desired behavior. Furthermore, he believes that pursuing work which intends to improve the condition of the world is a dead end scenario, both career-wise and financially. For that reason, he feels strongly that his best chance for "success" would be to open a one-stop shop for liquor, lottery tickets, and perhaps a spot where patrons can pour oil on trapped animals. Of course, maybe he's just overreacting.

Andrea Lam will be entering her fifth and final year at UBC, completing a BSc in Integrated Sciences and a BA in English Literature. In addition to her academic life, she enjoys playing the piano and organ, working with children, and trying new foods. Her interests range from medical genetics and Darwinian medicine to 19th century fiction and Harry Potter.

Kara Stanley is a graduate of UBC's MFA Creative Writing Program. She is currently hard at work finishing up her first novel gutbucket thunder. "Child's Play" originally appeared in Fugue.