What is Life?
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Basic Quantum Theory

- atoms/molecules exist in quantized states of energy (or energy levels)
- changes are discontinuous/discrete
- "jumps" from one energy level/configuration to another → quantum jump
- stability linked to magnitude of quantum jump (~~inversely proportional~~ directly proportional)
- heat can provide the E for the quantum jump [↑ P(shift to higher E)]
- W = energy difference between the 2 levels
- T = absolute temp, ∴ kT is heat energy (K is a constant that enables the conversion)
- W : kT ratio → if high (W far greater than kT), low P(shift), ∴ stable
  → corollary is that low gives rise to lower stability (lower time of expectation) ← estimated time till jump
- τ (time of expectation) = $\tau e^{\frac{W}{kT}}$ → thus $(\downarrow \frac{W}{kT}, \downarrow \tau), (\uparrow \frac{W}{kT}, \uparrow \tau)$
  ↑ constant of the order 10^{-13} or 10^{-14} s
- converting one isomer into another requires passage through high energy intermediates

Delbrück's Model

- for all intents and purposes, let solids = crystals (as the molecules form interactions between themselves in solids in a similar fashion to crystals)
- Normally, in solids, a 3D repetition of a particular organisation is perpetuated (∴ periodic crystal)
- aperiodic crystal ~ building extended aggregates within structure without extended repetition
- this crystal (chromosome) should have high resistivity + large number of "isomeric" arrangements
- not all theoretical combinations manifest
- $\tau = \tau e^{\frac{W}{kT}}$ accounts for stability, high ratio, high τ
- natural radiation (cosmic, e.t.c) too weak to account for all mutations
- mutations offer decreased stability → off-set by natural selection, ∴ low permenance
- higher T, greater P(mut) for wildtype genes compared to ~~normal~~ mutated genes
  - ionisation by X rays acts on a volume of chord 10 (atomic dist)^3
  - unstable mutants don't have higher X ray mut rates → X-rays ionisation density + EV power > threshold

~~Entropy~~

- A system may experience changes in electrical and chemical potential which become equalised + T becomes uniform, leading to the system fading into inert substances
- This is thermodynamic equilibrium, a.k.a maximum entropy
- Takes little time to get close, ages to close the final gap
- "Negative Entropy" - avoiding decay, for living things; metabolism helps, helps to slow entropy
- frees organism from the entropy it produces
- at 0K, ΔS always 0
- entropy = $k \log D$, k = Boltzmann constant, D refers to quantitative measure of atomic disorder
- if D = disorder, D^{-1} $(\frac{1}{D})$ is order ∴ $-(\text{entropy}) = -[k \log D]$ as $\log(\frac{1}{D}) = -\log 1)$
- thus we have -ve entropy by "sucking" in order [by gaining less complex molecules]

- this can also be thought of in terms of free energy

Life and The Laws of Physics

- it is clear that organisms show orderliness, governed by a well ordered set of atoms (in the aperiodic crystal)
- dislocation of atoms along loci lead to mutations
- In physics, individual determinism cannot be assessed (say 20 out of 100 particles decay in 20s, you can't say an individual particle underwent decay with 100% certainty)
- However, in Bio, phenotypic changes can be linked to changes on the gene relating to it
- We get orderliness in organisms from ① order to order (e.g. quantum jumps)
  ② disorder to order
- Large scale, statistical, laws in physics are based on the dynamic laws governing small scale processes (e.g. atomic)
- Clocks and Organisms → both solids, kept in order by quantum forces
  → evade tendency of heat motion to spark disorder
  → the aperiodic crystal is like a cog, but a finely made one