Nature wisely evolved its organisms to have immune systems that combat invasion by micro-organisms, including parasites, viruses & bacteria.

Nature, even earlier, evolved mechanisms in single cells that protect against chemical & radiological damage – repair systems, even genetic sharing in bacteria.

Chemicals can break or distort molecules important to cells, while energetic radiation simply breaks molecular bonds, such as in proteins & DNA, by ionizing individual atoms.

Decades ago, some poor science led to the conclusion that no level of ionizing radiation was small enough not to cause irrepairable damage to living cells. That belief led to radiation-exposure standards with no relation to reality or evolutionary history.

In recent years, that error & outright lies about radiation dangers have begun to be corrected. This talk attempts to explain why Mother Nature isn’t dumb about radiation.
Radiation & Health

*The thousand natural shocks that flesh is heir to.* -- Pinter

**Threats to Living Cells...**
Oxygen, chemical pollutants, particulates, microbes, solar/cosmic/nuclear-decay/fission/fusion radiation, auto-immune diseases, or parasites.

Nature has dealt with all for ~1.6 billion years, when photosynthesis finally produced enough Oxygen to alter air & water. Earlier, heat, radiation & Sulfur chemistry dominated life & its need for defenses. Oxidants are more dangerous.

Oxidants (OH Radicals, Alcohol, Peroxide...)

Nature’s Response

>1/Second DNA Repairs Per Cell

Dr. Alexander Cannara
cannara@sbcglobal.net
650-400-3071

Courtesy Wikipedia
Cells That Serve & Protect

~100 times the genes of a human are in internal/external microbes. *Virome* and *microbiome* coexist peacefully, and may even cooperate. More than 4,000 different viral strains in the human biome.

**Humans’ ~10 trillion cells are outnumbered by 100 trillion microbial cells throughout our bodies -- all are doing their work & repairs.**


T-cells attacking a cancer cell

~90% of “Us”
Radiation Lies I


“In 1946, Herman Muller was awarded the Nobel Prize in Medicine for work done on spontaneous gene mutation, including the effects of X-rays…right around the same time, the National Academy of Sciences formed a committee to offer expert advice to the government on the biological effects of atomic radiation. In his Nobel acceptance speech* and in the NAS committee meetings, Muller argued there are no safe levels of radiation exposure, a position the Academy came to adopt. That…influenced official policies toward radiation for decades. [UNSCEAR has partly corrected, 2012]

The problem is, Herman Muller knowingly lied. Says Edward J. Calabrese, a professor of toxicology at U. Mass. School of Public Health. He bases that opinion on a wealth of materials…formerly classified files and…overlooked correspondence between Muller and one of his co-researchers.”

Calabrese: “…In Muller’s own groundbreaking work that led to his Nobel Prize, his own dose responses really did not support a linear dose-response relationship. But he was particularly interested in trying to better define the nature of the dos-response in the low-dose zone, and, in fact, he got several individuals to work on that project and inspired other people... But the data that emerged was not very clear. Some data actually seemed to support a threshold, and some clearly did not, but the problem with the work that Muller and the people of that era were doing was that the doses of radiation that they were using were extraordinarily high and have nothing to do at all with anything that we might view as remotely low dose today...they were probably exposing fruit-fly germ cells at a level that would be equivalent to... about a thousand X-rays in 3.5 minutes...the lowest dose that they were testing.”

Radiation Exposure

Evolution has had to cope with chemical damage to RNA/DNA, etc. forever. Radioactivity is a minor actor in typical damages each living cell must repair each second of each day. So, it’s not surprising that unnaturally-high doses, even of Gamma radiation, are seen to have little effect on living things, due to DNA repairs done billions of times per second/animal.

Ingestion of radioactive elements that stay within cells, however, is the serious issue to deal with – $^{131}$I, $^{137}$Cs, $^{90}$Sr, etc. can be taken into biological molecules, in place of normal isotopes, say Calcium. Once in place, their radiation, even Alpha & Beta, can repeatedly challenge key structures such as DNA molecules. This is why protective clothing & masks are used by nuclear workers. Alpha & most Beta emissions are stopped by paper & skin, perhaps burning if strong, but if inside our Bodies, they are trouble, breaking molecular bonds.

### A study of British radiologists showed more radiation improved mortality

<table>
<thead>
<tr>
<th>Group</th>
<th>Av Dose per year</th>
<th>SMR reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipyard workers</td>
<td>280 mrem</td>
<td>24%</td>
</tr>
<tr>
<td>British radiologists</td>
<td>500 mrem</td>
<td>5mSv 32%</td>
</tr>
</tbody>
</table>

DNA Repair Stimulated?

### Leukemia deaths of atomic bomb survivors were not affected by radiation exposure < 200 mSv

<table>
<thead>
<tr>
<th>mSv step to..</th>
<th>Survivors</th>
<th>Survivor deaths</th>
<th>Control deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>37,407</td>
<td>92</td>
<td>84.9</td>
</tr>
<tr>
<td>100</td>
<td>30,387</td>
<td>60</td>
<td>72.1</td>
</tr>
<tr>
<td>200</td>
<td>5,841</td>
<td>14</td>
<td>14.5</td>
</tr>
<tr>
<td>500</td>
<td>6,304</td>
<td>27</td>
<td>15.6</td>
</tr>
<tr>
<td>1,000</td>
<td>3,963</td>
<td>20</td>
<td>9.5</td>
</tr>
<tr>
<td>2,000</td>
<td>1,972</td>
<td>39</td>
<td>4.9</td>
</tr>
<tr>
<td>&gt;2,000</td>
<td>737</td>
<td>25</td>
<td>1.6</td>
</tr>
</tbody>
</table>

40K .32Sv/year

Threshold?

Allison, “Radiation and Reason” 2009
Relative Radiation Dangers

Radiation Exposure to General Public: 87% Nature, 13% Manmade

0.2Sv
0.5 BED

Radiation Exposure to British Public:

Limited Test Ban Treaty
October 1963

Denver

Chernobyl
April 1986
Our 100+ Year CO₂ Emissions Debt

*The problem to work:* <1 ton of CO₂ per capita/year by 2050...

http://tinyurl.com/2a7lswe (latest projections)
http://tinyurl.com/3cw4rkc http://tinyurl.com/bueq2ev (how bad it is)

---

**Graph:**

- **Today:**
  - Global emissions: [Gt CO₂]
  - Peak year: 2011
  - Expected 2050 Population: 9 billion
  - If 2050 Population = Today’s 7 billion

- **At Best We’re on the Red Curve:**
  - Maximum Rate of Emissions Reductions Required:
    - 3.7% per year
    - 5.3% per year
    - 9.0% per year

- To Meet 2 degC Max Rise:
  - So sea rise only endangers ~160 million people.
  - Acidification not considered.

- Emissions goal < 1 ton per person/year, <100 gallons of petrol for everything, <14Gal/capita given acidification.

---

**Data:**

- World CO₂ emissions from just power grew 6% in 2010, to a record 30+ billion metric tons:
The Carbon cycle

Plankton & algae produced most of the Oxygen we have to breathe, starting ~2 billion years ago, with the earliest photosynthesizing ocean organisms. Land plants later evolved & helped. All fossil fuels we now dig up were made this way. Carbon emissions today are ~**10Gt** (~34Gt CO$_2$)

**www3.geosc.psu.edu/~jfk4/PersonalPage/Pdf/annurev_03.pdf**
**www.atmo.arizona.edu/courses/fall07/atmo551a/pdf/CarbonCycle.pdf**

---

**Solar Heat (IR)**

**Human CO$_2$ & IR**

**Land IR**

**Carbonate Stored In Limestone**

**C Burden >500Gt**

**Yearly Cycle is Swamped 5.5/0.2 ~ 27x**

**2005**
~40% of all human CO$_2$ emissions are now in oceans, creating more acidic seawater, preventing plankton growth, affecting entire sea food chain -- sea life provides 20% of human food protein & ~80% of people are coastal...

![Diagram showing pH changes and carbonate levels over time, indicating Plankton Stress and the impacts on Larvae.](image-url)
Emissions Effects

Global Temperature Rise Now Unmatched

- Modern: Fueled by high emission rates (up to 25 petagrams of carbon a year), global temperature is rising quickly and will level off only when emissions cease.
- Us Now: Where we are today.
- Previous Record Rate: 56 million years ago.
- PETM: Slow but steady emissions (up to 1.7 petagrams of carbon a year) resulted in a more gradual heating of the planet some 56 million years ago.

Sci. Amer. July 2011

Arctic Sea Ice Minimum

Actual
(model ignored exposed sea)

Estimates

China Ships to Iceland.
Russia deploys shipborne reactors to power Siberian coastal industrial development.

World Sea Rise

Satellite Observations

Tide Gauges

Recent Sea Level Rise

IPCC Predictions

1980 1990 2000 2010

Sea Level Change (cm)

1.5

0

-1.5

-3


Year

Average Sea Level Rise:
Minimum 1979-2006
2007
Ice Loss

**Greenland**: 51 Cubic Miles lost in 2008, doubling every 7-8 years, 20 feet of sea rise possible -- *most of Greenland’s surface melted in 4 days in July 2012:*

![Greenland Ice Mass Graph](image1)

![Kilimanjaro 2009](image2)

![Slush Map](image3)

5 August 2010, ~100 square miles of ice broke away from Greenland.

[http://tinyurl.com/cepkxag](http://tinyurl.com/cepkxag)
Scales of Reality

Nuclear ‘Strong’ Force
\[ \frac{1}{10000000000000} \]

Electromagnetic Force
\[ \frac{1}{1000000000000000} \]

Writing With Atoms

Gold Atom

Sun and gold nucleus are scaled to a radius of 1 foot.

Solar System

Sun and gold nucleus are scaled to a radius of 1 foot.

Chemistry

outermost electron

Nuclear Physics

3.3 miles

Electromagnetic Force

\[ \frac{1}{100} \] Size of Sun

\[ \frac{1}{100000000} \]

~900,000 miles

Nearest Star, 10,000 scale miles

4 Light-Years, ~24,000,000,000,000 real miles*

Proxima Centauri

Weak Gravity (10^{-40} E/M)

Outermost planet

Oort Cloud

79p + 118n

~1/100000000 inch

*Altered: 
~3,600,000,000,000 real miles*

*Altered: 
~900,000 miles

*Altered: 
~4 Light-Years, ~24,000,000,000,000 real miles*
Elements & Origins

Neutrons May Help Nuclear Stability

Gold, 79
Bismuth, 83

Star Fusion
Supernova Shocks

No Stability, Promethium, 61 and Technecium, 43
Iron, 26

89+ Instability, Radioactive Decay

Neutrons = Protons

Protons Define the Elements, Neutrons Define their Isotopes.

Hydrogen, 1
Uranium, 92

Protons
Neutrons

U & Pu Fission

Wiki.chemeddl.org
Nuclear Energy

Slow (Thermal) Neutron Fast Neutrons (v = ~10% c)

Unstable U

Uranium Fission

~17 MeV released per D-T fusion

~180 MeV released per U atom

Fission yields fast neutrons, gamma rays & energetic isotopes (Fission Products).

Gamma Rays

Stable U

Unstable U

Thermodynamic Shank

~4 MeV released per neutron interaction

Moderator


c

E = mc


t

235

U

236

U

232

Thorium

Fusion yields fast neutrons, gamma rays & neutrinos.

Fission Products

Fusion yields fast neutrons, gamma rays & neutrinos.

Gamma Rays

Fast Neutrons (v = ~10% c)

235

U

92

Kr

141

Ba

x 235 Nucleons

Less Mass E = mc²

232

Thorium

Density

200 MeV

Ground state

Excited state

Deformation J
Fission Products

Asymmetrical yields of thermal-fission-product pairs versus fissile element

Fission-Daughter Mass (Nucleons)

Bromine

Molybdenum

Strontium

Silver

Tin

Xenon & Cesium

Neodymium

Terbium

Neutron Hog

Uranium Bred from Thorium

233\text{U}
Types of Radiation

**Alpha** Particle (\(^{4}\text{He}\) ion): A fast-moving, Helium nucleus (2 Protons, 2 Neutrons) with +2 charge. Alpha Particle emission moves an element 2 positions down (Z-2) the Periodic Table, to become a lighter element. Radioactive decay produces Alpha emissions that can’t penetrate skin but can damage a cell’s molecules and cause radiation burns under high exposure. Cosmic Rays and solar fusion can create higher Alpha energies.

**Beta** Particle: A freely-moving, energetic Electron. Beta emission releases some nuclear energy and effectively converts a Neutron to a Proton, thus creating an isotope of the next element (Z+1) in the Periodic Table. The opposite move occurs by emission of a Positron. Beta emissions are also easily stopped but can burn if strong. An animation of Beta and Beta+ emissions is here: [www.colorado.edu/physics/2000/applets/iso.html](http://www.colorado.edu/physics/2000/applets/iso.html)

**Gamma** Ray: Photons of electromagnetic radiation whose energy exceeds those of Xrays (about 100keV) and UV (>1eV), with wavelengths less than an Angstrom (the scale of an atom). Gamma rays have exceedingly high frequencies and are highly-ionizing radiation, easily disrupting molecules. Ultraviolet light can deliver 3eV or more, breaking DNA bonds, while Gamma photons deliver thousands of times as much energy, freeing even innermost electrons from an atom. Gamma radiation above 10MeV occurs from environments near Black Holes, Magnetars, etc. Gamma rays are emitted by nuclear fission or fusion, by particles meeting Anti-Particles, or by interaction of energetic, charged particles with extreme magnetic fields.
**Alpha & Beta Decay Detail**

**Emitted Radiation**
- Alpha .. Helium ion
- Beta\(^+\) .. Positron
- Beta\(^-\) .. Electron
- EC .. X& Gamma rays

(EC = inner electron capture by a nuclear Proton)

**Decay Result**
- Alpha .. -2P -2N
- Beta\(^+\) .. -1P +1N
- Beta\(^-\) .. -1N +1P
- EC .. -1e -1P +1N

**Note 1:** Illustrated decays would only occur outside the Zone of Stability, or for isotopes not indicated by red dots, e.g., \(^{139}\)Ba.

**Note 2:** Decays are accompanied by Gamma or X radiation at some energies reflecting needed nucleon reshufflings.

**Protons Define Elements  
Neutrons Define Isotopes**
$^{235}\text{U fission}$ can result in the FP pair $^{94}\text{Strontium}$ and $^{140}\text{Xenon}$, which are highly radioactive, due to excess of several neutrons each. They decay within minutes or days to stable Zirconium and Cerium, by shedding Beta particles (electrons), thus moving up the Periodic Table to higher Proton/Neutron ratios.
Beta (Neutron to Proton) Decay

www.colorado.edu/physics/2000/applets/iso.html
Types of Radiation

**Neutron**: An uncharged nuclear particle about the same mass as a Proton, but unstable outside a nucleus – it Beta decays to a Proton, Electron and Anti-Neutrino within minutes. Its neutrality delayed its discovery until 1932, long after Alpha, Beta and Gamma discoveries. It carries away most of the energy from D-T fusion, but only a little of fission’s energy release, which is mostly carried by the energetic, new fission product nuclei (FPs). Neutrons are generally more interactive with Carbon, which can be used as a Moderator to slow Neutron velocities. But this also leads to them being damaging to the hydrocarbon molecules of life – the intention of the “Neutron bomb”.

**Proton**: The charged nuclear particle that defines elements: 1 P = a Hydrogen nucleus.

Radiation exposure is measured by the Gray or **Sievert** -- both correspond to 1 Joule (1 Watt-second) of energy delivered to 1 kilogram of target material (also equivalent to an exposure of 100 Rem). The **Sievert measures biological effect**, so different types of radiation are rated in “dose equivalents”, using multipliers (e.g., Photons/Electrons = 1, Protons = 2, Alpha particles or fission fragments = 20, thermal-fast Neutrons = 1-30…). Living targets depend on DNA-repair mechanisms to correct for natural Gamma exposures, oxidants & chemical insults, etc.

Electromagnetic Radiation

Satellite Photos of Us

Earth in UV from Solar Wind Protons; Polar Aurorae Below

All Radiant Energy (Electromagnetic Spectrum)

- X-rays
- UV
- Infrared
- Cell
- FM
- Radio
- TV
- AM

Frequency

Wavelength

Energy Absorption

Bio-Destructive

GHGs

Benign

Benign

Solar Energy Distribution

- 5% ultraviolet (300-400 nm)
- 43% visible (400-700 nm)
- 52% near-infrared (700-2500 nm)

Total = 1 kW/sqm at Earth's surface

Total: 1366 W/m² in Near Space

Dynamic polar auroras for March 14, 1999 courtesy L. A. Frank, University of Iowa
Natural Radiation – Solar

**Solar radiation** is mostly **Protons**. They arrive at ~1 million mph, from coronal mass ejections (CMEs) related to sunspots & create auroras as they spiral down Earth’s magnetic field in polar regions. The sun has an 11-year **Sunspot Cycle**, superimposed on a longer ~90-year activity cycle. We’re currently entering a peak of the 11-year and a trough of the longer cycle: [www.spaceweather.com/](http://www.spaceweather.com/)

---

**“SEEING” THE SUN**
Astronomers have seen the sun at every wavelength of light, and now they have seen it in neutrinos. The image is blurry—the Super-Kamiokande experiment that made it has a resolution of 26 degrees, whereas the sun is 0.5 degree wide (*black circle*)—but is still a technological milestone. Whereas light shows only the surface of the sun, neutrinos expose the core.

**Visible (Filtered)**
- **Too Bright**

**Ultraviolet**
- **Dangerous**

**Radio Waves**
- **Harmless**

**Neutrinos**
- **Harmless**
- **Billions/sq cm/sec**

*Courtesy NASA*
Natural Radiation

$^{40}$K is also a key driver of Earth’s magnetic field, as are Thorium & Uranium.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Half-Life (yr)</th>
<th>Natural Abundance (%)</th>
<th>Specific Activity (Ci/g)</th>
<th>Decay Mode</th>
<th>Radiation Energy (MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-40</td>
<td>1.3 billion</td>
<td>0.012</td>
<td>0.0000071</td>
<td>$\beta$, EC</td>
<td>-</td>
</tr>
</tbody>
</table>

Thorium’s $\frac{1}{2}$ life = 14 billion years
$^{238}$Uranium = 4.5 billion years
$^{235}$U = 700 million years
$^{234}$U = 250,000 years

- Emissions
  - Beta = electron
  - Gamma = photon

Earth’s inner heat is 80% due to radioactive decay of Th, U & $^{40}$K – geothermal energy is nuclear energy. Earth’s protective magnetic field only exists because its mostly Iron/Nickel core is molten & electrically conductive – no field = no air, but plenty of solar & cosmic radiation. Mars – no molten core & almost no air.
Natural Radiation

Foods concentrate various elements, including natural, unstable isotopes.

40K is a very small fraction of stable Potassium & decays to stable 40Calcium by emitting a beta particle with no attendant gamma radiation (89% of the time) or to stable 40Argon gas by electron capture with emission of an energetic gamma ray photon (11% of the time).

With a biological half-life of 30 days, the 40K content in the body is constant. Each year 40K decay delivers doses of about 0.18 Sievert to soft tissues of the body & 0.14 Sv to bone. This suggests a 4/100,000 lifetime cancer risk, compared to 20,000/100,000 for all cancers.

Argonne National Laboratory, Human Health Fact Sheet 2005

http://en.wikipedia.org/wiki/Banana_equivalent_dose
http://www.bbc.co.uk/news/magazine-15288975
The mountains in Oklo, south-eastern Gabon are home to several natural $^{235}$Uranium fission reactors. They operated about 2 billion years ago, when the 700-million-year half life of that isotope would have meant it was about 8 times as abundant in typical rock containing Uranium ore. The Earth’s growing atmospheric Oxygen content, water & bacteria concentrated $UO_2$ enough that rainfall & groundwater acted as a neutron moderator to enhance fission by slowing neutrons to ‘thermal’ speeds, making their capture by $^{235}$U nuclei more probable. When water stopped flowing, the reactors stopped fissioning. When it flowed again, they restarted. The site is now useful to judge stability of fission wastes. Niger & Gabon have very significant U deposits.

http://www.ans.org/pi/np/oklo/
http://www.ans.org/pi/np/oklo/
http://en.wikipedia.org/wiki/Natural_nuclear_fission_reactor
www.physics.isu.edu/radinf/Files/Okloreactor.pdf
Natural Radiation – Cosmic Rays

A Primary Cosmic Ray is a Gamma Ray or high-speed particle from the Sun or other distant stellar sources, including supernovae, black holes, magnetars, even from another galaxy. It can be an atomic nucleus, an Electron or other subatomic particle. About 85% are Protons, ~12% Alpha particles, & the remainder Electrons & nuclei of heavier atoms. Most primary rays are charged & thus influenced by the Earth's & interplanetary magnetic fields. Most have energies >1 GeV -- speeds >87% the speed of light. Solar Protons arrive at ~1 million mph, from coronal mass ejections & create auroras as they spiral down Earth's magnetic field in polar regions.

Secondary Cosmic Rays are particles streaming downward from Primary collisions with air molecules. This is the source of radioactive atmospheric isotopes (e.g., $^{14}$Carbon & $^{18}$Oxygen) used for dating fossils, sediments, ice cores, temps, etc. The downward stream of these particles is quite constant. Strong Gamma bursts come straight from vastly-distant sources, such as colliding black holes & collapsing massive stars.
**Natural Radiation – Solar Fusion**

*Sun’s energy density is low* – about ¼ that of a resting human’s body heat: 260uW/cm³ -- lower than a candle’s -- why it’s been around for over 4 billion years, turning Hydrogen into Helium, then Beryllium, plus neutrinos and gamma rays (light).

---

**Diagram:**

- Sun’s average proton pair waits ~8 billion years to fuse & via this chain, emit ~27 MeV
- Positron annihilates with an electron releasing ~1MeV more as Gamma rays
- Neutrino
- Gammas take ~10⁶ years to reach surface as light
- Next is ⁴Be ~10⁶ years

---

Each second, 600 million tons of Sun’s Hydrogen fuse to form 596 million tons of Helium -- 4 million tons of matter is converted into 3.9x10²⁶ Watts (E = mc²), which is just 1 picoWatt per Helium atom produced.

---

*Courtesy Wikipedia & Institute for Advanced Study at Princeton*
Natural Radiation (From Unnatural Acts)

Allowed combustion emissions/wastes – NORM exemptions…
https://en.wikipedia.org/wiki/Naturally_occuring_radioactive_material

^40K, Radium, Radon, Polonium, Uranium, Mercury…

http://tinyurl.com/y97vq5r

“We deeply regret that a retention wall for ash containment at our Kingston Fossil Plant failed, resulting in an ash slide and damage to nearby homes…”

Arsenic, Lead, Uranium…

~300 Acres

TVA Kingston Coal Plant, Dec. 2008
Radiation Lies II

A lie: Welsh child leukemia was caused by the Sellafield nuclear plant…

“…the long-running failure by people within the ‘green’ movement to challenge the claims made by a Dr. Christopher Busby …a visiting professor at the U. of Ulster… formerly the science and technology spokesperson for the Green Party, which still consults him on…low-level radiation and depleted uranium. Following…revelations published by the Guardian today, this may now change. One of Busby’s…contentions, widely repeated by anti-nuclear campaigners, is that there is a leukaemia cluster among children living close to the coast of north Wales. This cluster, he maintains, is caused by radionuclides in the sea, from Sellafield and other sources.

His findings were self-published and released by the consultancy he runs, called Green Audit…they were not subjected to the scientific assessment required by peer-reviewed journals.

Busby’s claims were later assessed by professional scientists working for the Welsh Cancer Intelligence and Surveillance Unit at the NHS. They published…peer-reviewed…Journal of Radiological Protection. Their paper reported a simple and devastating finding: there is no such cluster. Busby’s claims…were the result of some astonishing statistical mistakes:

• He counted the overall leukaemia incidence for Wales twice;

• He mixed up the figures from urban areas with those from small rural areas, “trebling the local incidence in north Wales” and creating “spurious clusters in various locations”;

• He claimed there were ten cases of leukaemia in young children in Snowdonia. In reality there was just one case;
[re Busby] **Worst of all...**

- “We found clear evidence of data dredging which renders all subsequent statistical inference spurious...the dataset has been systematically trawled.” Busby’s “findings” were repeated uncritically in the Welsh media, spreading fear and distress among local people.

As for his **“second event theory”**, which maintains that radionuclides are far more dangerous than scientists say they are, the paper asserts that there is no evidence supporting this, and it has “no biological plausibility”.

None...is as disturbing as the remarkable story published in the Guardian today. **Busby appears...on YouTube.** In it he makes a number of wild allegations...[a] that the Japanese government is deliberately spreading radioactive material from Fukushima all over Japan. The reason, he says, is that when clusters of childhood cancer start appearing in Fukushima, the parents...will want to sue the...government.

“But the only way that they can say that they’ve got high levels of cancer is to have a control group in an area that’s not contaminated, for example the south of Japan. So I believe that the project to take this material and burn it all over Japan is to destroy all of Japan, to increase the cancer rate in the whole of Japan, so that there will be no control group to which you can compare these children in the Fukushima area.” -- Busby
[re Busby on YouTube]: *He produces no evidence to support this claim.*  Given that no radioactive waste has been removed from Fukushima prefecture, and there are no plans to do so, it is hard to see how he could.

*He then goes on to [b] promote expensive new pills and tests which, he says, will protect people in Japan* from these alleged horrors.  Scientists contacted by the Guardian describe these treatments as useless and baseless.

*An organisation based in Japan, calling itself the Christopher Busby Foundation for the Children of Fukushima, and linked to Busby’s own enterprise in Wales called Busby Laboratories, solicits donations for its work.*  But the bank account it asks people to send them to is not in Japan.  It is called Green Audit, and the bank is in Busby’s home town of Aberystwyth.  *Green Audit is an environmental consultancy and research organisation founded by Busby.*

When I [Monbiot] *phoned Busby* to ask him some questions about these issues, his responses were less than enlightening.  *He began as follows: “You can f__k off frankly.”*  When I asked him what his involvement was with the Christopher Busby Foundation for the Children of Fukushima, he told me:  *“I think you can f__k off.  I’m not going to answer your questions.”*

Those who oppose nuclear power often maintain that they have a moral duty to do so.  But it seems to me that moral duties cut both ways.  – George Monbiot

“A lie gets half way around the world before the truth gets its boots on”  -- Mark Twain.
Radiation Dose Thresholds

Chernobyl Workers (237)

Death Rate %

Dosage mSv

Solid cancer deaths of atomic bomb survivors were not affected by radiation exposure < 100-200 mSv

<table>
<thead>
<tr>
<th>mSv step to...</th>
<th>Survivors</th>
<th>Survivor deaths</th>
<th>Control deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>38,507</td>
<td>4,270</td>
<td>4,282</td>
</tr>
<tr>
<td>100</td>
<td>29,960</td>
<td>3,387</td>
<td>3,313</td>
</tr>
<tr>
<td>200</td>
<td>5,949</td>
<td>732</td>
<td>691</td>
</tr>
<tr>
<td>500</td>
<td>6,380</td>
<td>815</td>
<td>736</td>
</tr>
<tr>
<td>1,000</td>
<td>3,426</td>
<td>483</td>
<td>378</td>
</tr>
<tr>
<td>2,000</td>
<td>1,764</td>
<td>326</td>
<td>191</td>
</tr>
<tr>
<td>&gt;2,000</td>
<td>625</td>
<td>114</td>
<td>56</td>
</tr>
</tbody>
</table>

Allison, “Radiation and Reason” 2009

A-Bomb Survivors

UNSCEAR 2010

Hormesis?

0.2Sv 0.32Sv

Hormesis?

-5%

40K 320mSv/year

DoE, Redpath et al, 2001
Deinococcus Radiodurans can withstand an acute dose of 5,000 Gy of ionizing radiation with almost no loss of viability, and an acute dose of 15,000 Gy with 37% viability. 5,000 Gy is estimated to introduce several hundred double-strand breaks into the organism’s DNA. 5 Gy can kill a human, 200-800 will kill E. coli, & >4,000 kills the radiation-resistant Tardigrade.
Relative Industrial Dangers

Public Health Impacts per TWh*

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Lignite</th>
<th>Oil</th>
<th>Gas</th>
<th>Nuclear</th>
<th>PV</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of life lost:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonradiological effects</td>
<td>138</td>
<td>167</td>
<td>359</td>
<td>42</td>
<td>9.1</td>
<td>58</td>
<td>2.7</td>
</tr>
<tr>
<td>Radiological effects:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accidents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory hospital admissions</td>
<td>0.69</td>
<td>0.72</td>
<td>1.8</td>
<td>0.21</td>
<td>0.05</td>
<td>0.29</td>
<td>0.01</td>
</tr>
<tr>
<td>Cerebrovascular hospital admissions</td>
<td>1.7</td>
<td>1.8</td>
<td>4.4</td>
<td>0.51</td>
<td>0.11</td>
<td>0.70</td>
<td>0.03</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>0.80</td>
<td>0.84</td>
<td>2.1</td>
<td>0.24</td>
<td>0.05</td>
<td>0.33</td>
<td>0.02</td>
</tr>
<tr>
<td>Restricted activity days</td>
<td>4751</td>
<td>4976</td>
<td>12248</td>
<td>1446</td>
<td>314</td>
<td>1977</td>
<td>90</td>
</tr>
<tr>
<td>Days with bronchodilator usage</td>
<td>1303</td>
<td>1365</td>
<td>3361</td>
<td>397</td>
<td>86</td>
<td>543</td>
<td>25</td>
</tr>
<tr>
<td>Cough days in asthmatics</td>
<td>1492</td>
<td>1562</td>
<td>3846</td>
<td>454</td>
<td>98</td>
<td>621</td>
<td>28</td>
</tr>
<tr>
<td>Respiratory symptoms in asthmatics</td>
<td>693</td>
<td>726</td>
<td>1786</td>
<td>211</td>
<td>45</td>
<td>288</td>
<td>13</td>
</tr>
<tr>
<td>Chronic bronchitis in children</td>
<td>115</td>
<td>135</td>
<td>333</td>
<td>39</td>
<td>11</td>
<td>54</td>
<td>2.4</td>
</tr>
<tr>
<td>Chronic cough in children</td>
<td>148</td>
<td>174</td>
<td>428</td>
<td>51</td>
<td>14</td>
<td>69</td>
<td>3.2</td>
</tr>
<tr>
<td>Nonfatal cancer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1998 Swiss report on power sources…
http://tinyurl.com/42wvr9l

2010 UN SCEAR Report…
http://tinyurl.com/7amwjqq
(beginning to recognize threshold)

Review…
http://tinyurl.com/3nwjboz

2012 UN begins to admit LNT false…
http://tinyurl.com/babxels

Wind-Death Sample…
caithnesswindfarms.co.uk/accidents.pdf

### Severe accidents with at least 5 fatalities (1970-2005)

<table>
<thead>
<tr>
<th>Energy chain</th>
<th>OECD</th>
<th></th>
<th></th>
<th>EU 27</th>
<th></th>
<th></th>
<th>non-OECD</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accidents</td>
<td>Fatalities</td>
<td>Accidents</td>
<td>Fatalities</td>
<td>Accidents</td>
<td>Fatalities</td>
<td>Accidents</td>
<td>Fatalities</td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>81</td>
<td>2123</td>
<td>41</td>
<td>942</td>
<td>144</td>
<td>1363 (a)</td>
<td>5360</td>
<td>24,456 (a)</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td>174</td>
<td>3388</td>
<td>64</td>
<td>1236</td>
<td>308</td>
<td>17,990</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Gas</td>
<td>103</td>
<td>1204</td>
<td>33</td>
<td>337</td>
<td>61</td>
<td>1366</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPG</td>
<td>59</td>
<td>1875</td>
<td>20</td>
<td>559</td>
<td>61</td>
<td>2636</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>116 (b)</td>
<td>12</td>
<td>30,007 (c)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>31 (d)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) First line: coal non-OECD without China; second line: coal China
(b) Belci dam Romania (1991)
(c) Banqiao and Shimantan dam failures alone caused 26,000 fatalities
(d) Latent fatalities treated separately

OECD = Organisation for Economic Co-operation and Development
Relative Industrial Dangers

Years of life lost worldwide per TWHr --

- **Nuclear**: 25
- **Gas**: 42
- **Coal**: 140


Years of life lost had Japanese electricity been generated by nuclear versus combustion --

<table>
<thead>
<tr>
<th>Source</th>
<th><strong>Fukushima Total</strong></th>
<th><strong>Japanese Total Nuclear</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source…</strong></td>
<td>898 Twh</td>
<td>6097 Twh</td>
</tr>
<tr>
<td>Coal</td>
<td>124,000</td>
<td>840,000</td>
</tr>
<tr>
<td>Gas</td>
<td>38,000</td>
<td>260,000</td>
</tr>
<tr>
<td><strong>Nuclear (normal)</strong></td>
<td>22,000</td>
<td>153,000</td>
</tr>
<tr>
<td><strong>Fukushima (est.)</strong></td>
<td>4,800</td>
<td>4,800</td>
</tr>
<tr>
<td><strong>Total Nuclear</strong></td>
<td>26,800</td>
<td>157,800</td>
</tr>
</tbody>
</table>
Cellular DNA Repair

DNA Ligase Repairing a Chromosome Break

A Real Cell’s Nucleus:

Chemicals/Radiation

Healthy cell

Rate of DNA damage = rate of repair

Damage

Malignant cell

Rate of DNA damage > rate of repair

Pathology

Cancer

Senesce

Apoptosis

>1/Second DNA Repairs Per Cell

Exogenous damage

Endogenous damage

Metabolism

Nuclear DNA

Mitochondrial DNA

Unrepaired DNA

Unrepaired DNA

Credits:

Courtesy Wikipedia

Courtesy AAAS
Cellular Scale & Structure

- Large Atom Nucleus -- .000000001 micron
- Large Atom -- .00005 micron
- Virus -- .02 -.45 micron
- Red Cell – 10 microns
- Avg. Cell – 50 microns
- Hair/Paper – 100 microns
- Skin Mites – 100-400 microns

1: Cell Nucleolus
2: Nucleus
7: Cell Membrane
10: Vacuole
12: Lysosome

~20,000 Genes for Proteins
~4,000,000 for Control
Cellular Structure & Function

DNA Control (former ‘junk’ DNA) & Reading

Oceanic Picobiliphyte ~3 micron

Mitochondrium

Cell Respiration:
Lysosomes are cellular organelles that contain acid hydrolase enzymes to break down waste materials and cellular debris. They can be described as the stomach of the cell. Lysosomes digest excess or worn-out organelles, food particles, and engulf viruses or bacteria. The membrane around a lysosome allows the digestive enzymes to work at the 4.5 pH they require. Lysosomes fuse with vacuoles and dispense their enzymes into the vacuoles, digesting their contents. They are created...from the Golgi apparatus...The size of a lysosome varies from 0.1–1.2 µm...The lysosomal membrane protects the...rest of the cell, from the degradative enzymes within the lysosome...

They are used for the digestion of macromolecules from phagocytosis (ingestion of other dying cells or larger extracellular material, like foreign invading microbes), endocytosis (where receptor proteins are recycled from the cell surface), and autophagy (where in old or unneeded organelles or proteins, or microbes that have invaded the cytoplasm are delivered to the lysosome). Autophagy may also lead to autophagic cell death [apoptosis], a form of programmed self-destruction...which means that the cell is digesting itself.

Other functions include...helping repair damage to the plasma membrane by serving as a membrane patch, sealing the wound. In the past, lysosomes were thought to kill cells that are no longer wanted...in the tails of tadpoles or in the web from the fingers of a...fetus.

-- Wikipedia
Cellular Protection

- Lung Cell Cilia
- Egg Cell
- Thick Membrane
- Pin
- Immune System T Cells
- Cancer Cell
- Parasite (Sleeping Sickness)
Cancer

Cancer Cells Often Switch To Higher Metabolic-Rate Chemistry & Incite Blood-Vessel Growth

Cancer Cell Dividing/Replicating

Cancer Cells With Too Many Chromosomes Get Attacked By T Cells

Cancer initiation requires several specific genetic changes in sequence – heredity helps.
Cancer, DNA-Repair Abilities

Young Cells

- BRCA1 Repair Proteins
- RAD51
- Mre11

Strong Expression, Many Molecules Made Per Cell

Old Cells

Weak Expression, Few Molecules Made Per Cell

White arrows indicate cell cytoplasm. Red indicate cell nucleus.

AAAS Science
Avoiding Cancer

Cancer Induction requires several ‘successful’ cellular genetic changes to achieve malignancy. Each such step is subject to detection and retribution from the immune system. The immune system depends on a rich supply of useful chemicals, like anti-oxidants, from food, not pills. Diet, family genes and environment are all key to maintaining a strong immune system.
Gut Cancer

Latest cancer/genetic studies show individual predispositions, like: [http://tinyurl.com/8jnmabo](http://tinyurl.com/8jnmabo)

Cancer of the Gut Is Often Induced By Inflammation Due to Unmanaged Gut Bacteria Exploiting Hereditary Propensities and/or High Radiation Exposure

Chance of cancer has been demonstrated to be reduced by good multi-vitamin regimens. Radiation damage has been shown to be reduced by cellular Oxygen reduction, as via anti-oxidants, or even via Nitrogen asphyxiation during exposure (see Frigerio ref.).
Inflammation & Cancer

Cancer Cells May Be Induced Via Chronic Inflammation That Stimulates Overzealous Cell Reproduction For Tissue Repair – Treatments Can Halt Such Erroneous Feedback

Inflammation-Induced Cancer

AAAS Science

Mutants Given Antioxidants

Mutants Making Free Radicals

Worm Lifetimes

Anti-Oxidants Role Unclear

Scientific American Feb. 2013

Worms with More Free Radicals Lived Longer

Normal Worms

Mutant worms that produced high levels of free radicals

Mutant worms given antioxidants

Normal Worms

Days

Worms That Survived (percent)
Skin & Gut Microbes

Benignly Keeping Baddies Away

Helping Digestion & Policing the Grounds

The Gut Microbiota

Our Gut Friends

Scientific American June 2012
Skin & Teeth Friends

Cleanup & Digestion Aid Crews

Skin Mites:

Tooth Plaque Community...

Wikipedia

J. Dupre -- Processes of Life
Our Microbes’ Genetics

Archaic Root Cell
Thorium’s Radiation Exposure

- 1 Alpha every 69,000 sec.
- 0.2 pg Th = 40K
- 4400 Bq in body
- = 2 g Th for 14B years

~14 Billion Years

Times are half lives

~8 Years

~4 Days

Emissions:
- Alpha = Helium nucleus
- Beta = Electron

Alpha & Beta can barely penetrate skin/paper

Gamma
Thorium-Bred $^{233}\text{U}$-Based Fission

Abundant, Cheap, low radioactivity

Breeding Th232 to fissionable U233

Slow neutrons

Gamma & particle radiation + nuclear fragments of mass 89 to 156

3,200,000kWHrs/lb
4,300,000HpHrs/lb (gasoline, 6kWHrs/lb)

Alternatively, spallation-injected neutrons can breed Th$_{232}$ directly to U$_{233}$

Th Naturally decays to Radium, Actinium, Francium, Astatine, Bismuth, Polonium, Thallium & Lead. It’s responsible for ~60% of Earth’s core heat.

Bismuth 209 is the heaviest, non-radioactive element

Greek Alpha stands for an emitted Helium nucleus (+2 charge), while Beta stands for an electron (-1 charge).
**Alpha** -- Particle (\(^4\text{He}\) ion): A fast-moving, Helium nucleus (2 Protons, 2 Neutrons) with +2 charge. Alpha Particle emission moves an element 2 positions down (Z-2) the Periodic Table, to become a lighter element. Radioactive decay produces Alpha emissions that can’t penetrate skin but can damage a cell. Cosmic Rays create higher Alpha energies.
References

Comparative Radiation Sources:  http://blog.xkcd.com/2011/03/19/radiation-chart/

*Green Nuclear Power*, J. Eerkens, University of Missouri:  http://tinyurl.com/2amxte4


ORNL Document Archive:  www.energyfromthorium.com/pdf/


*Radiation Research May Be Slashed by Budget Cuts*, A. Madrigal The Atlantic, 2011;  http://tinyurl.com/6pgu5dn

www.energyfromthorium.com/javaws/SpentFuelExplorer.jnlp

*Toward Improved Ionizing Radiation Safety*, Raabe, Health Physics, Vol. 101, July 2011;


Comparative Dose Chart

http://imgs.xkcd.com/blag/radiation.png

Radiation Dose Chart

This is a chart of the limiting radiation dose a person can absorb from various sources. The unit for absorbed dose is "sievert" (Sv), and measures the effect a dose of radiation will have on the cells of the body. One sievert (all at once) will make you sick, and too many will kill you, but we safely absorb small amounts of natural radiation daily. This is called "background radiation." The chart below represents a typical American's yearly exposure (40 mSv). Note: The same number of sieverts absorbed in a shorter time will generally cause more damage, but your cumulative long-term dose plays a big role in things like cancer risk.

- **Sleeping next to someone** (0.05 mSv)
- **Living within 50 miles of a nuclear power plant for a year** (0.89 mSv)
- **Eating one banana** (0.4 mSv)
- **Living within 50 miles of a cool power plant for a year** (0.3 mSv)
- **One x-ray** (1 mSv)
- **Using a Geiger counter for a year** (1 mSv)
- **Extra dose from spending one day in an area with higher-than-average natural background radiation, such as the Colorado plateau** (1.2 mSv)
- **Conventional chest x-ray** (5 mSv)
- **Extra dose from one day in an average town near the Fukushina plant** (3.6 mSv; varies a bit)
- **Background dose received by an average person over one normal day** (18 mSv)
- **Airplane flight from New York to LA** (40 mSv)

**CT Scan**
- Chest CT scan (5.3 mSv)

**3-Mi Island**
- EPA yearly limit on radiation exposure to a single member of the public (1 mSv)
- Maximum external dose from Three Mile Island accident (1 mSv)

**Fukushima Day**
- One-day dose (-3.6 mSv) at two sites 5.5 km N of Fukushina on 3/16, seen again on 3/17. However, other areas near Fukushina saw barely-elevated doses.

**Normal Year**
- Normal yearly background dose. About 8% is from natural sources. Nearly all comes from radon in your home.

**Chernobyl Now**
- Dose from spending an hour on the ground at the Chernobyl plant in 2010 (5 mSv in one spot, but varies wildly)

**All Blue**
- EPA yearly release target for a nuclear power plant (30 mSv)
- EPA yearly release limit for a nuclear power plant (25 mSv)
- Maximum yearly dose permitted for US radiation workers (48 mSv)