Chapter 6 - aging across the tree of life

If you're a whale than you can live a century or two
Or barely make it to your second birthday as a shrew
Some critters are immortal in a fascinating way
And you may learn their secrets if you concentrate today

Aging aging aging here and there
Aging aging aging aging aging everywhere!

From animals - dna repair and Cgas sting, Next chapter genetics of aging, centenarian xc genes, progeria and menopause dna damage genes , and yeast even deeper .

Plot log mass versus log lifespan which is maximum lifespan like in a zoo so you can have 1 g in two years that's the shrew all the way to Tenne to the power 8 g and 200 years which is the bowhead whale. 10 to the 8 g is 100 tons 100×1000×1000 and similarly mice dogs Humans.

This turns out to be a line on the log blog plot and that's called an allometric metric law longevity goes as mass to the power one fourth in other words the square root of the square root of the mass
There is a famous metric law that holds very well for mammals which is that the metabolic creator power total power watts calories per hour or whatever of the organism goes like mass to the three4 power. It's close to 2/ third power that you can get from surface to volume if we look at power per unit mass, we get a mass to the -1/4. So that cells from a mouse are about 100 times more power or metabolic rate than cells from a whale. And that holds up to be true.

so the ratio between the lifespan of a whale and a shrew Should be like the 1/4 power of the ratio of their mass that's 10 to the 8th g divided by 1 g to the power 1/4 or 10th to the two or 100 and that indeed fits because it's 200 years compared to 2 years

The fact that there's a quarter power in both lifespan and the specific metabolic rate suggests that the number of heartbeats in a life is constant about 3 billion and that's very romantic
This relation prompted the theory of aging called the rate of living theory that said that lifespan goes one over metabolic rate so faster metabolic rate more damage we live shorter that candle that burns the brightest goes out earliest

But there's only one problem in this element law for lifespan is wrong the people who did it appear to neglect some important data for example many back species way similar to mice or rats and live for decades like brands bat 5 g lives 40 years by the way on the middle on the metabolic rate or power element metric they fall exactly where they show according to their way

they're very high metabolic rate but they also live very long so it can't be the rate of living and bats are the only organisms. There's also naked mole rat which weighs like a rat and lives underground. Also lives for about four Years all kind of gliding animals like flying squirrels et cetera that's called the longevity quotient animals with high longevity quoting live longer than they should for their own mass.

We talk about patterns in this course and you can see that sometimes they can lead you astray- you need to have good data to see the true pattern .

Szekely when he was phd with me mass lingevoty triangle
anAge life is retreats for mammals mass length of pregnancy number of babies for birth, et cetera
It's a triangle with through whales and bats of vertices
And it's kind of full you're the bad you have some squirrels naked mole rat. There is a human near to it or some primates on the bottom. There's dogs cows African elephant and you could also put in birds which are also homoeothermic to keep their own temperature and say turtles are the same temperature as the environment flightless birds are near the bottom of the triangle flying.birds near the top
And when you see a triangle r tetrahedron we think of evolutionary theory of tradeoffs
No animal can run like a cheetah, fly like an eagle and swim like a dolphin. That's because there's limited reserves or the same in Yiddish you can't dance in two weddings with one touchas.
The thing is when we think of trade-offs we'll almost try to count out the different things that animal needs to do like this week needs to eat seeds and also pick insect but the number of different tests are our mind imposing a story on nature. There's a way to look at the number of vertices you get and understand what the number of tasks are That's called Pareto task inference

For example, let's think of the beaks of the finch that you imagine that there's two tasks eating large see seeds and and picking insects, we can measure the beak the width depth those are called traits and plot the space of traits and on a space of traits. There's a beak design optimal for task one eating seeds. Maybe it's a beak that looks like a plier there is another optimal beak for picking insects. Maybe it looks like a pincer those are called arc types arc type one and arc two . Of course the Arc tapes are different and that's the whole point with a single seed you can't be optimal both proceeds and for in .
so if there's only seeds you have arc type one if natural selection optimises and if there's only insect you'll have arc type two
but now let's imagine where the situation where there is both seeds and insects and we try to make a beak that can do both . It's point B in beak space:. It's performance at eating seeds decays with distance from arc type one it's performing eating insect decays with distance from archetype two. Now look at the line between the arc types we can guarantee there is a point A on the line that's closer to both archetypes than point B so it does both tasks better and since A dominate B in terms of fitness, in an evolutionary race beak A would win

there was nothing special about point B so we can erase all points and end up with the line. The line is the suite of variation we expect from species according to their niche if there's only insects your architect too, if there's only seeds in your archetype one if there's a mixture somewhere in the middle

What if there's three tasks the place to be is inside the triangle any point outside the triangle? There's a point inside. It's closer to all three art types so if we have data that falls on a plane and inside a triangle we can imagine
What if there's four tasks to see that we need to measure three traits and we find a tetrahedron? For example in gene expression of a liver cell if you look at the three principal components of gene expression you can find a liver cells fall into the tree Ron at vertices or cells that are specialists in important tasks like detoxification of the blood creating glucose creating blood proteins creating hormones And in the middle or generalist cell cells

So when we look at the mass triangle, we're trying to think of three tasks for life history and aging
In ecology there is a classic tradeoff between r and k strategies
Live fast die young live a good looking corpse-mice
Live long make one baby the time - elephants
They have smallest brain/mass ratio- army predated or starved because of their size
Third archetype - protected niche (flying, underground, cognitive niche) one baby, longest inter borthbwpaaocng compared to lifespan, largest brain/mass. Th EU teach their kids, eg bats carrying baby in back teaching th where forum tree is 20km away.
In ecology one thought hth tami that extrinsic mortality detained lifespan- a mouse will be killed in one year won't invest in slow growth and good repair that would make it live 10 years because it's gonna be killed off before that instead of investing making many babies growing quickly indeed my turn out to a very bad DNA repair compared to humans.
It's it's good to compare animals within the same. Let's say rodent to rodents from molecular topics.

Some evidence of a fourth archetype
when we add birth mass divided by mother mass it happens is very small babies near the archetype are pandas- oooh it's the archetype of cuteness-bears, lions, large carnivores. Perhaps the babies are small and cute to prevent the adults killing them mistaking them for prey.

Phylogeneticity does not explain the triangle - relationship censor whales are close to mice etc ,and marsupials which evolved from a different common ancestor than the rest of the mammals basically filled out a similar triangle.

Well you can tell by the way I use my leaves
That I'm a tree that lives a thousand leaves
Check out my girlfriend watch her swish
She's an immortal Jellyfish

Go ahead cry your tears
You humans only live for 80 years
You may teach an aging class
Compared to us you just won't last

Whether you regenerate or whether you degenerate
You're staying alive stayin alive
Whether you're symmetric or your telomeres are hectic
You're stayin alive staying alive