

Table of Contents

What Comes Naturally	325
➤ Optimal Planets.....	325
➤ Hospitable Planets	325
➤ Habitable Planets	325
➤ Unpleasant & Hostile Planets	326
➤ Low Population Colonies	326
➤ Cabin Fever	326
Math Exercises	326
Natural Assumptions	327
➤ Senescence	328
Everyone has a Venus	328
➤ No Mars Light.....	329
Minimum Viable Population	329
➤ Inbred Populations.....	330
Moving Parts	331
➤ Headroom & Legroom.....	332
Endnotes	333

See Appendix T&C – Taxation & Census Example

“The onset and progression through the various stages of puberty are influenced by a number of factors. In both animals and humans, the age of puberty appears to be related more to body weight than to chronologic age. Undernutrition and low body fat, or an altered ratio of lean mass to body fat, seem to delay the adolescent spurt and to retard the onset of menarche....”

Poor nutrition alters the ratio of lean mass to body fat and delays the onset of menarche. In the US, the age at menarche decreased by 3 years since 1840 due to improvements in the population’s nutritional status. Underweight females generally experience menarche at later ages than normal weight females. In contrast overweight females often experience menarche earlier than the average weight female. Athletic females and ballet dancers frequently experience late menarche, and these delays may be due to the disruption in fat accumulation which results from excessive exercise. Physically, inactive adolescents, on the other hand, tend to experience menarche at an earlier age than normally active females. In conclusion, the body’s fat content along with a variety of environmental and psychosocial factors are responsible for the development and maintenance of female reproductive functions.”

– E.R. Baker, “Body weight and the initiation of puberty,” (abstract at <https://www.ncbi.nlm.nih.gov/pubmed/4053451>), Clin Obstet Gynecol. 1985 Sep; 28(3):573-9

What Comes Naturally: The Census only affects Friendly and Naturalized Colonies owned by the position that activated the Census Power. Conquered and Converted Colonies never ‘grow’ population (Converted Colonies *do produce* during taxation), nor do populations currently located on Colony Ships or Orbital Cities grow during the Census. The growth of populations during the Census¹ depends on the Habitability Class of the colony planet and the amount of population present at the beginning of the Census. Additionally, for the purposes of Naturalized Colony growth, it is important to remember that Habitability Class depends entirely on the Native Population Type of the colony. Thus, while the owner of the colony might see their planet as Unpleasant, the alien population might regard it as an Optimal Planet and grow accordingly.

- **Optimal Planets:** Population located on planets that their Native Population Type considers Optimal will increase at a rate of one per 5 population factors present at the beginning of the Census (i.e. 20%).

The growth rate for populations on Optimal Class planets would mirror the growth rate of the population on their industrialized origin planet before the game. Consider that the human population of the Earth near the end of the Middle Ages might have been *half a billion people*; whereas, 500 years later, despite wars, plagues, famines, and disasters (as Thomas Malthus noted), the population of the world had multiplied 14 times to *seven billion people!*

- **Hospitable Planets:** Population located on planets that their Native Population Type considers Hospitable will increase at a rate of one per 10 population factors present at the beginning of the Census (i.e. 10%).
- **Habitable Planets:** Population located on planets that their Native Population Type considers Habitable will increase at a rate of one per 20 population factors present at the beginning of the Census (i.e. 5%).

- Unpleasant & Hostile Planets: Population located on planets that their Native Population Type considers Unpleasant will grow by 1 population factor, regardless of the total population of the planet. On Hostile Planets, no population growth occurs; living in camps and domed cities doesn't encourage growth, at best, those populations simply replenish their numbers and deliberately maintain a zero-growth condition to avoid overburdening the precious environmental systems. Zero growth in this situation is not a Disruption Event.
 - ✓ In a perverse way, dumping population onto Unpleasant and Hostile Habitability Class planets is a means to curb runaway population growth (e.g., if the position is required to activate the Census Power). This is entirely consistent with what natural science says about the effect of environment on evolution and viability of species, and on the arguments about climate change/global warming: We may be wiping out thousands of species (see Sixth Mass Extinction Event Excerpt, this section) and making the Earth Unpleasant even to us, curbing our own runaway population growth.
- Low Population Colonies: Colonies whose total *planet surface* population at the beginning of the Census is below the threshold level for growth based on their Habitability Class will grow at half the normal rate each Census until they reach the threshold. Fractions will be rounded up. For example, a colony on a Habitable planet that has 10 population will grow one population factor each Census, until the colony reaches 20 population and then will continue growing at the standard rate set for the Habitability Class of the planet.
- Cabin Fever: Population located on an Orbital City (or Colony Ship, see Colonies in a Can, 3 Expansion, p. 913, *infra*) during activation of the Census Power does not grow. This is *not* a Disruption Event, see Peaches for Mad Molly, 2 Disruption, p. 273, *supra*. Orbital Cities both allow a colony to exceed the planet's Maximum Habitability (see Dayworld, 3 Taxation & Census, p. 315, *supra*) by up to half of the original Maximum Habitability and as a means to stymie runaway population growth if the position is required to frequently activate the Census Power (as a result of either a Fundamental Reality or Government Title).

“It is a feeble population that cannot double itself every generation if it tries.”

– Frederik Pohl, “The Deadly Mission of Phineas Snodgrass,” *Galaxy Magazine*, No. 20, Vol. 5, pp. 5-8, June 1962 (available free online)

Math Exercises: “The Deadly Mission of Phineas Snodgrass” is a 3½ page math exercise in runaway population growth. It is the story of a time traveler who made himself Augustus, Roman Emperor, just before the birth of Christ. He introduced sanitation and medicine to the Roman Empire, and convinced Rome to share it with the rest of the world. Peace and prosperity descended on the world. Population exploded hitting a billion by 60 A.D. and after starvation and housing shortages, science and technology were finally forced along, nuclear power was available in around 200 A.D. Eventually they liquidated the solar system for energy and then it took a galaxy to supply energy for humanity's exploding population. The total mass of humanity would exceed the mass of the Earth in 1962, and eventually the mass of the galaxy in a few centuries.

- ✓ “Those who in principle oppose birth control are either incapable of arithmetic, or else in favor of war, pestilence and famine as permanent features of human life.” – Bertrand Russell.

The story glosses over a staggering amount of details to get from ancient Rome to 1962 in three pages; apparently there was no Concierge and no Social Entropy Theory (see SETTiGGDM, 1 Entropy, p. 220, *supra*). The main point that has changed since 1962 are the energy calculations, miniaturization has changed the energy equation of civilization; the failure to develop miniaturization technology (i.e. the transistor) is the basis for the massive energy shortage and global nuclear war in the alternate history Fallout video game series.

- ✓ This 1962 story mentions a system of force mirrors around the sun so that none of the sun's energy escaped and the outer planets all froze. The concept known as a Dyson Sphere (a term not mentioned in the story) was formalized in 1960, though similar megastructure technologies had been described in science-fiction stories in decades before. The Kardashev Scale was proposed in 1964. Collectively, it appears that a new scale of thinking about civilizations emerged in the early 1960s both in science and engineering, and in its disowned step child, science fiction literature.
- ✓ See Kardashev Scale discussion in Scaling Eras, 1 Eras, p. 755, *infra*; more energy consumption doesn't equate to superior technology and may, in fact, demonstrate an inferior technology.

“You take a cell, circumvent the Hayflick limit, you can prevent senescence. ... It means the cell doesn't grow old, it becomes immortal. Keeps dividing, doesn't die. They say aging is a natural process, but it's actually a fault in our genes. ... Without it, I could keep looking like this forever.”

– Prof. Lena, Annihilation (2018)

Natural Assumptions: The game makes broad assumptions that in any colony, sufficient conditions exist for continuation of the species. For example, that the population contains sufficient numbers of viable members of the biological sexes (however many there may be) required for reproduction, that birth ratios are normal for the species (in human populations about 105 males are born for every 100 females, while among cats, 46.5% of kittens are female), that the conditions are otherwise right for reproduction. Alternatively, it is also colorable to assume that sufficient and satisfactory artificial means of reproduction exist in any technologically advanced civilization to insure local reproduction. All of this is *trivial* to the game unless the Concierge or players decide to make it non-trivial (that is, to ‘look’) by developing interpretations, technologies, or activating Interventions; there is plenty of room here for the Concierge to Intervene.

- ✓ Interventions are a form of ‘looking’ in the game where things are created by word.²

GGDM makes no direct reference or calculation regarding natural birth and death rates of any species, or of the aging of populations. It is generically assumed that, absent mass destruction of urban centers, birth and survival rates exceed death rates, and hence population increases during each Census. It is also assumed that infrastructure and systems grow with the population, as a sign of prosperity and wellbeing. Any deviation from these assumptions can be handled by Interpretations and Interventions; most permanent Census and population deviations are Type 1 Fundamental Realities.

The cost of raising and educating the next generation (\$233,610 USD per child born in 2015 and raised to age 17, according to the USDA) are, for game purposes, assumed as part of the basic

domestic subsistence of the colony, i.e. that portion of what the colony produces that is not available to the interstellar government through Taxation. That is why there is no ‘cost’ to the Treasury for the Census. It may even be possible that for some species, the young are born as adults needing little care or education (while human children require at least 12-14 years, other animals require only 1 or 2 years to reach adulthood), perhaps genetically programmed to perform certain tasks (e.g., eusocial insects). This makes little difference in the game system due to the uncertainty and variability of the time periods represented by each Regular Turn, and other undefined factors, such as the number of individuals per population factor, what exactly is a RP, etc.

- **Senescence:** The Hayflick limit is the main reason humans have a concept of the afterlife and more importantly, why modern humans cling to (and will continue to cling to) the ancestral ideas. Without it (well ok ... and predators, natural disasters, disease, and violence – do you still think the universe is our friend?), would anyone have wondered what happens after death? Would we have the need to reassure ourselves of continued existence in another form after we have lost this one?

Few people now ask why we cannot have immortality with the advance of technology; to the extent that they give it any thought, they probably just assume it will happen *someday*. It is not from scientific literacy that they do not ask, but rather because it is not a pressing issue; notice that seeking immortality has seemingly gone out of fashion in science-fiction literature in the last four decades?³ Is the lack of thought about technological immortality a result of an acceptance that entropy is the way of the universe, or is it something perhaps more sinister: A lack of desire of humanity to be immortal in the current world? Condemned to endless absurdity?

Think that this cannot be true? Mass shootings and murder suicides have become a popular express checkout in recent years. People blame it on guns, television, movies, anything to not have to look up from the ground, look around.

Paris: *For Venus smiles not in a house of tears.*

– William Shakespeare, “Romeo & Juliet” (1595)

Everyone has a Venus: The focus of much of our thought about habitability of planets is based on what sort of atmosphere the planet has and whether it has water. Breathing and hydrating are pretty darned important to us. But beyond that, there are many other factors to consider, in order, gravity, light/heat, air pressure, storms, and perhaps, corrosive substances in the air and on the surface. Everyone has a Venus. Despite Controlled Environment Technologies in the game, a percentage of planets, about 10%, will have an Uninhabitable Habitability Class. While CET might establish colonies in those places, the viability of the colony is short (in GGDM terms) and the cost is too much, and there are many other places far better; positions will shortly have knowledge of hundreds of planets in the Galactic Space.

- ✓ Though largely irrelevant for Uninhabitable planets, Maximum Habitability will also be generated.

Ten percent or less of planets being deemed Uninhabitable to a Major Race in GGDM is quite generous, based on the technology which must exist in the GGDM setting. Currently, nearly 100% of planets we have discovered – including both planets in our own solar system and the

exoplanets – are (probably) Uninhabitable (or at the least, Mars is Hostile Habitability Class) in our current technology (and we cannot even get humans to another planet in our own system currently), so we have a long mountain to climb. The Concierge can adjust the percentages up or down; Uninhabitable does not prohibit isolated Orbital Cities from being established if the technology is developed in the game. ‘Improved’ CET technology can also be developed.

But colonization of ‘Uninhabitability Class’ (i.e. Uninhabitable Habitability Class) planets is more than just a technology issue, it is also a question of why bother? What is there that would lead an interstellar civilization to expend such effort?

➤ No Mars Light: GGDM stops just short of absolutely prohibiting colonization of Uninhabitable Class planets. But it will have to be a special situation, perhaps costing extra RPs, Acts, and/or maintenance, and with the potential for catastrophic loss of the entire colony (or significant loss in population) each Regular Turn. The Darien Scheme, discussed in Colonization, 3 Expansion, p. 911, *infra*, gives a hint of what might happen; the Isthmus of Panama where the Scots tried to settle in 1698 was effectively ‘uninhabitable’ based on the technology and logistics of the time, and is sparsely settled even now. And it is worth noting again, that a planet that is Uninhabitable to one species is home to another (and thus, there may be combat there, the Spaniards attacked the Scots in Panama and suffered greatly in the environment): microbial life has been found near volcanos on Earth.⁴

- ✓ “In fact, organisms that do not just survive but thrive in such environments are appropriately named ‘extremophiles.’ They have evolved to gather nutrients from very strange chemical processes, and they are hardy enough to exist where other forms of life would simply dissolve away, suffocate or starve. Yellowstone’s superheated, anoxic, acidic hot springs are a great example. These deathly pools are full of extremophiles; there’s even a microbe there that has been found to save energy by literally piggybacking around on other, larger extremophiles and stealing their nutrients to get by.” – Robin Andrews, “Living In Hell: The Possibility Of Life Inside A Volcano,” Forbes, April 15, 2017.

“A viable population is a population capable of maintaining itself, without significant manipulation.... A minimum viable population is an estimate of the smallest viable population that will persist for a specified length of time (e.g., 500 yrs.) and with a specified level of certainty (e.g., 95%).... Generally, genetic and demographic uncertainty are only important in affecting viability of very small populations. Demographic uncertainty usually kicks in first.”

– Iowa State University, Natural Resource Ecology and Management, “Minimum Viable Populations,” retrieved March 14, 2018

Minimum Viable Population: Discussion of the minimum viable population (MVP) of humans necessary to prevent inbreeding depression, pedigree collapse,^{5[example]} and/or extinction from catastrophe (e.g., Lake Nyos disaster, 1986, killed over 1,700 people and 3,500 livestock in a few minutes) is a very fine subject occasioned first by the threat of global nuclear apocalypse and later by consideration of colonization of distant worlds, especially by generation ships.

Opinion ranges from approximately 50 humans (some go as low as 15 humans) up to about 4,000; many argue that a small village of about 160 people would be sufficient, barring disaster.

History provides some fine examples, such as the population of Pitcairn Island who are all descended from survivors of the *HMS Bounty* and Tahitian natives they brought along – after most of the men had died in internecine fighting (consider also the murderous rampage among the survivors of the *Batavia* mutiny, in a crude attempt at social engineering).

Population in GGDM is not defined in genetic terms, nor does it represent any fixed number except resource production. Further, population in GGDM might not even be human, but one must assume universally that reproduction requires some sort of information pattern that can be both replicated and corrupted. As such, inbreeding effects could occur or be introduced for very small, isolated colonies, with the participants deciding what population level and isolation period falls below the ‘minimum viable population’ for the species.

- ✓ In the Stargate SG-1 series, the Earth humans established an Alpha Site on another connected world to serve as an off-world base of operations, a quarantine site, a VIP evacuation site, and with enough population to insure that humanity would survive if the Earth were destroyed.
- Inbred Populations: It may occur during play, by accident or design that a position consists mostly of or entirely of low-population colonies. Absent large worlds, this would be a difficult position to play without extraordinarily high technology and industry output. But working from an established and well-defended world, it could be a strategy to seed space as far and wide as possible to explore and prevent extinction.
 - ✓ “Moreover, the Taíno woman’s genome doesn’t contain long repetitive sequences characteristic of inbred populations. Her community, therefore, was likely spread out across many islands and not confined to 500-square-kilometer Eleuthera. ‘It looks like an interconnected network of people exchanging goods, services, and genes,’ says William Schaffer, a bioarchaeologist at Phoenix College who helped excavate the remains in Preacher’s Cave.” – Lizzy Wade, “Genes of ‘extinct’ Caribbean islanders found in living people,” *Science Magazine*, February 19, 2018.

The Taíno island culture is an example for both low Maximum Habitability Habitable/Hospitable/Optimal planets and for the genetic integrity of interstellar nations generally.

- ✓ “Small, isolated populations such as those of remote islands represent extreme examples of pedigree collapse, but the common historical tendency to marry those within walking distance, due to the relative immobility of the population before modern transport, meant that most marriage partners were at least distantly related. Even in America around the 19th century, the tendency of immigrants to marry among their ethnic, language or cultural group produced many cousin marriages. If one considers as a function of time t the number of a given individual’s ancestors who were alive at time t , it is likely that for most individuals this function has a maximum at around 1200 AD. It has been suggested that everyone on Earth is at most 50th cousin to everyone else.” – from Wikipedia article, “Pedigree Collapse,” captured January 15, 2020.
- ✓ “Turns out, it was RYR2 – the gene the researchers had suspected all along. But there wasn’t just one mistake in the gene. More than 300,000 base pairs in the gene had been duplicated. ... To develop the duplication that causes sudden death, a child has to inherit a mutated gene from each parent – the chances of which are 25 percent.

That four children in one family inherited the mutation and died sudden deaths is incredibly unfortunate, [Michael] Ackerman said. The Amish may be more vulnerable to recessive inherited conditions because they are descended from a small number of ancestors and tend to intermarry, [David] Tester said. The two families studied in the report are seemingly unrelated, but because the children all had the exact same duplication in a gene inherited from both parents, Ackerman said that it's likely that they have a common ancestor." – Harmeet Kaur, "No one knew why the kids in 2 Amish families were dying suddenly. Now researchers have some answers." CNN, January 16, 2020.

"Several recent studies suggest that the timing of the onset of puberty in girls has become earlier over the past 30 years, and there is strong evidence that the increasing rates of obesity in children over the same time period is a major factor. This article reviews studies from the United States that examined the age of menarche and the age of onset of breast development and pubic hair as a function of body mass index, which is a good surrogate measure of body fat.

... The linkage between body fat and the reproductive axis in girls may have evolved in mammals as a mechanism for ensuring that pregnancy will not occur unless there are adequate fat stores to sustain both the mother and the growing fetus."

– P.B. Kaplowitz, "Link between body fat and the timing of puberty," (abstract at <https://www.ncbi.nlm.nih.gov/pubmed/18245513>), *Pediatrics*. 2008 Feb;121 Suppl 3:S208-17. doi: 10.1542/peds.2007-1813F

Moving Parts: As noted in the top feature quote and the quote above, the age of menarche is regressing in the human female population.⁶ It doesn't require science however, I have heard commented many times over my life that females are growing up faster, maturing younger, etc. (some of this may have been sparked by the Traci Lords scandal). I have often thought it was due to cosmetics and culture, but there may be a physical reason as well. At the same time:

- ✓ "Researchers assessing the results of nearly 200 studies say sperm counts among men from North America, Europe, Australia, and New Zealand, seem to have halved in less than 40 years. Some experts are skeptical of the Human Reproduction Update findings. But lead researcher Dr. Hagai Levine said he was 'very worried' about what might happen in the future." – Pallab Ghosh, "Sperm count drop 'could make humans extinct,'" BBC Health, July 25, 2017.
- ✓ "In 1992, scientists from Denmark published a study claiming that there had been a decline in the quality of men's semen over the preceding 50 years. Though worries have persisted since then, it has been hard to back up this claim. Now a comprehensive new study has emerged that appears to support the research from decades ago. The average Western man's sperm count has fallen by about 60 percent in the last 38 years, sparking anxiety about what this might mean for humanity's future. The latest study was a meta-analysis of English-language studies on sperm count and concentration that was published this week in the journal Human Reproduction Update.

Led by researchers from the Hebrew University-Hadassah Braun School of Public Health and Community Medicine and the Icahn School of Medicine at Mount Sinai,

the work analyzed 185 studies on sperm count and quality that were published between 1973 and 2011. After combing through the material, the researchers found a large decrease in sperm quality among men from North America, Europe, Australia, and New Zealand. The drop was particularly notable among men who had never had kids and were unaware of their fertility status. In these men, they found a 52.5 percent drop in sperm concentration, and a 59.3 percent decrease in total sperm count. They did not find the same decrease in men from non-Western countries, although the authors acknowledged that this could potentially be due to a lack of data” – Leah Rosenbaum, “The Sperm Counts of Western Men Have Declined Dramatically, Alarming Experts,” *seeker.com*, July 26, 2017.

- ✓ “The state of male fertility has been one of the most hotly debated subjects in medical science in recent years. While a number of previous studies found that sperm counts and quality have been falling, some dismissed or criticized the studies over factors such as the age of men included, the size of the study, bias in counting systems and other aspects of the methodologies. Some other concerns are outlined in an analysis published by the American Society of Andrology which focuses on the male reproductive system. The skepticism also has to do with the difficulty of comparing records from a fertility center in the 1970s with one from today and with the fact a single man’s sperm count may fluctuate during his life span due to his weight, use of alcohol and many other factors.

However, Shanna H. Sawn, one of the authors of the new study published in the *Human Reproduction Update*, said that the new meta-analysis is so broad and comprehensive, involving all of the relevant research published in English, that she hoped it would put some of the uncertainty to rest.... The most important data points in the new study involved sperm concentrations of ‘unselected’ men who haven’t yet proven they are fertile. These are men in the studies who are on the younger side and are not yet fathers or do not have partners who are pregnant. Researchers estimated that the men had an average sperm concentration of 99 million per milliliter in 1973 but that had dropped to an average 47 million per milliliter in 2011.” – Adriana Eun-jung Cha, “Sperm concentration has declined 50 percent in 40 years on three continents,” *Washington Post*, July 25, 2017.

No one is sounding the alarm bells yet for human extinction due to dramatically decreased sperm concentrations. Rather the opposite is true; the population of the world has doubled from 3.5 billion to 7 billion in the time since I was born (about 50 years ago). *Exploding population is still one of the major looming catastrophes of the world*, but is a couple of notches down from some others that will kill us much more quickly. But one wonders at the process that is playing out.

It is an interesting dynamic eh? Earlier fertility in females and less fertility in men. The actual effect is more likely to be sociocultural than physical; e.g., our concepts of sexuality, youth, have changed vastly during the time that these physical phenomenon have occurred in the population. It’s hard to say if there is any connection, since there are so many other factors, such as the introduction of true, widespread contraception means in the 1970s.

- Headroom & Legroom: Similarly, and hand in hand with these phenomena, the average height of humans in developed and developing countries has also *increased* since the middle of the 19th Century. No one thinks this is an evolutionary development in humanity – in fact,

it is counter evolutionary in some respects – rather, the increase in height is likely a nutritional and medical benefit of modern food supply and healthcare maximizing our genetic potentials (Michael J. Dougherty, “Why are we getting taller as a species?” *Scientific American*, June 29, 1998).

This process has become so pronounced that the Chinese military has recently had to re-measure its soldiers and re-size its equipment (especially tanks and vehicles) which was becoming too small for the average soldier (Max Fisher, “Chinese soldiers are getting too big for their tanks,” *Washington Post*, February 18, 2014; Zhao Lei, “Chinese soldiers get bigger, requiring new gear to match,” *chinadaily.com.cn*, February 19, 2014). It has also been well commented in discussions about safety rules that professional sports athletes (except possibly horse jockeys) have become larger since the middle of the 20th Century (e.g., the injuries by big modern hockey players hitting each other at 20-30 mph on skates, or in American football, 300 pound ‘big eater’ linemen hitting each other); television cameras don’t really do it justice unless they are standing next to regular people; standing next to other big professional athletes on the field, the players look like normal people.

“Other experts say it’s not surprising that human longevity may have hit a ceiling. ‘Right now, all we’re doing is we’re combating one disease at a time: heart disease, cancer, stroke,’ says S. Jay Olshansky, who studies aging at the University of Illinois and wrote a commentary article accompanying the report. ‘It’s like a game of whack-a-mole. You know: One disease goes down another comes up,’ he says. Olshansky says the only way that could change is if scientists figure out a way to fight the underlying cause of aging, not just individual diseases. ‘That would be a game changer,’ he says.”

– Rob Stein, “Has The Human Life Span Hit the Ceiling?” NPR, October 5, 2016

Endnotes.

¹ **Commentary:** I did not understand for most of my life that I was included in the cohort called Generation X. In my view, Generation X represented the children born in the 1980s whose coming of age coincided with the widespread availability of PCs and the early internet. Those children don’t remember the world before PCs, the internet, game consoles and hundreds of TV channels, they don’t remember 13-channel cable, over the air television, grocery store check cashing cards, government checks printed on Hollerith Code Cards, no direct deposit, paying cash for gas. So, even now, I do not see how children born after 1980 have not been assigned a different cohort than mine.

² **Commentary & Citation:** Lord Foul could not kill Thomas Covenant because he had tricked him previously into breaking the law that separates the dead from the world of the living. He spent himself into nothingness trying.

³ **Commentary & Citation:** The exception, of course, is Dr. Who, e.g., “The Lazarus Experiment” (2007), but I think even in Dr. Who the concept is rarely addressed directly, or much less so than in the Tom Baker years.

⁴ **Citation:** “Extremophile bacteria found living on South American volcanoes,” *Science News Releases* (bitsof-science.org), June 9, 2012; “Volcanic life – the first microbes to colonise the Fimmvörðuháls lava,” Dr. Laura Kelly guest post (posted by John A. Stevenson), all-geo.org (Iceland volcano ash geology open source GIS python), July 28, 2014.

⁵ **Commentary:** Most people have two grandmothers; the simplest pedigree collapse is when this is not true. Most historical examples are more complicated, like not having eight great-grandparents or your uncle is your father.

⁶ **Citation:** “Although the average age of menarche (onset of first menstrual period) has been getting younger in U.S. women.... The average age at menarche is now about 12.4 years old, down from 13.3 in women born prior to the 1920s, but the average age at menopause has been around 51.5 for decades.” – WebMD article, “Menopause.”

✓ Think of the opening scene of the 1976 Stephen King horror-movie classic, *Carrie*.