



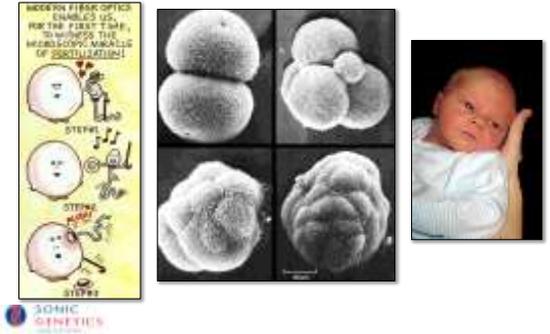
# Genes, survival, and survivorship

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*Survivorship 2015*  
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## Consider the everyday miracle



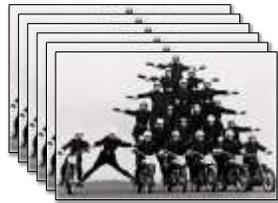
## DNA is long - very very very long



## Copying DNA accurately is hard

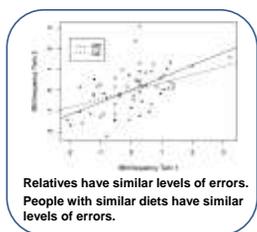
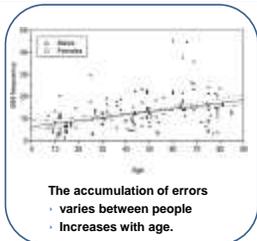


- Over 800 genes cooperate in maintaining the integrity of the genetic code in every cell.
- Each cell division requires 6 billion steps to copy the DNA.



Errors are inevitable every time, and accumulate.

## The load of genetic errors



## Causes and consequences of errors

### The rate of genetic errors is increased by

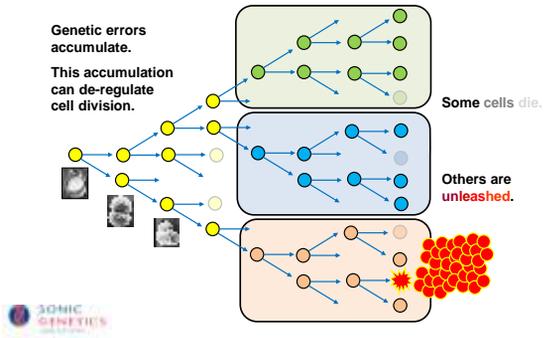
- Insufficient minerals & vitamins
- Exposure to toxins
- Inherited variations in 800 genes.
- Inherited errors in certain genes.

### Higher rates of genetic errors are associated with

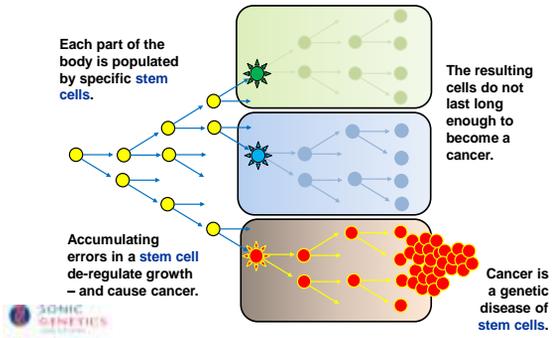
- Infertility
- Congenital malformations
- Cancer in infancy
- Cancer in adult
- Dementia



## Cancer is a genetic disease



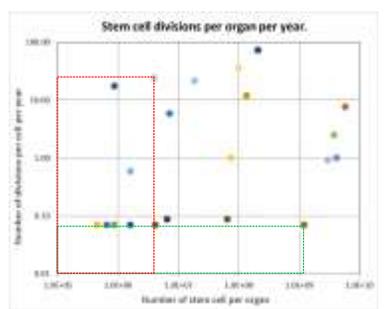
## Most cells cannot cause cancer



## Stem cells and DNA errors

The number of stem cells ( $x$ ), and the number of divisions per cell per year ( $y$ ), vary a lot throughout the body.

The rate at which genetic errors accumulate per tissue (area of box) varies a lot in different parts of the body.



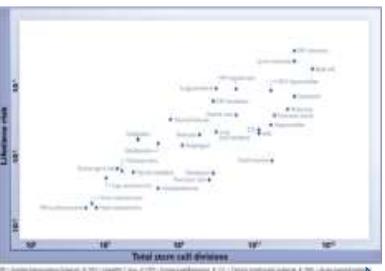
Science 347 (6217): 78-81, 2015

## Cancer risk vs stem cell divisions

Lifetime stem cell divisions  $\times$  tissue cancer risk over scale of **100 million-fold**.

Cell divisions (genetic errors) account for  $2/3^{\text{rds}}$  of variation in lifetime risk of cancer in tissues.

Family history, environment, diet, lifestyle etc account for **only 1/3<sup>rd</sup>** of tissue cancer risk.



No. of accumulated genetic errors in tissue stem cells

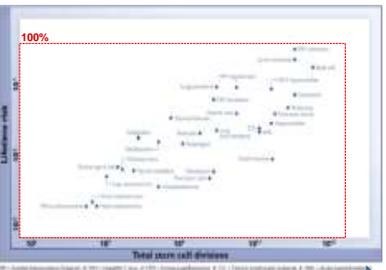
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## Cancer is inevitable

If you accumulate enough errors e.g. live long enough, cancer is inevitable i.e. **100% risk**.

Surviving cancer does not change that risk.

The only people who don't develop cancer for the first or multiple times have died of something else first.

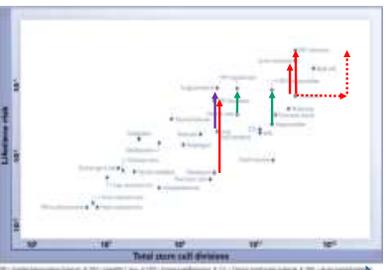


No. of accumulated genetic errors in tissue stem cells

## Making the inevitable worse

Familial variations in **DNA repair genes** increase the risk of cancer by increasing the underlying rate at which genetic errors accumulate.

Exposure to **toxins** or **infections** increase the risk of cancer by increasing the rate of stem cell division or by causing additional genetic errors.



No. of accumulated genetic errors in tissue stem cells

## Making the inevitable better

Your risk of cancer (again) can be reduced by

- choosing your parental genes carefully (*lose adaptability?*)
- having fewer stem cells (*fetal malnutrition?*)
- slowing the rate of stem cell division (*adult malnutrition?*)
- having a shorter life (*er ...*)
- avoiding toxins like chemo and radiotherapy (*that's helpful!*)



## Making the inevitable better

Your risk of cancer (again) can be reduced by

- avoiding avoidable toxins and infections (some bugs are friendly)
- Changing your diet and lifestyle. The following are associated with **slower** accumulation of genetic errors **and lower** risk of cancer.
  - Normal blood sugar control i.e. not diabetic
  - Normal weight for height i.e. not obese
  - Regular exercise i.e. keep active.



## Can dietary supplements help?

- Some vitamins reduce the rate of genetic errors (folate, B12).
- Others do not (vitamins C and E).
- Multivitamins are reported to decrease (usually) or increase (sometimes) the rate of genetic errors.
- Folate can block the damaging effects of some toxins *in vitro*.

Vitamins do **not** always reduce the risk of cancer

*e.g. folate effect on adenomas.*

Balanced diet & lifestyle **do** reduce the risk.



Mutagenesis 26 (6): 745-752, 2011  
Nutrition Research Reviews 16 (1): 109-22, 2003

## Meeting the inevitable

For every living thing, the ultimate risk of cancer is 100%.

Professors can advise on **HOW** and **WHAT**.

Only you can advise on **WHY**.

*Life is a sexually-transmitted fatal disease!*

There are beautiful wild forces within us.  
Let them turn the mills inside  
and fill sacks  
that feed even  
heaven.

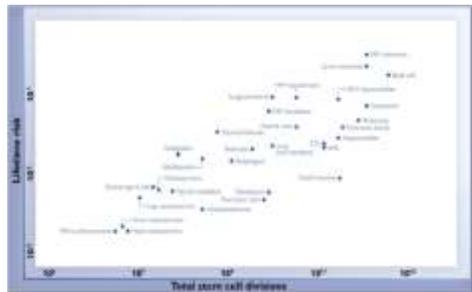
*St Francis of Assisi (1182-1226)*



Thank you.

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## Cancer risk vs stem cell divisions



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