L-15

UNIVERSITY OF..

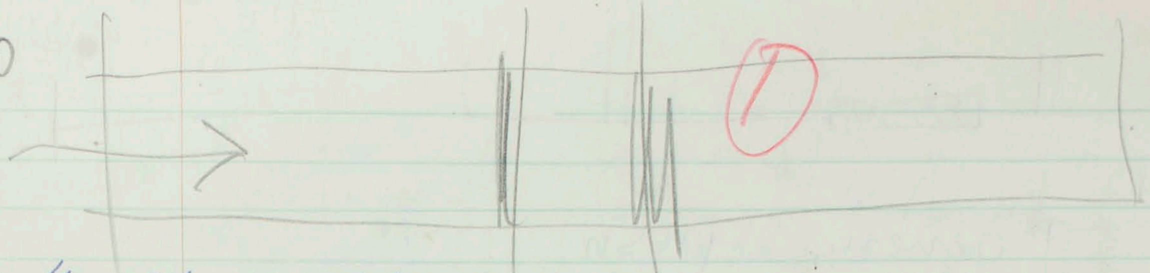
COLORADO

"Buffaloes"

UNIVERSITY OF COLORADO

1876

pho



1

Phot of table

388

530

Gay Woodruff
Hi 2-7124
Ext 7009

~~Condon~~
~~HI 2 2189~~
~~860 12th St~~

Our Load of Mutations
H.J. Muller ~~p. 171~~
The Am Journ of
Human Genetics ~~p 111~~
Vol 2 p. 111 1950

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~~M.D.~~ Birth 29 Aug 1927
A.B. Harvard 1950 (49)
M.D. Harvard 1954
Intern Colo Gen Hosp ~~195~~ 7/54 - 6/55
Resident Med " " " 8/55 6/57
Instructor Dept Biophysics " 7/57 - 6/59

Humanities

~~Rosenblith~~
R. Duncan Luce
Wash.
in Colorado Unite Weather Service

Ch 4 7473 Webb
Kitt Lyons
Local Newspaper
Sage Bromish

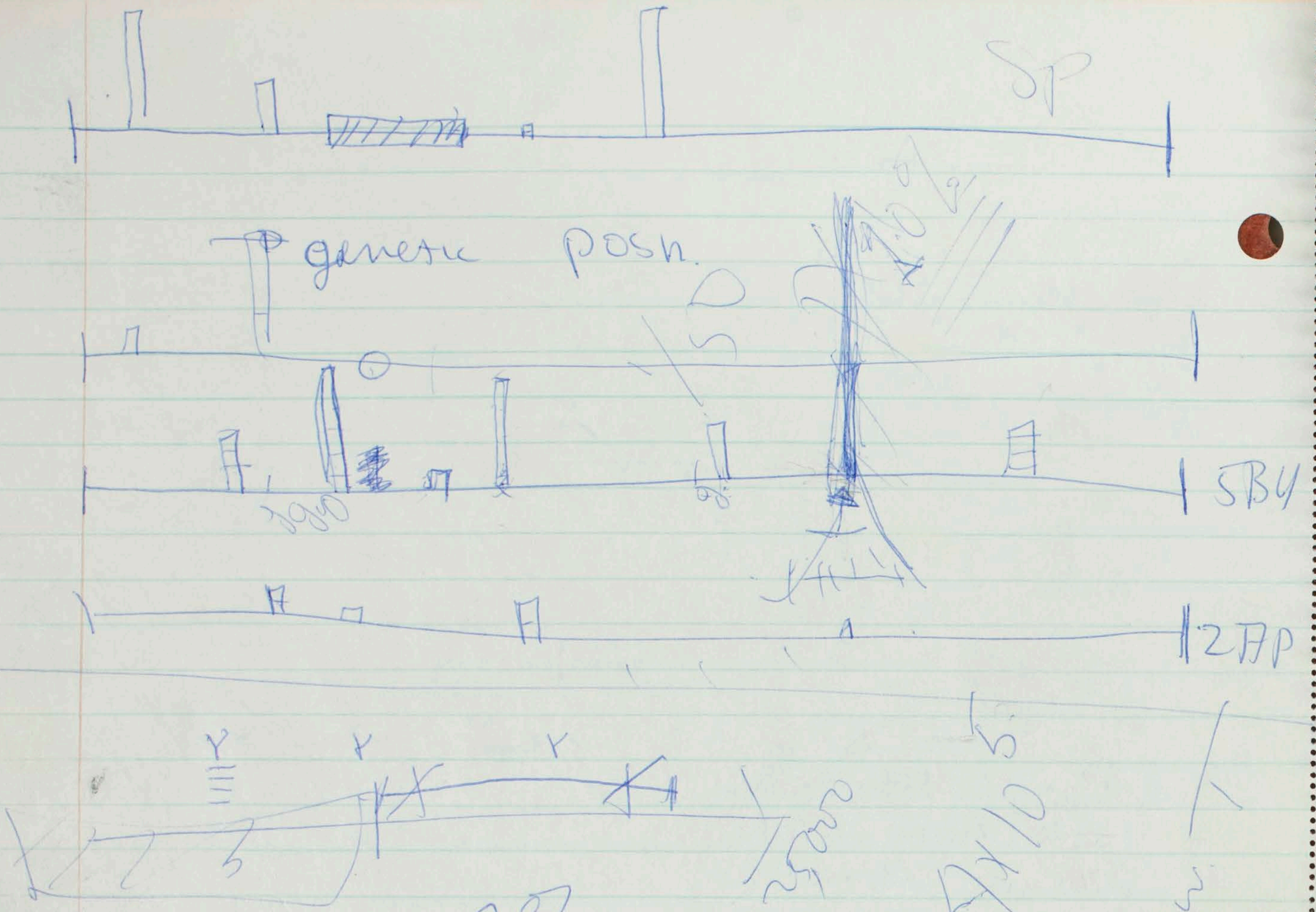
Facts from figures
p. 105
M. J. Moroney
Penguin Books 1951

Handbook of Probab
and Statistics
Burlington & May
Handbook Publishers
Inc. Sandusky, Ohio

$$\Gamma n = (n-1)!$$

Feller
Probability Theor
Wiley 1957

freq ↑



2%

Φ_{BU}

1/500

50

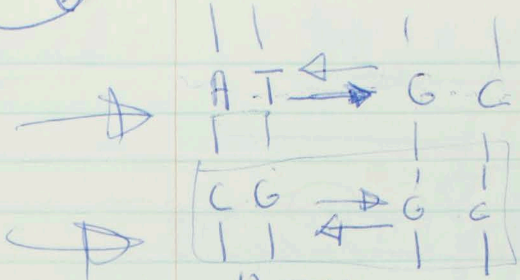
$2\% \times 4\times10^5$ /2

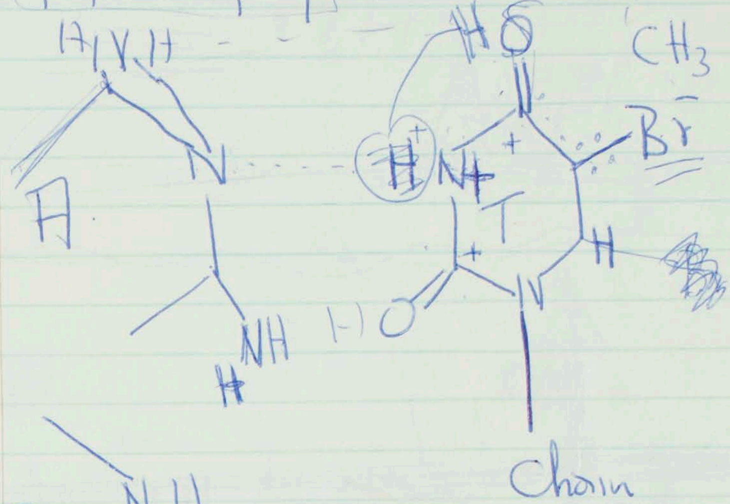
4×10^3 pts

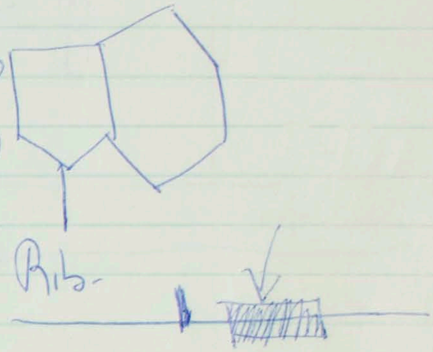
4×10^5

2

5 IU } Pyrim
5BU }
5 ClU } Uracil
5 FU }



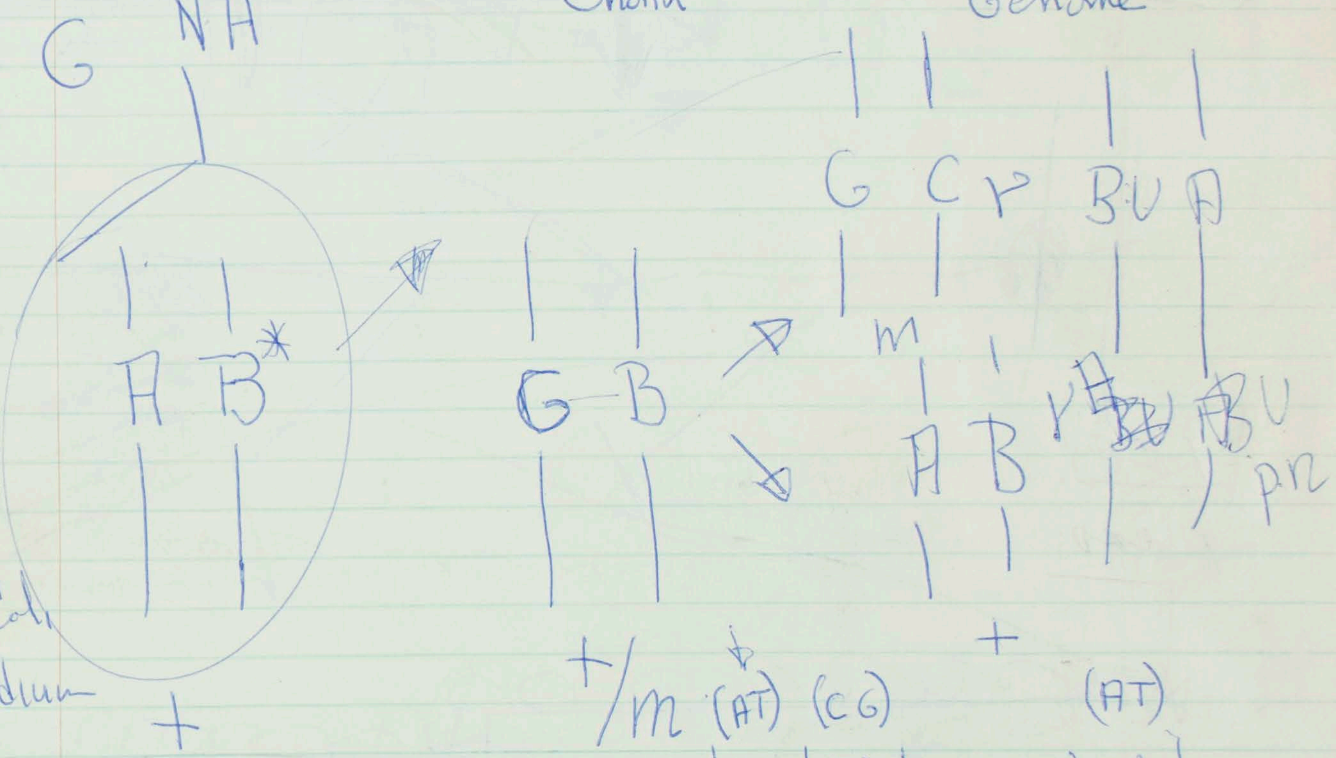




+

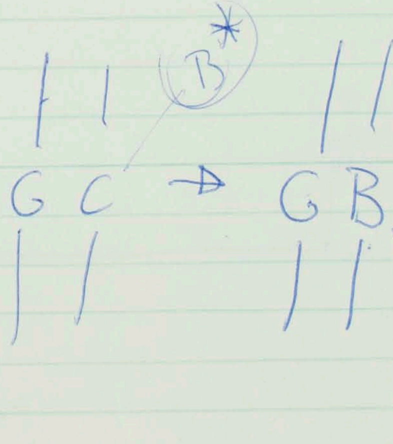
Pu

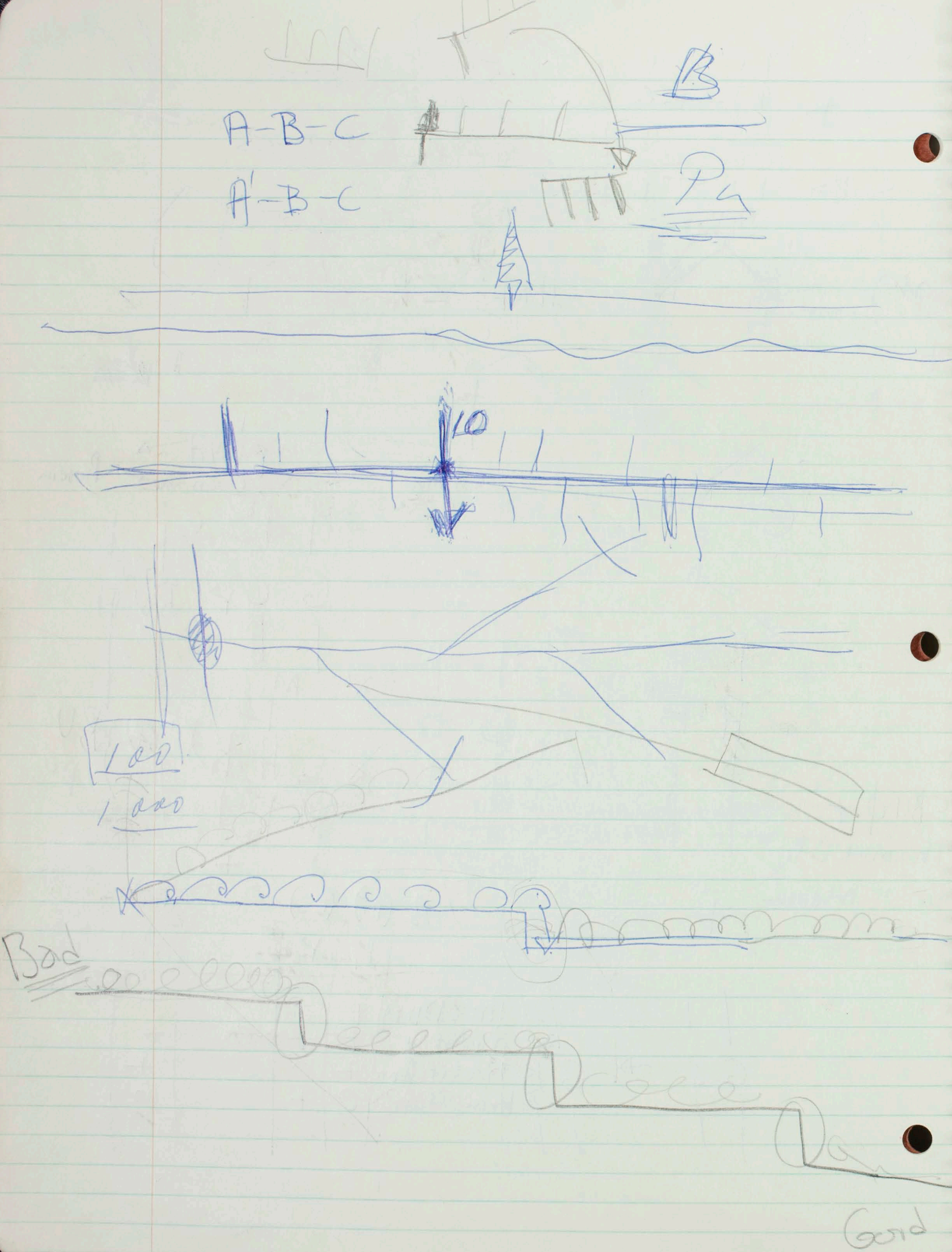
?↕ DNA $\xrightarrow{?}$ Protein
Genome ↔ Protein



5BU φ +
Thymine Coli
In " medium

+/m	(AT) r_1	(CG) r_2	. . .	(AT) r_n
Arise Dirty	+	+		+
Revert "	+	+		+
Revert Clean	+	0		+
Arise Clean?	0	+		0

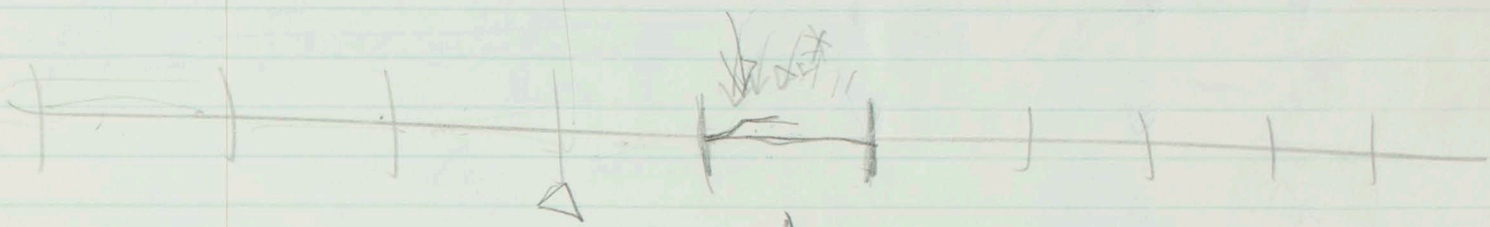


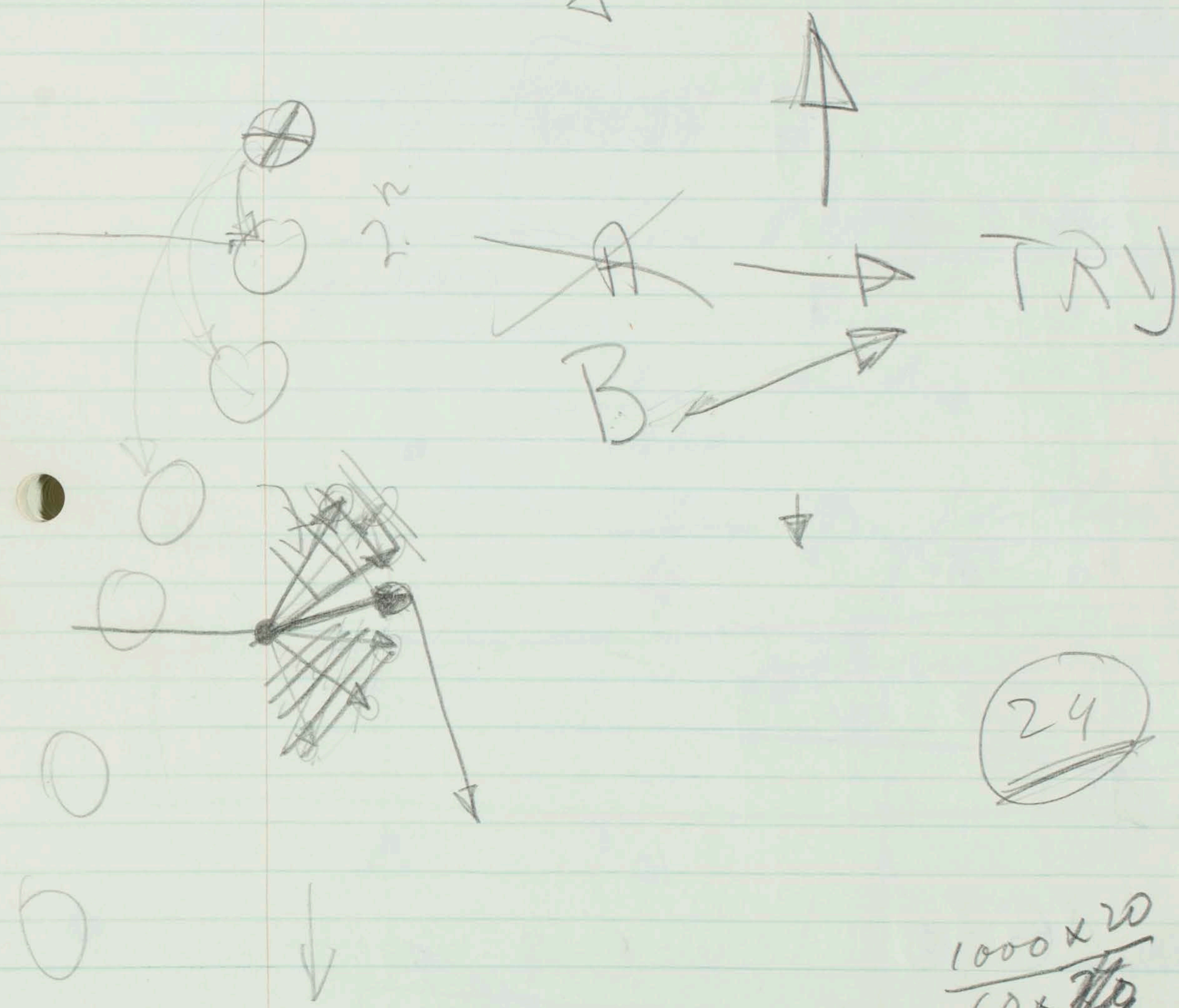

A–B–C
A'–B–C
B
Pu
10
100
1000
Bad
Good

400 x 50 20000

3

H





24

1000

100

24

$\frac{1000 \times 20}{60 \times 24}$

$\frac{24}{1}$

30000

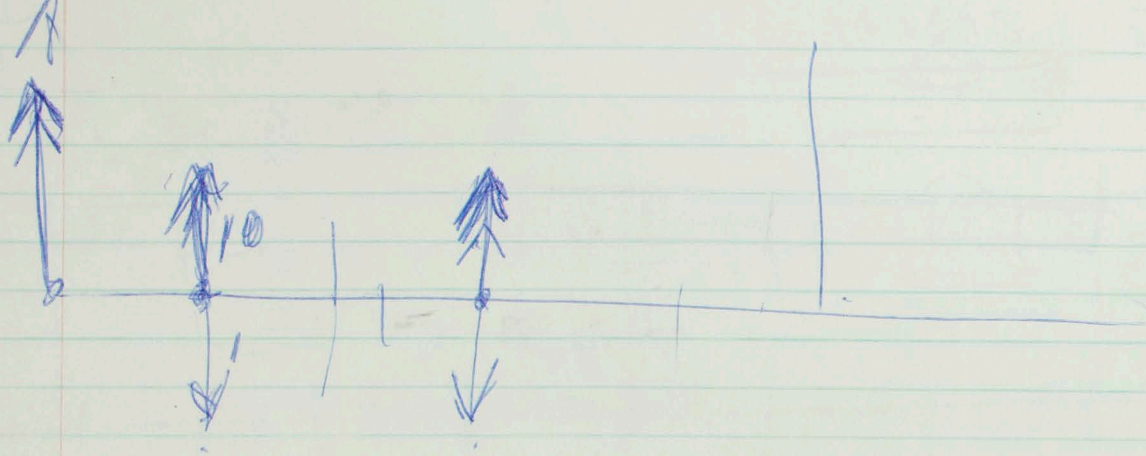
$\frac{30}{7}$

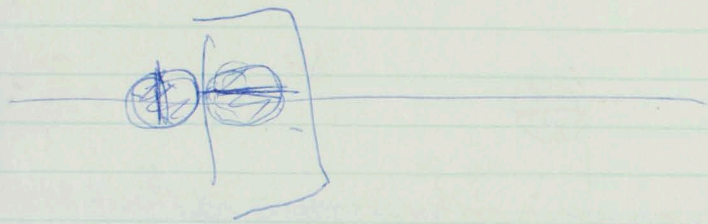
100

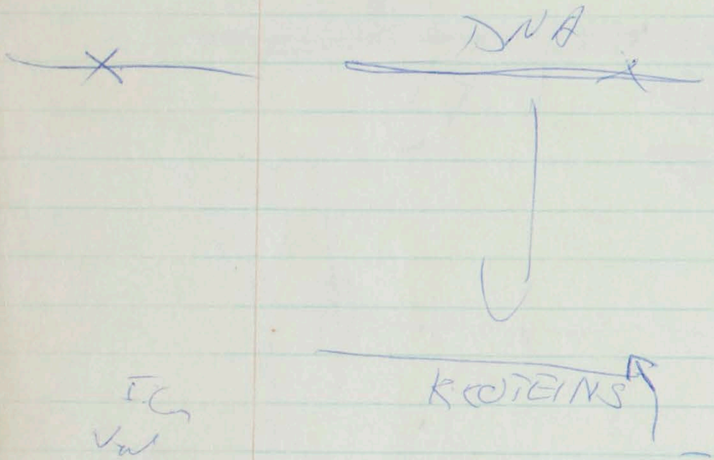
20000

15/sec

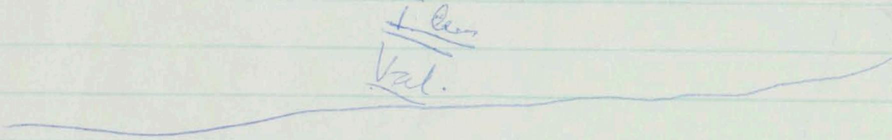
1500







I.C.
Val



10^6

$\underline{1.0^6}$

10^2 (1.02)

4 $x+y$ $\{(1-x)(1-y)\}$

RNA is 5% of [illegible]

RNA for 20 AA –

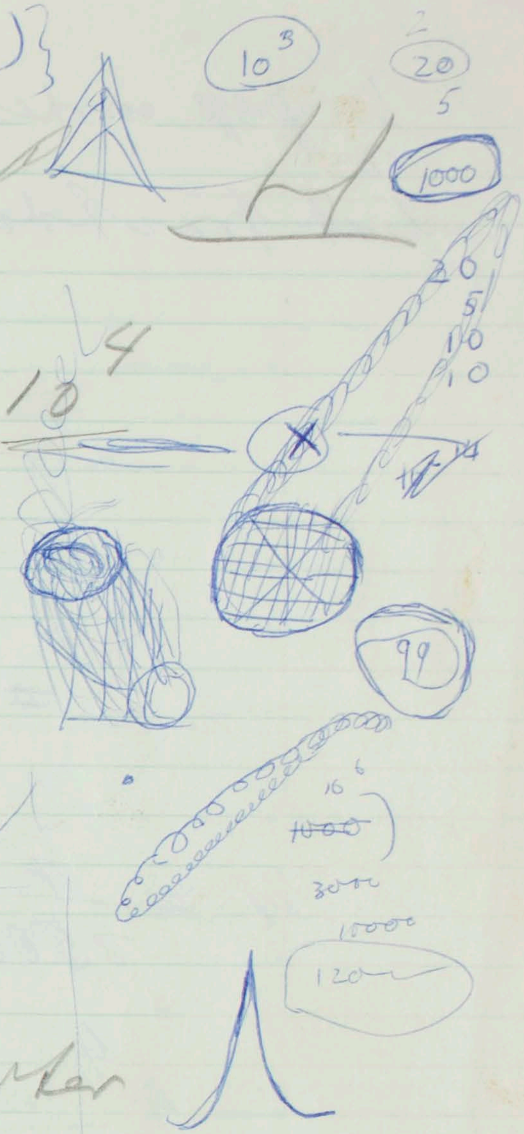
M = 50 nucleotides = 10^4

3500

10% of dry weight

$\frac{1}{200}$ of dry weight

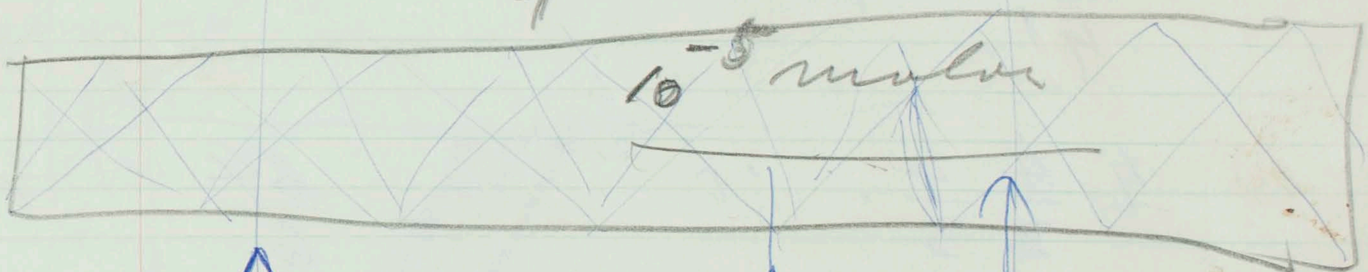
$\frac{1}{20} = \frac{1}{4000}$ for 1 AA

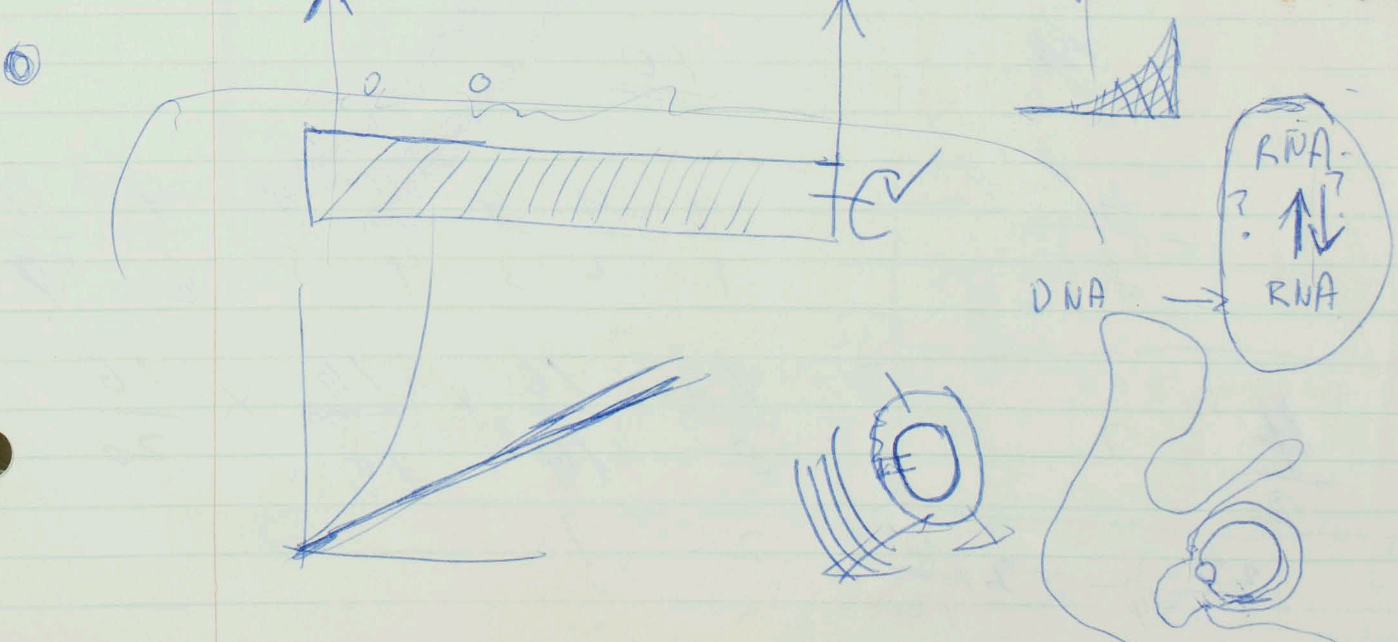


$\frac{1}{4000}$ gm/cc

$\frac{1}{4}$ gm/liter

10^{-5} molar





$\frac{1}{2}$ pop circles 4 birds

what fraction circles & birds

$\cancel{\frac{n^r}{r!}} e^{-n}$

$$= \frac{n^r}{r!} e^{-n}$$

$$\frac{n^r}{r!} \approx e^{-\frac{r^2}{n}}$$

$$e^{-\frac{(r-n)^2}{n}}$$

$$\int_0^{r} e^{-\frac{(r-n)^2}{n}} dr$$

$$n = \frac{4}{2500}$$

$$\frac{4^4}{4!} \cdot 10^{-\frac{4}{2\cdot3}}$$

$$\frac{4}{1}\frac{4}{2}\frac{4}{3} \cdot 10^{-\frac{4}{2.3}} = \frac{64}{6} \quad 10$$

$$\underline{\underline{10}}$$

$$\frac{4^8}{8!}$$

$$\frac{4}{1} \quad \frac{4}{2} \quad \frac{4}{3} \quad \frac{4}{4} \quad \frac{4}{5} \quad \frac{4}{6} \quad \frac{4}{7} \quad \frac{4}{8}$$

$$\frac{16}{8} \quad \frac{16}{14} \times \frac{16}{18} \times \frac{16}{20}$$

2 1

$$\frac{4}{2} = 2$$

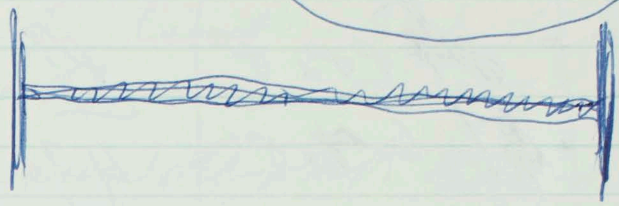
$$\frac{2222}{1234} = 2 \times \frac{4}{12}$$

$$= \frac{2}{3}$$

Aging 5 W

50r = 1 break $\frac{1}{50}$ lifetime

50 hits



100000 genes

n p | $\left(\frac{p}{m}\right)^2 m = \frac{1}{2}$ 1 or 10

$p = 50$

$$\frac{(50)^2}{m} = \frac{1}{2}$$

$m = 2500$ | 100,000

20

40 genes n

$e^{-\left(\frac{p}{m}\right)^2 m}$ 8 genes || 4 hits

= surviving fraction of diploid cells

$\cancel{n = 8}$

$$\frac{8^8}{8!}$$

$$\frac{8^4}{4!}$$

$$\frac{8^{12}}{10!}$$

$$\frac{8^4}{4!} \quad \frac{8}{6} \quad \frac{8 \times 8}{7 \times 8}$$

$$\frac{8^4}{4!} \quad \frac{8\,8\,8\,8}{5\,6\,7\,8}$$

$$\frac{64}{30} \quad \frac{64}{56}$$

$$\frac{8^8}{8!} \quad \frac{8\,8}{9 \times 10} \quad \frac{8}{11} \quad \frac{8}{12}$$

$$\frac{64}{90} \times \frac{64}{120}$$

$$\frac{64\ 64}{13 \times 14 \times 15 \times 16}$$

$$\frac{13\ \ 14\ \ 15\ \ 16}{9\ \ 10\ \ 11\ \ 12}$$

1.4 14. 14 14

4

H

If the Germans had done it.-

Line of least resistance was unconditional surrender.-
Moral considerations were not ~~[illegible]~~ given sufficient weight to induce the Am. Govt. to deviate from the line of least resistance.- *

Postwar sees ~~[illegible]~~ no evidence of dissent in public.-
Dissent was present on subconscious level.-

Outline:

The Govt. & the scientists.

The Germans:

Americans   Postwar - dissent

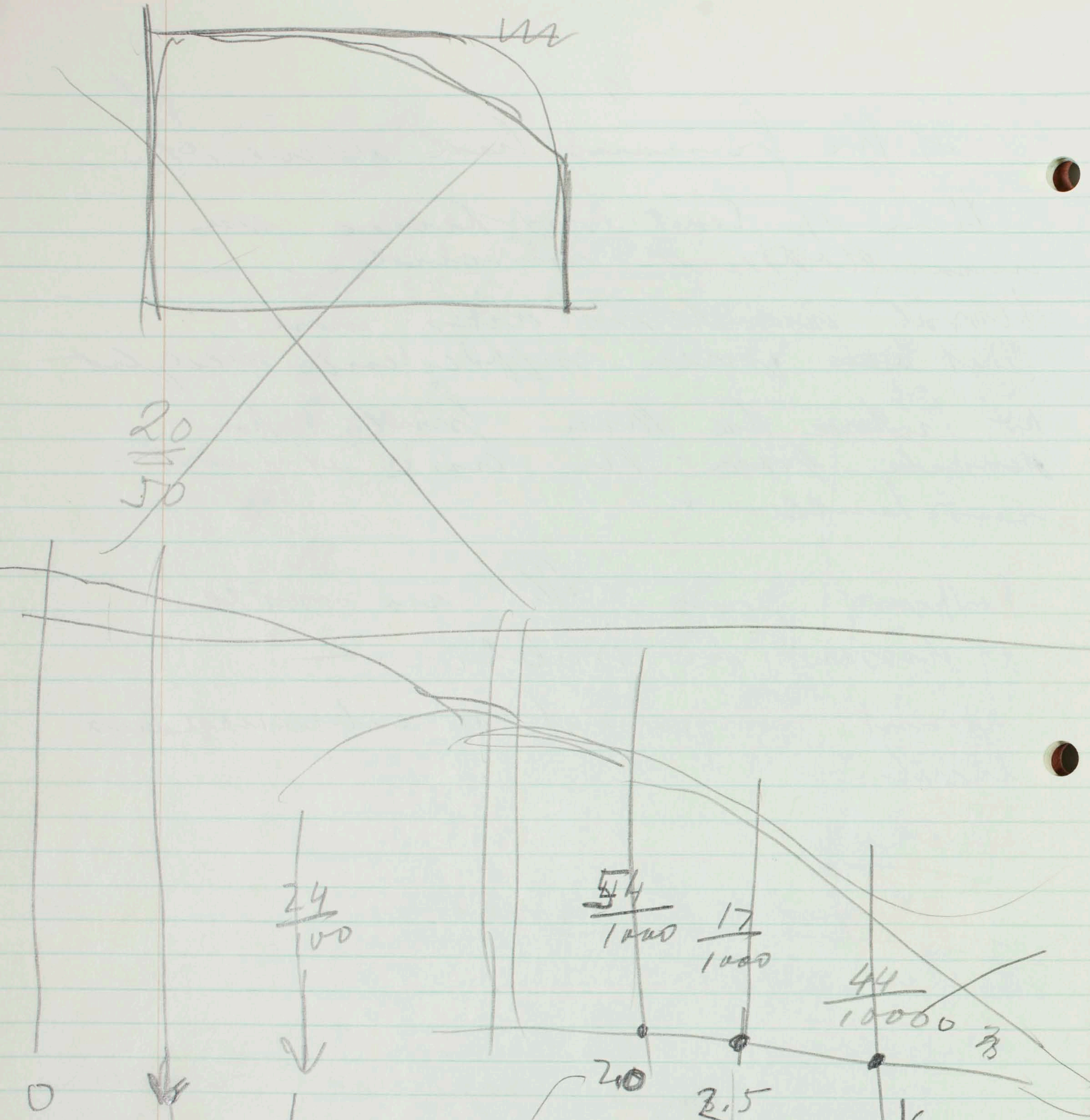
Bush. - English exp. with German

Bethe's what saved Los Alamos
Teller - one is name

In retrospect - preventive war
what might have happened if America had increased its lead

Might is right   Korean war

The shooting war
[illegible] [illegible] backward



$\frac{0.399}{0.500} = 0.8$

$\frac{24}{15.87} = 1.5$

1.87

3 | 0.0013

.0227

.0062

$\frac{17}{6.2}$

$\frac{44}{13} = 3.4$

$\frac{54}{22.7} = 2.38$

1.6

1.42

7 4

At the end of distance

1 1

8 8

64 32

$\frac{8\times 64}{2\times 3}$ $\frac{8}{6}$ 64

8 years

$\frac{64\times 64}{1,2,3,4} = 64\times\frac{64}{24}$

$\frac{n^r}{r!}$ $r << n$

$\int_0^{r_0}\frac{n^r}{r!}\,dr$

$$\frac{m^r e^{-m}}{r!}$$

$m = 3$

$r=1$	$r=2$	$r=3$	4	5	6	7
				~~2.00~~	1	$\frac{3}{7}$
1	$\frac{9}{2}$	$\frac{27}{6}$	$\frac{81}{24}$ 3.36	$\frac{81 \times 3}{24 \times 5}$	$\frac{81}{24}$ $\frac{9}{30}$	
	$s = \frac{33}{6}$	$s = \frac{60}{6}$	$s = 13.3$	15.3	16.3	16.7

1
4
6
29
27
60

$\frac{720}{750}$

e^{-3}

1	$\frac{27}{33} = 0.82$	$\frac{27}{60} = 0.45$	0.25 ~~0.265~~	0.13	0.063

ratio is k

$\frac{3}{k}$ $\frac{3}{k}$ $\frac{3}{k+1}$

A

A+1

A $\frac{3}{7}$ $\frac{7}{3}$

$\frac{9}{3}$

8

H

.24
100
0.24

800
1000

293
1000

3

44/104
.9987

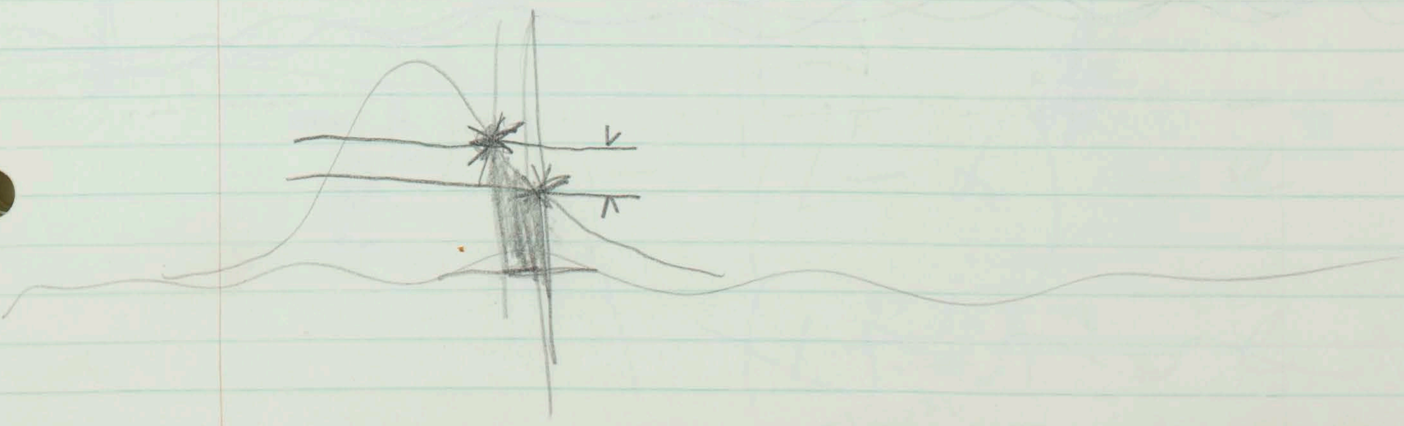
2

x6

0

54/1000
0.9773

2.09



$$\frac{p^2}{m^2} m = 1$$

$$\frac{1}{e}$$

$$\frac{p^2}{m^2} m = 4.1/2$$

$$10^2 = 100$$

$$e^{2 \times 2.3} = 100$$

$$p^2 = 2500$$

$$p = 50$$

$$p^2 = \cancel{15{,}000}\ 10{,}000$$

$$p = 100$$

for ——— 1/10 nonrolling

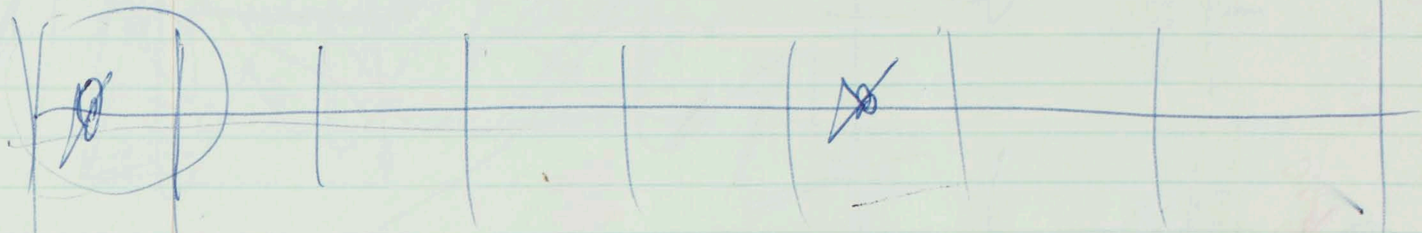
$$p^2 = 6000$$

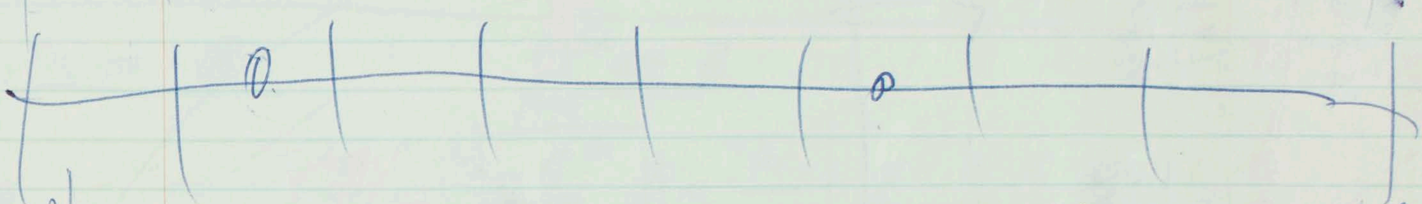
$$p = 80$$

H

$$\frac{100{,}000}{40}$$

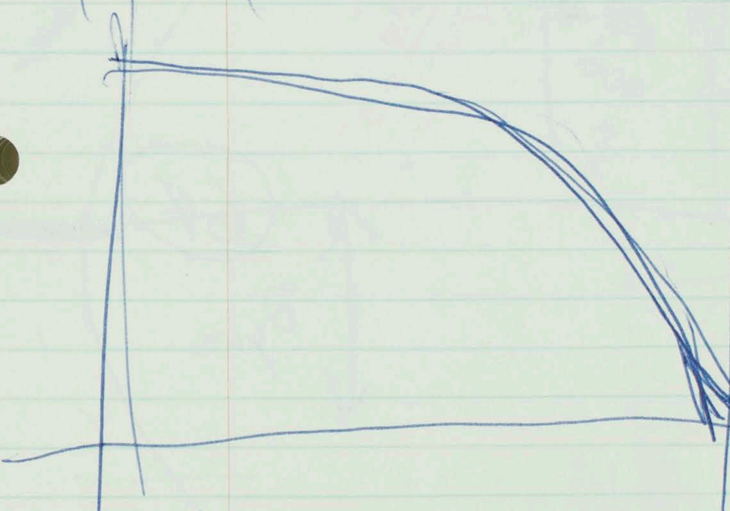
$m = 2500$



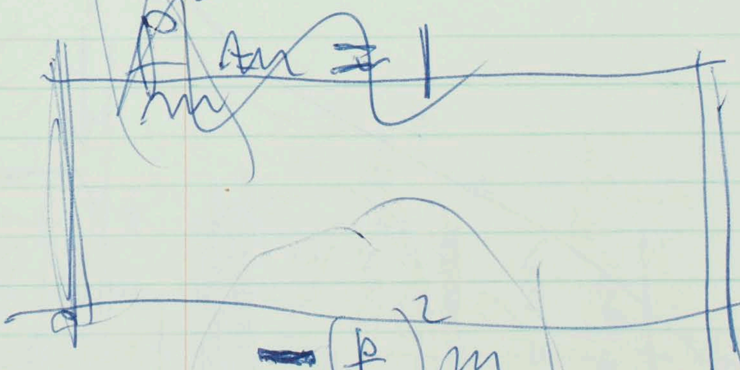


p damages/division

$$\frac{p}{m} \ll 1$$



$$\left[1 - \left(\frac{p}{m}\right)^2\right]^m$$

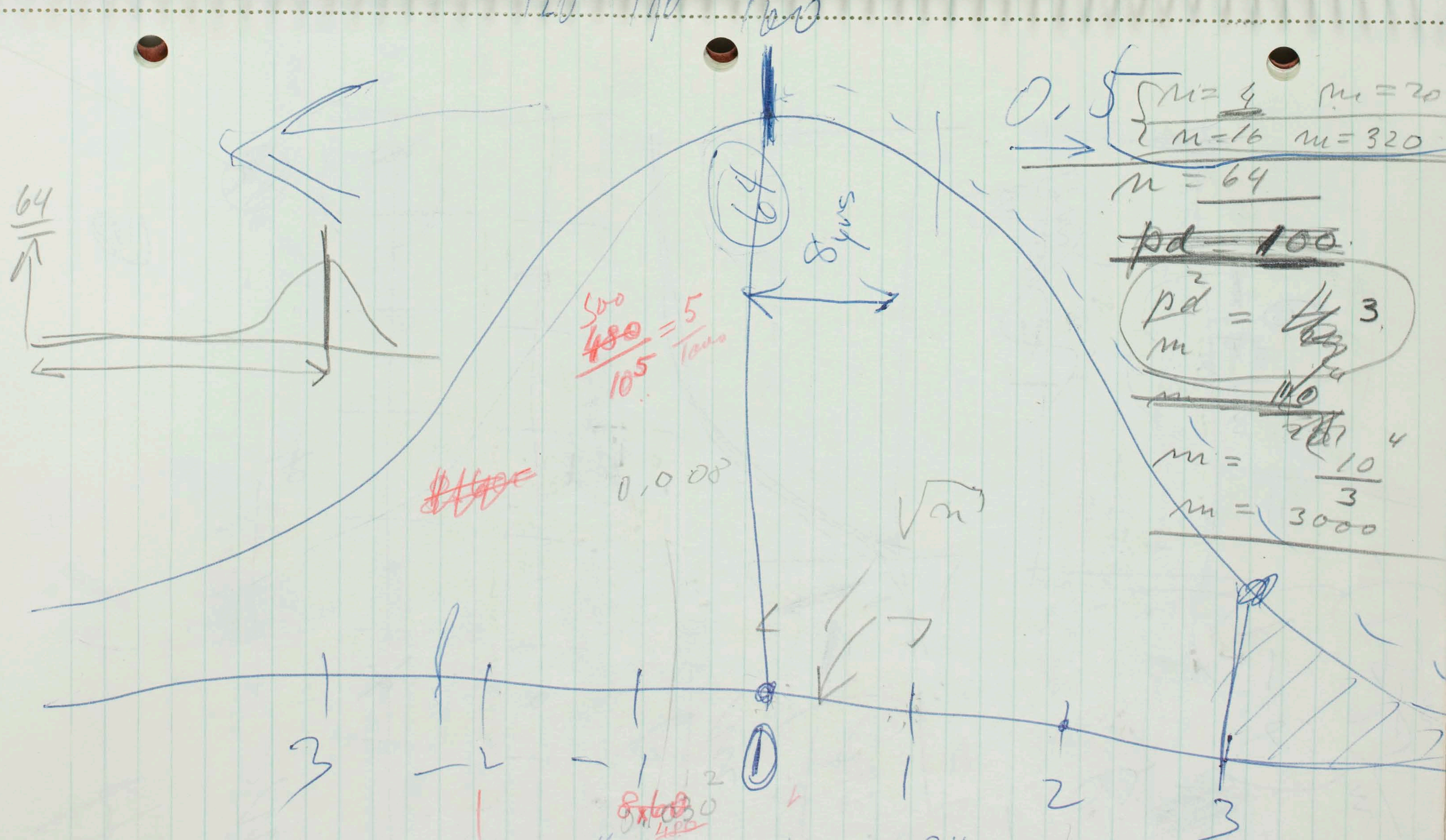


$$-\left(\frac{p}{m}\right)^2 m$$

e

$$e^{-\left(\frac{p}{m}\right)^2 m} = (1-\alpha)^m = e^{-\alpha m}$$

$$\left(1 + \frac{1}{m}\right)^m = e$$



$0.5 \left\{ \begin{array}{ll} m = 4 & m = 20 \\ m = 16 & m = 320 \end{array} \right.$

$m = 64$

~~pd = 100~~

$\frac{pd^2}{m} = 4$ 3

$m = \frac{10^4}{3}$

$m = 3000$

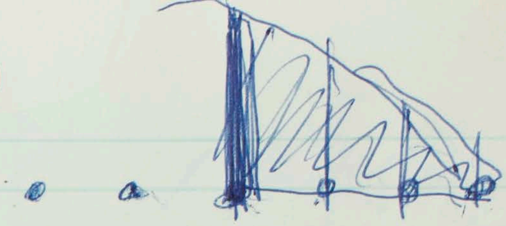
$\frac{0.0044}{1}$	$\frac{0.054}{0.977}$	$\frac{0.24}{0.84}$	$\frac{0.4}{0.5}$	$\frac{0.24}{0.16}$	$\frac{0.054}{0.0227}$	$\frac{0.0044}{0.0013}$
0.0044	0.055	0.285	= 0.8	= 1.5	= 2.37	= 3.4
	5.2	2.8		1.58		1.44

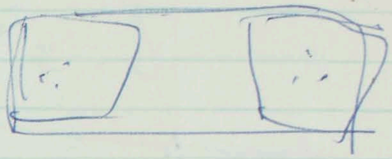
$\frac{0.0044}{8} = 0.00055$

$\frac{0.054}{8} = 0.0068$

$0.00125 \times 8 = 0.01000$

10





Page

$n = 6$

$r = 6$

$\frac{215}{500} = 0.46$

1

A_0			
$\frac{6^6}{6!}$	$A_0 \times \frac{6}{7}$	$A_0 \frac{6}{7} \frac{6}{8}$	$A_0 \frac{6}{7} \frac{6}{8} \frac{6}{9}$
	A_1	A_2	A_9
	$r = 10$	$r = 11$	$r = 12$
	$A_9 \frac{6}{10}$	$A_9 \frac{6}{10} \frac{6}{11}$	$A_9 \frac{6}{10} \frac{6}{11} \frac{6}{12}$

$\frac{36}{2}$

$\frac{215}{1,300}$

$= A_9\ 0.165$

$$\frac{6^3}{123} \frac{6^3}{456} = \frac{215 \times 215}{6 \times 120} = \frac{4.6 \times 10^4}{720} = A_0\ 0.076$$

$$= \frac{4600 \quad 10}{720} = \underline{\underline{64}}$$

$(1.5)^4 = 5$

$(1.5)^8 = 25$

6.5

$\boxed{50}$

42

$1.6 = \frac{1}{1-x}$

$x = \quad 1.6 - 1.6x = 1$

$x = \frac{.6}{1.6} = 0.375$

$\left(\frac{p}{m}\right)^2 < 0.375$

$\frac{p}{m} < 0.61$

$p = 5$ if $m = 10$

raise p to 10 what is m

$\left(1 - \left(\frac{10}{m}\right)^2\right)^m = \frac{1}{100}$ $\boxed{m = 20}$

try $m = 20$ $\sqrt[20]{100} = 1.26 = \frac{1}{1-\left(\frac{10}{20}\right)^2}$

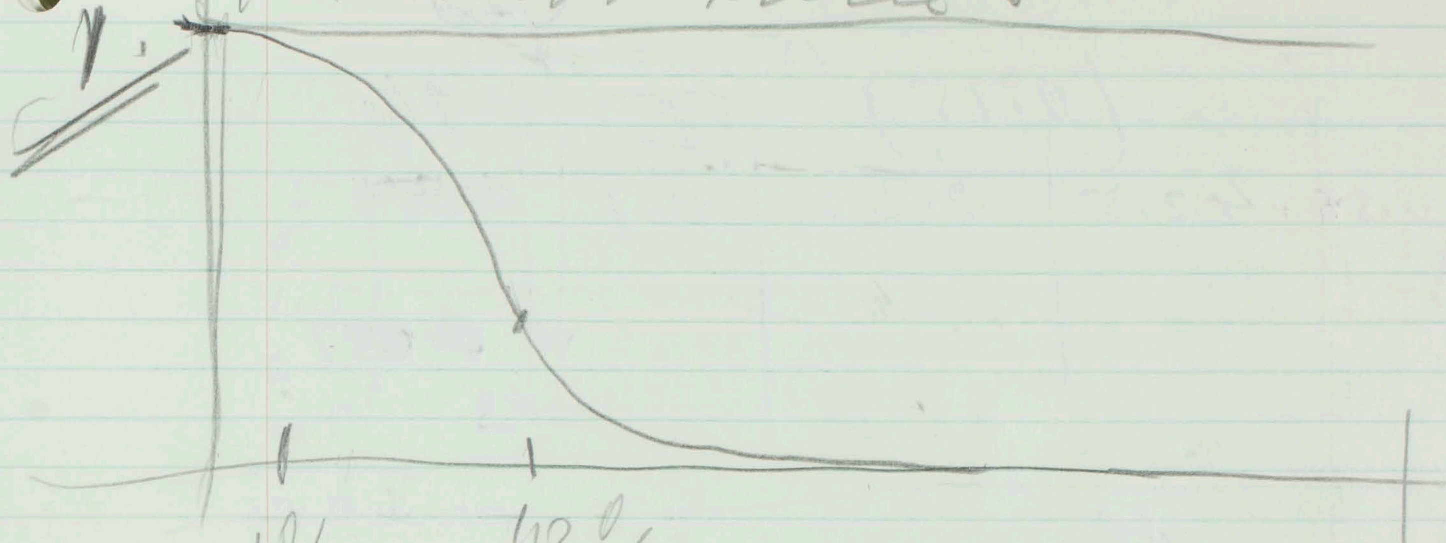
$x = 0.26$

$p/m = 0.5$ $1.26 = \frac{1}{1-x}$ $1.26 - x = 1$

11

Probab of dying in unit time

1/7

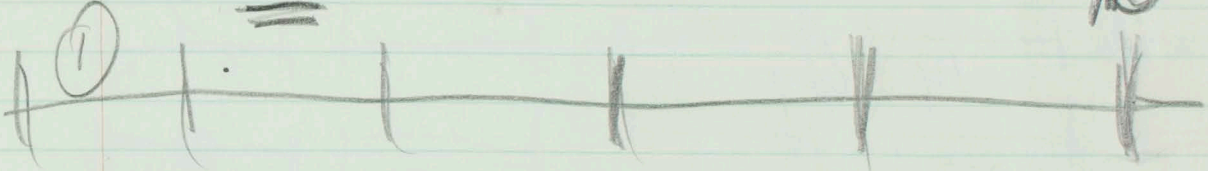


1%   10%

fractional num.

$m = 10$

$e^{-p^2/m}$



probab that no double hit

$2p/m$

$e^{-2p/m}$ is that (1) is not hit

$m = 10$

$p = 3$

$$\left(1 - \frac{p^2}{m}\right) = \frac{1}{100}$$

$$100 = \left(\frac{1}{1 - \frac{p^2}{m^2}}\right)^{10}$$

log

14

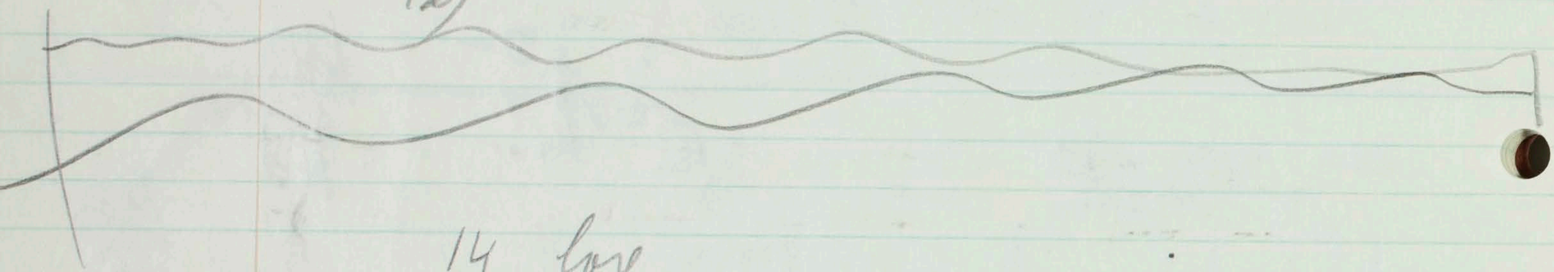
$$\left(1-\left(\frac{7}{14}\right)^2\right)$$

12

$$(0.75)^{15}$$

$.75$ | 0.56 | $.42.5$ | 0.32 | $\boxed{8}$ 0.1 | 14 ~~0.01~~ 0.017

0.03



14 log

$$\frac{2}{8}\,\frac{0.301}{8} = \underline{0.071}$$

1.18

$$\frac{2}{1.18} = \boxed{1.7}$$

12

$\frac{4^4}{24}$

$\frac{16}{2}$

$\frac{256}{24} =$

5

8

1.5

6

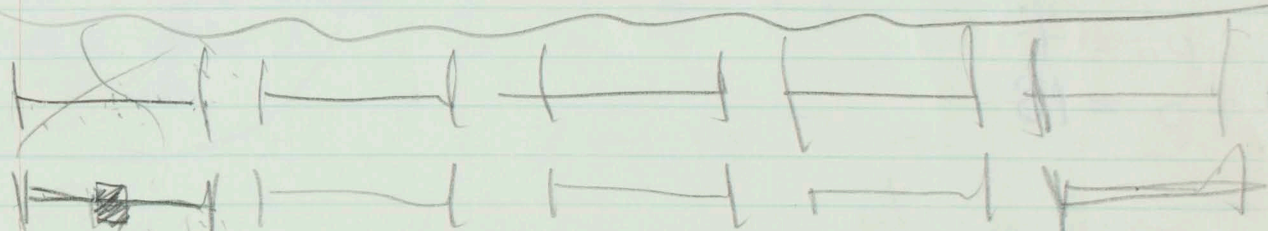
2.5

23.0

① lifespan derivable from

A

B



$m = 10$

$\left(1-\frac{p}{m}\right)^{2m} = \frac{1}{20}$

$20 = \left(1-\frac{p}{m}\right)^{20}$

$\left(1-\left(\frac{p}{m}\right)^2\right)^m = 100$

0.75

e^4 100

$$\left[\cancel{1}\left(\frac{p}{m}\right)^2\right]^m$$

64

$$\frac{p^2}{m} = 1$$

$\cancel{p}\ 8$

$$\left(1-\left(\frac{p}{m}\right)^2\right)$$

$$e^{-\frac{p^2}{m}}$$

$$\frac{p^2}{m} = 3$$

$p^2 = 3m$

$64 = 3m$

$m = 21$

$$\begin{cases} 2p_0 = 4 \\ 2p = 16 \end{cases}$$

$$[1-0.16]^{20} \approx \frac{1}{20}$$

$$\left[1-\left(\frac{6}{20}\right)^2\right]^{20}$$

$$(1-y)^m = e^{-ym} \quad e^{-y}$$

5 $\frac{1}{e}$ 8 $\frac{1}{20}$

$\frac{36}{20}$ $\frac{1}{20}$

$\cancel{e^{-20}}$

$e^{-\frac{36}{20}}$

13

$\cancel{1}\ 2p = 16$ for death

what about $\underline{m}$

$$\left[1-\left(\frac{2p}{2m}\right)^2\right]^m = \cancel{\frac{1}{20}}\ \frac{1}{10} = e^{-2.3}$$

$$\left(\cancel{1}0\right)^{\frac{1}{m}} = \frac{1}{1-\left(\frac{2p}{2m}\right)^2}$$

$m = 20$

$\underline{0.05}$

$$\left(e^x\right)^{\frac{1}{m}}$$

$$\left(1+\frac{a}{q}\right)^{q \times b} = e^{ab}$$

$$\left[1-\left(\frac{2p}{2m}\right)^2\right] = e^{-\frac{2.3}{m}}$$

$$1 - x^2 =$$

$$\frac{1}{20}$$

$$x^2 = 0.115$$

$$x = 0.34 = \frac{p}{m}$$

$$\frac{p}{m} =$$

$$\left[1-\left(\frac{8}{40}\right)^2\right]^{20}$$

$$\boxed{m = 23}$$

$$\left[1-(0.4)^2\right]^{20}$$

$$\left[1-\left(\frac{2p}{2m}\right)^2\right]^m$$

$$\left(1-\frac{0.4}{100}\right)^{25}$$

$$\left[\quad\right]^{\left(\frac{m}{p}\right)^2} = e^{-\frac{p^2}{m}}$$

$2p = 4$

G

~~the~~ $n = 4$

Webb
Dung 11/58

e^{-at^2} 14

$\left(\frac{1}{e}\right)$ $\left(\frac{1}{20}\right)$

$m = 20$

A

B

$\frac{2p}{2m}$

$$\left(1-\left(\frac{2p}{2m}\right)^2\right)^m = \text{surviving probab.}$$

$$\left(1-\left(\frac{p}{m}\right)^2\right)^m = e^{-\frac{p^2}{m}}$$

$m = 20$

~~$2p = 16$~~

$$\left(1-\left(\frac{p}{20}\right)^2\right)^{20} = \frac{1}{20}$$

$$e^{-\frac{p^2}{20}} = \frac{1}{20} = e^{-3}$$

$$\frac{p^2}{20} = 3$$

$$p^2 = 60$$

$$p \simeq 8 \quad (7.75)$$

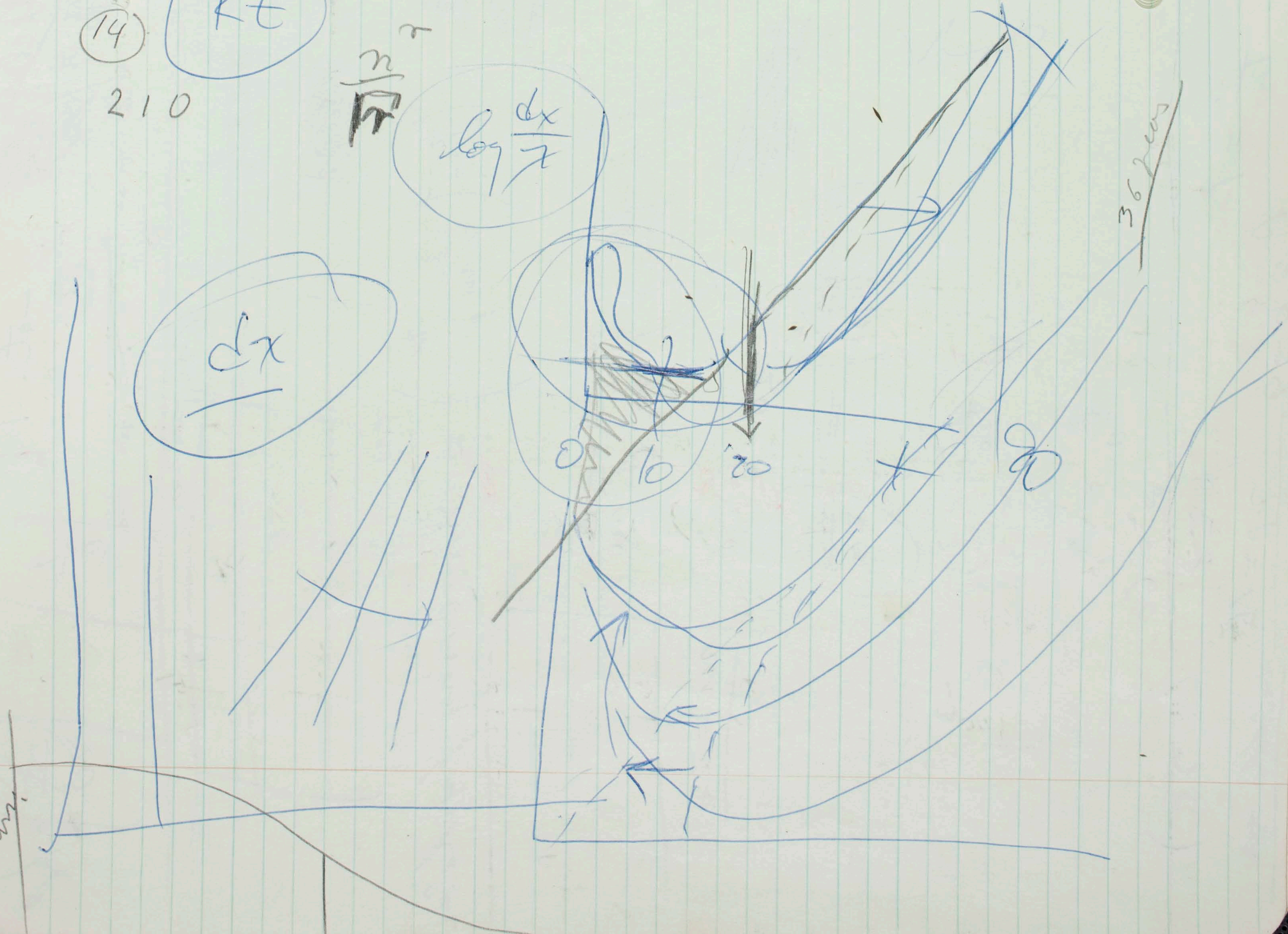
$\frac{p^2}{20} = 1$ $p = 4.5$ $2p = 9$ $2p = 16$ middle age

14

Kt

210

n^r



0	1	2	3	4	5	6	7	8	9
1	4	8	10.75	10.75	8.6	5.7	3.28	1.64	$\frac{n^r}{r!}e^{-n}$
1/2	3	9	18.3	29	38.8	46	50.4	53.	54.1
1.3	0.89	0.59	0.37	0.22	0.12	0.067	0.031	0.013	
1.46	1.51	1.6	1.7	1.8	1.8	2.1	2.4		

2.5 6 9.37

43.1
2.85

52.1

0.7

15

1
4
8

2.4

3.06

0.23 0.13 0.077 0.041 0.023

10.75
10.75
34.50
8.6
43.10
5.7
48.8
3.28
52.08
1.64
53.72

1/0 per 6 years

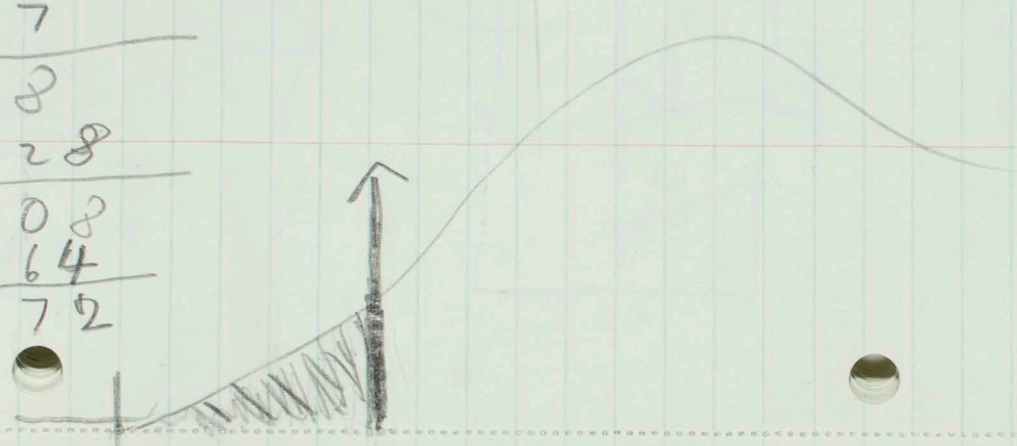
$\frac{360}{10^5}$

0.000360

16 100 years

~~6 hits~~

1 hit 6 year



At birth on averages

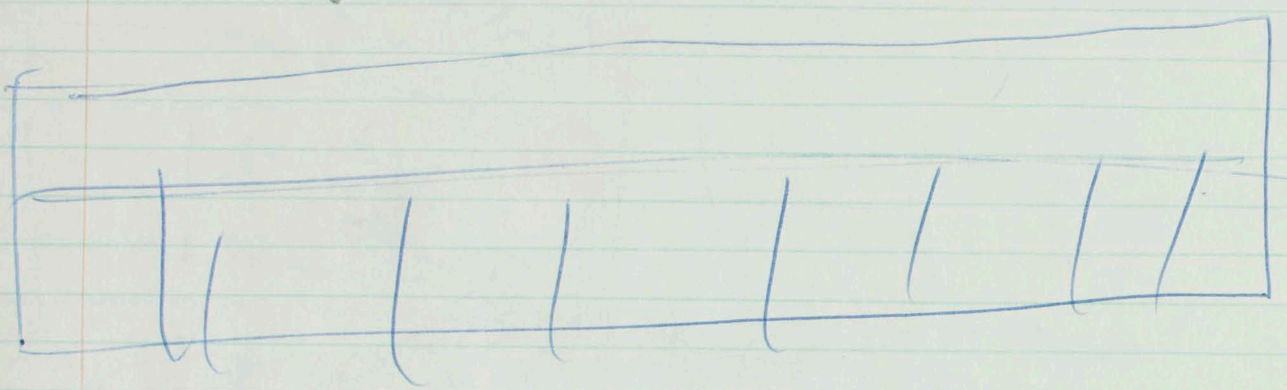
$\underline{\bar{p} = 2} \xrightarrow{3} p = 5 \xrightarrow{3} p = 8.$

mut. 100

<u>10 days</u> 1 yr

♀

♂



$p = 8$ 1b

$m = 20$

$$\left(1 - \left(\frac{p}{m}\right)^2\right)^{\cancel{20}\, m}$$

4

$$= \left(1 - \left(\frac{8}{20}\right)^2\right)^{20} = \left(1 - \left(\frac{2}{5}\right)^2\right)^{20}$$

$$= \left(1 - \frac{4}{25}\right)^{20} = \left(\frac{21}{25}\right)^{20} = (0.84)^{20}$$

$20 \log 0.84 = \log (0.84)^{20}$

$\log 0.84 = 0.9243 - 1$

$\times 20 \quad 18.486 - 20$

antilog $.486 = .306$

characteristic $-2 \Longrightarrow \boxed{0.0306}$

$p = 5$ $\left(1 - \frac{1}{16}\right)^{20} = \left(\frac{15}{16}\right)^{20}$ $.94$

$\log 15 = 2.1761 - 1$

$16 = 1.2041$

$\log 15/16 \quad .9720 - 1$

$18.440 - 20$

0.275

5-14

27/105 = 40%
acc

15-24

61 from acc 50% | 60 | 453

25-34

47.7 29% of total 159
from acc.

55

60/1000 % 6/100 %

less than 1/10 % could be added

Krebs & Kornberg.
Springer-Verlag
Berlin Göttingen Heidelberg
[illegible]

$$\frac{p_a^2}{m} = 1 \qquad \frac{p_b^2}{m} = 3$$

$$p_a = \sqrt{m}$$

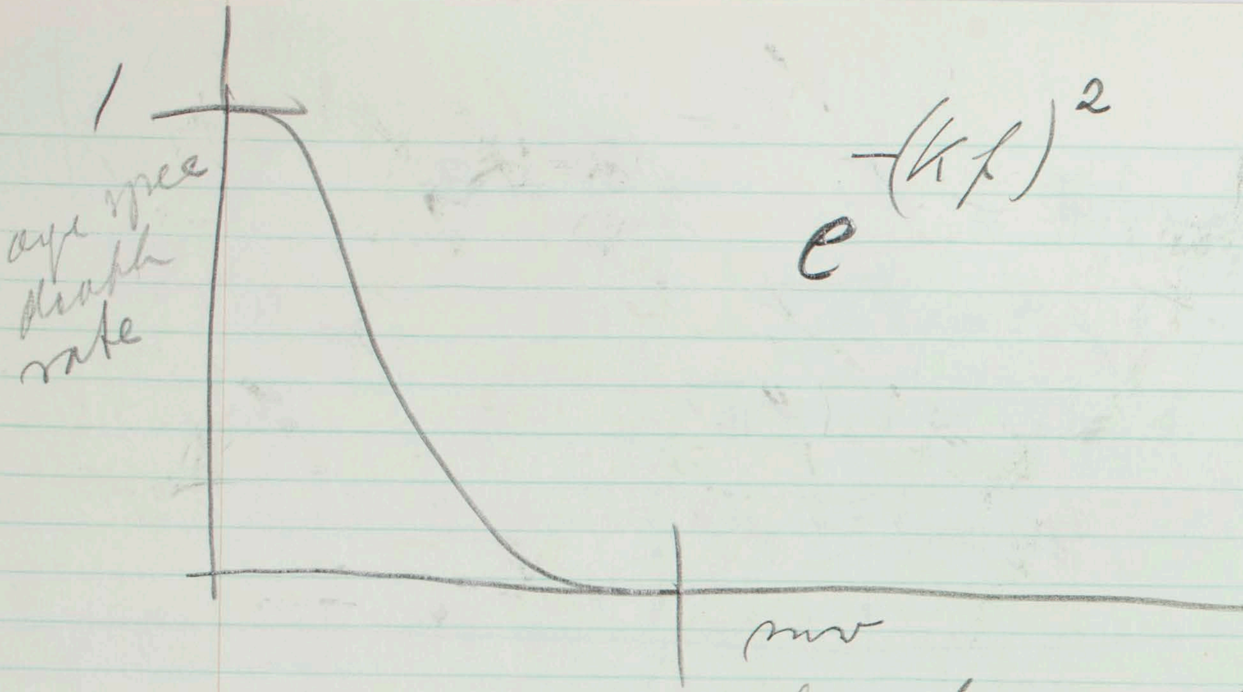
$$p_b = \sqrt{3}\,\sqrt{m}$$

$$p_b = \sqrt{3}\, p_a$$

$$\frac{p^2}{m^2} = \frac{3}{m}$$

$$m < 20$$

~~experimentally~~ error
~~that appreciable~~
quite substantial —



$e^{-(kf)^2}$

1 fraction $= f$

$k = 5$

$f = \frac{1}{20}$

$f = \frac{1}{2.7}$

$e^{-\frac{1}{16}} = 1 - \frac{1}{16}$ or 84%

$e^{-\left(\frac{5}{2.7}\right)^2} = e^{-\frac{25}{7.5}} = e^{-3.3}$

2.5 x 2.3

$10^{-2.5} = e$

$e^{5.7}$

$\left(\frac{x}{2.7}\right)^2 = 5.7$

$\frac{x}{2.7} = 2.4$

$k = \cancel{\ } \quad 7$

$f = \frac{1}{2.7}$

$kf = 2.6$

$(kf)^2 = 6.75$

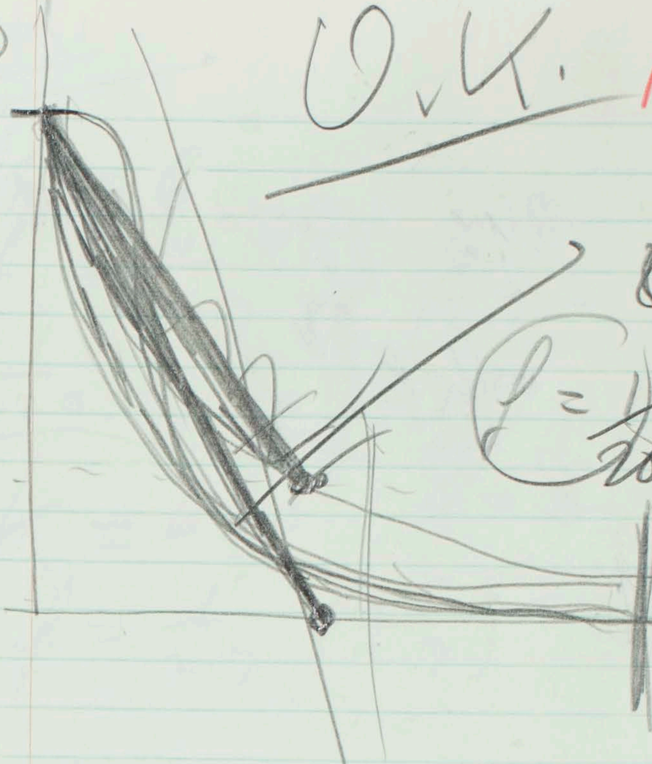
$e^{-6.75} = 10^{-3}$

$f = \frac{1}{20}$

$\left(\frac{7}{20}\right)^2$

$1 - \frac{1}{9} \approx 90\%$

~~mortal~~ age spec
death
rate



O.K. 18

$e^{-(kr)^2}$

H

$r = \frac{1}{20}$ $f = \frac{1}{3}$

0.75

$\frac{1}{150}$

$k = 5$

involving fresh

~~0.75~~

$\frac{5}{20} =$

$\int f(t\ r)\,dr$

$X - \frac{1}{r_{native}}$

$(1 - f_{max})$

$\left(\frac{2}{3}\right)^5 =$

$-kr$

$e^{-(f)k}$

k

$-kr$

Limits age spec. mort.

$$e^{-(kf)^{Q}}$$

$f = \frac{1}{20}$

$k = 20$, $Q >>> 1$

$Q \to \infty$

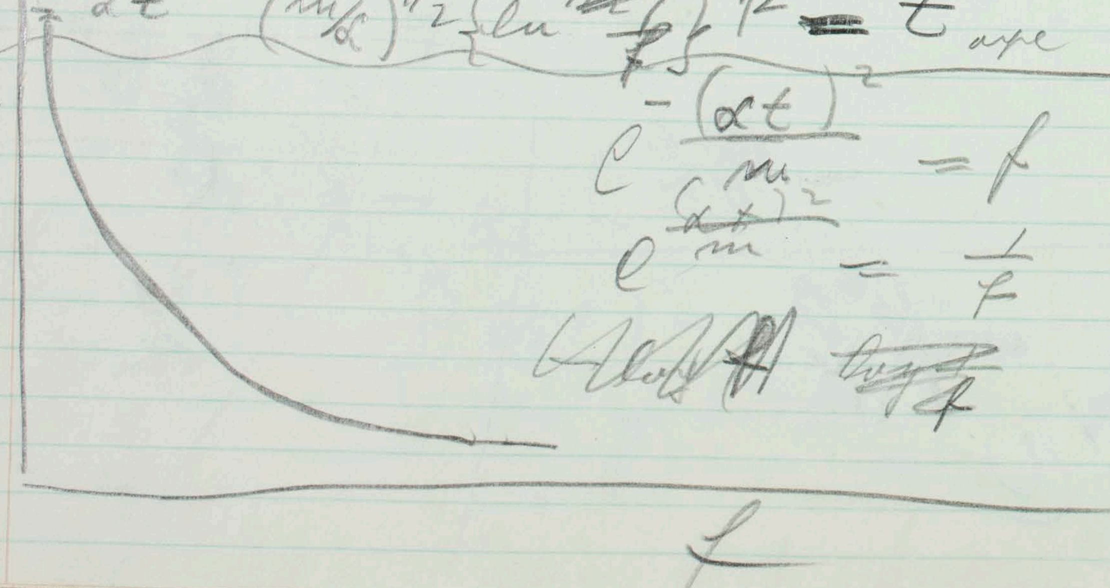
Postulate for $f = \frac{1}{20}$ we want ~~at least~~ longer than 90% death rate and for $f = \frac{1}{217}$ we want 10^{-215} death rate, choose Q to be 2 or 3 or 4 and determine f.

$m \log \frac{1}{f} = \alpha t^2$ $\quad (m/\alpha)^{1/2}\{\ln \frac{1}{f}\}^{1/2} = t_{age}$

$$e^{-\frac{(\alpha t)^2}{m}} = f$$

$$e^{\frac{(\alpha t)^2}{m}} = \frac{1}{f}$$

$\cancel{\log \frac{1}{f}}$



$O_1 K_1$

18

H

$k = 6$

$f = \frac{1}{2.7}$ $\frac{6^2}{(2.7)^2} = 5$

$f = \frac{1}{20}$ $\left(\frac{6}{20}\right)^2 = \frac{36}{400}$ $e^{-5} = 10^{-\frac{5}{2.3}} = 10^{-2.16}$

Best $k = 6.5$ $Q = 2$

$f = \frac{1}{2.7}$ $\left(\frac{6.5}{2.7}\right)^2 = \frac{42}{7.5} = 5.7$ $e^{-5.7} = 10^{-\frac{5.7}{2.3}}$

$= 10^{-2.5}$

$f = \frac{1}{20}$

$f = \frac{1}{10}$ $\left(\frac{6.5}{10}\right)^2 = \frac{42}{100} = \frac{1}{e}$

Why not:

e^{-lf} ?

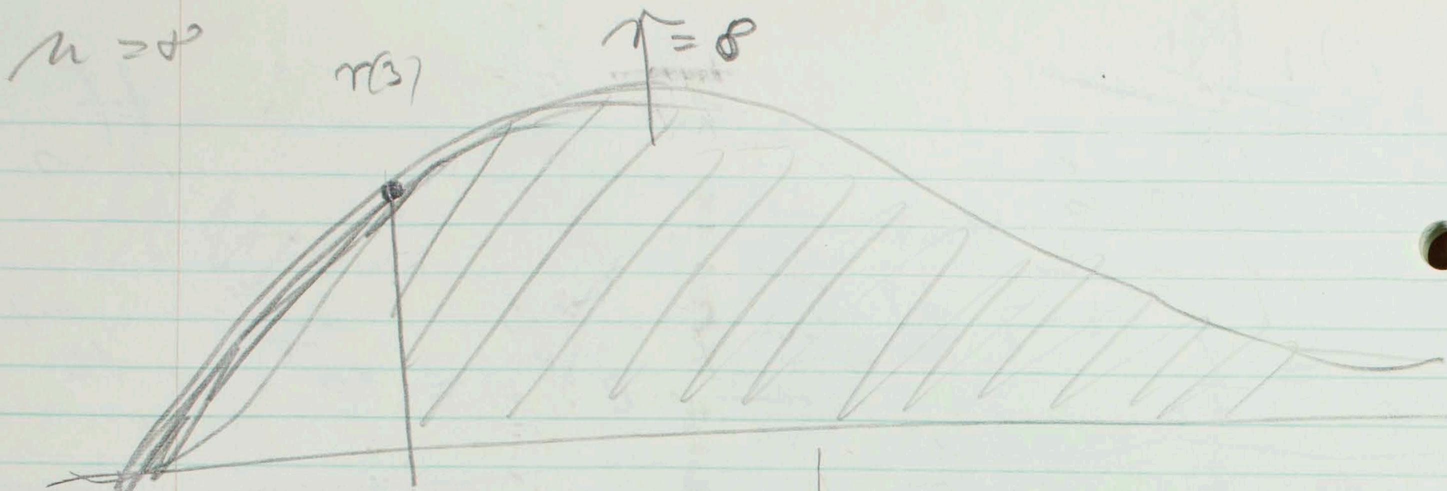
$f = \frac{1}{2.72}$ $e^{-lf} = 10^{-2.5} = e^{-5.75}$

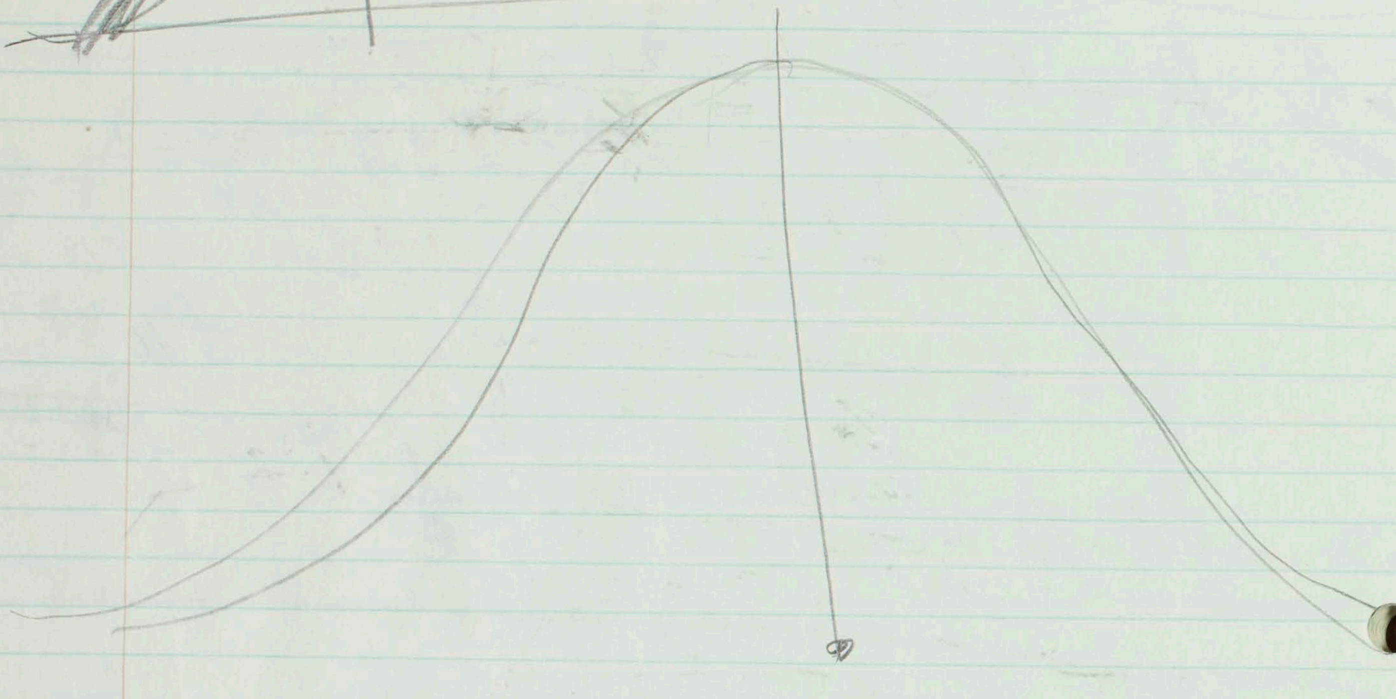
$lf = 5.75$ ~~x 2.72 =~~

$l = 5.75 \times 2.72$ ~~x20~~

$l = 15.5$

No


r(3)

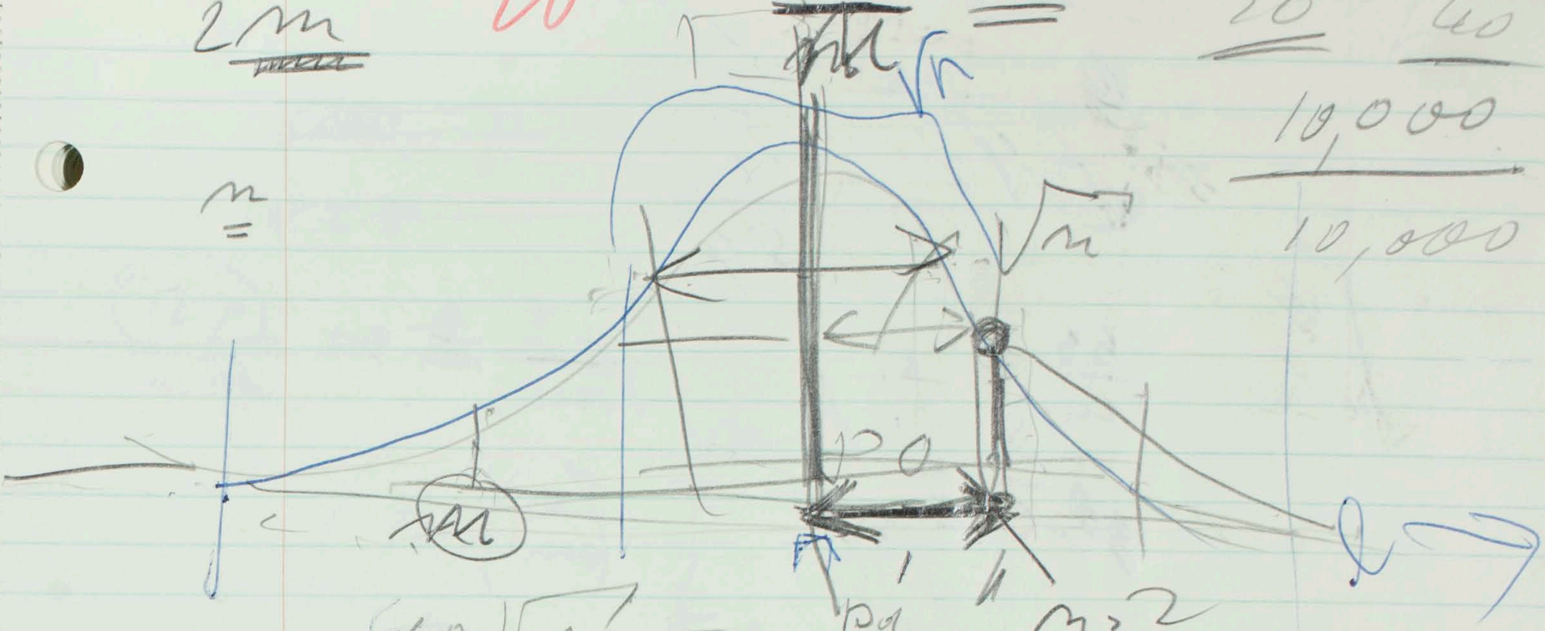


$\frac{2m}{\quad}$ 20

$\underline{n}$

$\frac{20}{\quad}$ $\frac{40}{\quad}$

$\frac{10{,}000}{10{,}000}$



$1.0\sqrt{n} = pd$

$$\boxed{\frac{p_d^2}{m} = 3}$$

$pd = \text{const}\sqrt{n}$

$$-\frac{p_d^2}{m} = \frac{1}{20}$$

Condition of death

$$\frac{1}{20} = \frac{p}{m}$$

$$\frac{(\sqrt{n})^2}{m} = 3$$

m is prop to n

$$\frac{2pd}{2m}$$

$e^{-3} = \frac{1}{20}$

$e^{-4} = \frac{1}{54}$

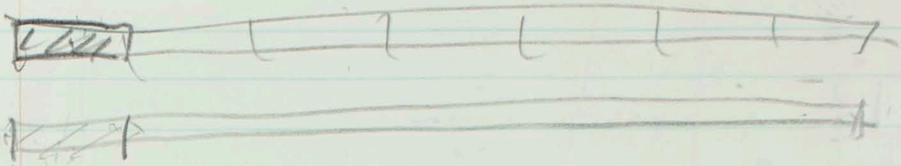
$\frac{p_x^2}{m} = 3$ / $\frac{p^2}{m} \equiv 4$

$\cancel{p}\cdot d =$

1:7 2

m 21

H



$$\frac{2p}{2m} = \frac{p}{m}$$

$$\left(1-\left(\frac{p}{m}\right)^2\right)^m = e^{-\frac{p^2}{m}}$$

$$p = \alpha t$$

$$(1-x)^{\frac{1}{x}} = e^{-x}$$

$$\boxed{(1+a)^{\frac{1}{a}} = e}$$

$$\left(1-\left(\frac{p}{m}\right)^2\right)^{\frac{m^2}{p^2}} = e^{-\cancel{\frac{p^2}{m}}}$$

$$e^{-\frac{p^2 d}{m}} = \frac{1}{20}$$

$$\frac{p^2 d}{m} = 3$$

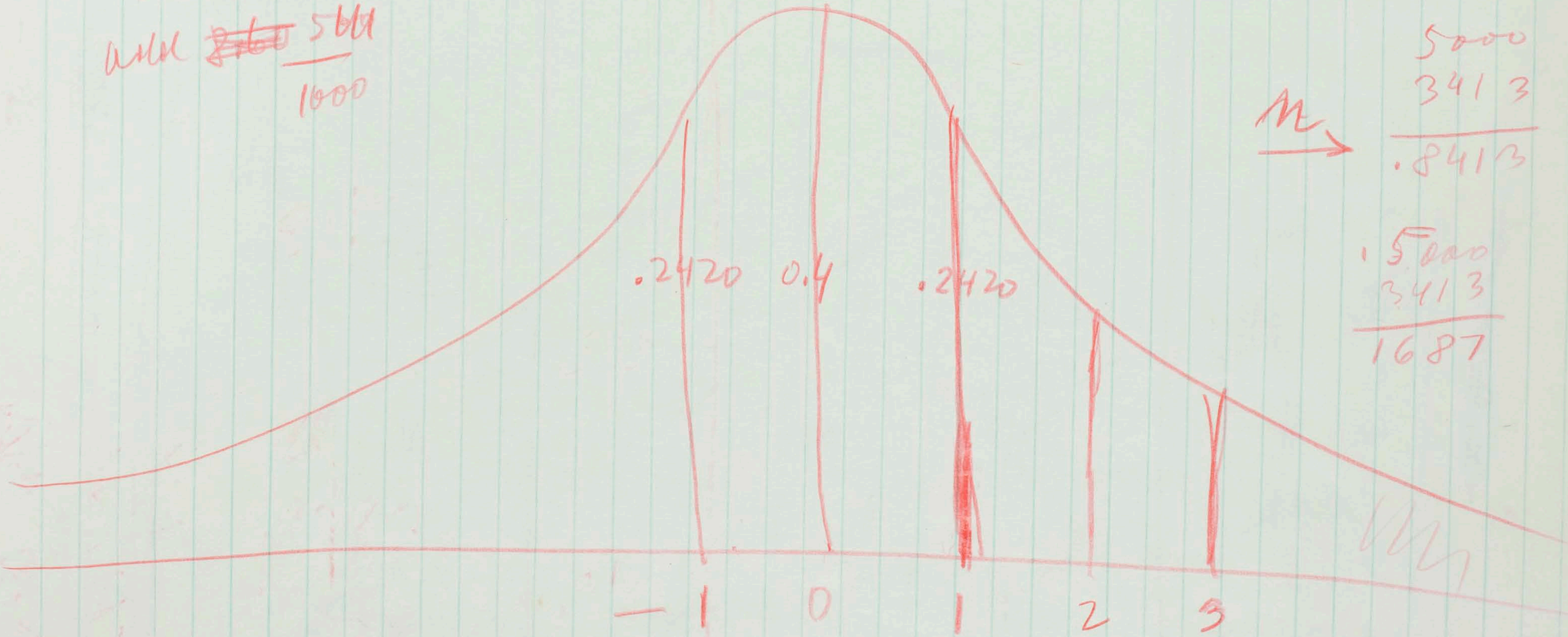
$$\cancel{p^2 = 3m}$$

$$\boxed{\frac{p^2 d}{m^2} = \frac{3}{m}}$$

[illegible]

5
1587

with ~~[illegible]~~ 5[illegible]
1000



5000
3413
.8413

.5000
3413
1687

$\frac{0.29}{8} = 0.03636$

no use

$\frac{0.2420}{.8413}$ $\frac{0.4}{0.5}$ $\frac{.2420}{0.8413}$

[illegible] 0.8 0.29

8

$\frac{0.2420}{.1687}$

1.43

1.8

2.75

$n = 9$

Non Gaussian

at 1 standard dev

$$\phi(x) = \frac{0.2420}{0.399} = 0.6$$

$$\frac{9^9}{9!} \qquad \frac{9^{\cancel{9}}}{9!} \quad \frac{9}{10}\ \frac{9}{11}\ \frac{9}{12} = \frac{730}{1320}$$

$n = 4$

$$\frac{4^4}{4!} \qquad \frac{4^4}{4!} \quad \frac{4}{5}\ \frac{4}{6} = \frac{16}{30}$$

prpro

p

23

Our load of Mutations. H

Adelphi 68 II

Mut rate in man: between

~~from 2 to 1~~

New point $\uparrow \frac{1}{10}$ to $\frac{1}{2}$ per germ cell

At least 8 rec. lethals.

~~100,000 y~~ 30,000 years | $\mathcal{N} = 100$

$e^{-\frac{\cancel{10^2}\ 10^4}{30000}}$ $e^{-\frac{1}{3}}$ survivors

If fecker ² for 8 years
then for 9 years
& 10 years

$0.30103 \times \frac{9}{8} = 0.338$

~~0.338~~

~~$0.30103 \times \frac{10}{8} = 0.376$~~

$\boxed{2.178}$

Geom. mean of
Gaussian at 1 standard
dev. $\boxed{2.22}$

$r = 9$

$\pi = 3$ corresponds to 9 years

10 death

$$\frac{(\alpha t + r)^2}{4m} = 3$$

~~$t = 100$~~
~~$r = 0$~~

$$\cancel{\frac{\alpha\, 100}{4m} = 3}$$

$$\cancel{\alpha = \frac{12 \times m}{100}}$$

11 $\alpha t + r = (12\, m)^{1/2}$

12 $\alpha t_1 + r = (12\, m)^{1/2}$

$\alpha t_2 + r + \sqrt{r} = (12\, m)^{1/2}$

$\alpha(t_1 - t_2) = \sqrt{r}$

$t_1 - t_2 \cong 9$

13 $$\alpha \cong \frac{\sqrt{r}}{9}$$

14 $(\alpha t)^2 = 12\, m$

$$\alpha = \frac{(12\, m)^{1/2}}{t_{max}}$$

$t_{max} = 100$ $$\alpha = \frac{(12\, m)^{1/2}}{100}$$

Paper H

prob not hit $= e^{-\frac{p}{m}}$

hit $\approx 1 - e^{-\frac{p}{m}}$

both hit $= \left[1 - e^{-\frac{p}{m}}\right]^2 = \left[1 - 2e^{-\frac{p}{m}} + e^{-\frac{2p}{m}}\right]$

"survival" as component $=$

$$= 1 - [\ ] = 2e^{-\frac{p}{m}} - e^{-\frac{2p}{m}}$$

survival of all m regions $= \left[2e^{-\frac{p}{m}} - e^{-\frac{2p}{m}}\right]^m$

for small p

$$\left[2e^{-\frac{p}{m}} - e^{-\frac{2p}{m}}\right] \approx \left[2\left(1 - \frac{p}{m}\right) - 1 + \frac{2p}{m}\right]$$

$$= 1 - \frac{2p}{m} + \frac{2p}{m} + \frac{2}{2}\left(\frac{p}{m}\right)^2 - \frac{4}{2}\left(\frac{p}{m}\right)^2$$

$$1 - \left(\frac{p}{m}\right)^2$$

$$f = \left[1 - \left(\frac{p}{m}\right)^2\right]^m = e^{-\frac{p^2}{m}}$$

$2p = \pi$

$\cancel{\Delta t = \frac{p}{2m}}$

$$\boxed{f = \left[1 - \left(\frac{\pi}{2m}\right)^2\right]^m = e^{-\frac{\left(\frac{\pi}{2}\right)^2}{m}} = e^{-\frac{\pi^2}{4m}}}$$

$$\boxed{\pi = \alpha t + r}$$

~~this gives width~~ ~~= 4.6 n~~

$$\cancel{\frac{n^2}{4 \times 4.6\, n} < \frac{1}{3}}$$

$$\cancel{n < \frac{4 \times 4.6}{3} =}$$

~~M = 10^4~~ ~~or~~ ~~10^5~~

~~n =~~

$$n < (M)^{1/2}$$

M number of genes in ~~these~~ "dynamic"

~~with~~ ~~M = 10^4~~ | ~~M = 10^5~~

leave

~~n < 100~~ ~~n < 300~~

with ~~n = 4.6 n~~

number of genes per ~~seg~~ "segment"

$$= \frac{M}{4.6\, n} \geq \frac{M}{4.6\, M^{1/2}} = \frac{1}{4.6} M^{1/2}$$

$$\frac{n_{max}}{4.6}$$

$M = 10^4$ genes / segm 22

$M\ 10^5$ genes / segm 72

M

13 and 14

$$\frac{\sqrt{m}}{9} = \frac{(12\,m)^{1/2}}{t_{max}}$$

$$\cancel{\sqrt{\tfrac{2}{3}}}\ \cancel{t_{max}}\quad \frac{t_{max}}{9\sqrt{12}} = \left(\frac{m}{n}\right)^{1/2}$$

$$\frac{m}{\cancel{m}} = \left(\frac{t_{max}}{9\sqrt{12}}\right)^2 n$$

$t_m = 100$

$$m = \frac{10^4}{81 \times 12}\, n = \frac{10^4}{2175}\, n$$

$$= \cancel{4.6\,m}$$

~~Segments:~~ $\frac{M}{4.6\,n}$ genes

Upper limit for n:

survivors of cross

$$\varphi = e^{-\frac{n^2}{4M}}$$

% death in cross $1 - e^{-\frac{n^2}{4M}}$

of one postulate

$$1 - e^{-\frac{n^2}{4M}} < \frac{1}{4}$$

$$e^{-\frac{n^2}{4M}} > \frac{3}{4}$$

$\cancel{\tfrac{n^2}{4m}} <$

~~but we may write from~~

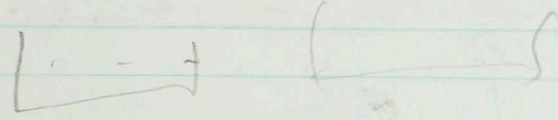
$$e^{\frac{n^2}{4M}} < \frac{4}{3}$$

$$\frac{n^2}{4M} < \frac{1}{3}$$

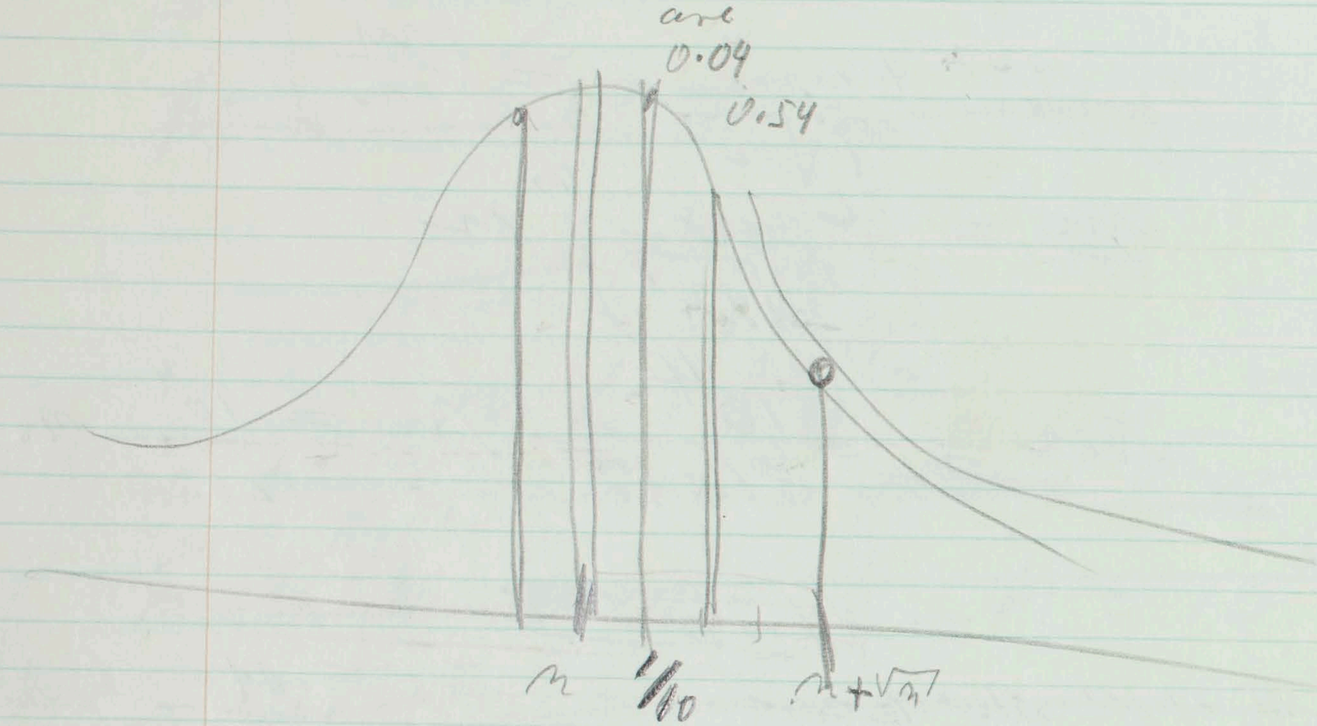
$$n < \left(\frac{4}{3} M\right)^{1/2}$$

M

$\underline{\underline{n}}$



$\bar{n}$ $\quad$ $\bar{n}+\sqrt{n}$



$(\bar{n}-\bar{n}+r)^2$

$$\frac{0.389}{5} = 0.2 \qquad \frac{0.3870}{0.54}$$

7.78 $\quad$ 7.35

$$\boxed{\frac{1.06}{2}}$$

$$(0.06)^x = \frac{1.06}{2}$$

by 0.0253 $\quad$ 0.3010

$X = 12$ this corresponds

~~Th~~ Correction of theory   H

$$e^{-\frac{\pi^2}{4m}} \cdot e^{-\beta t}$$

$$\frac{\pi^2}{4m} + \beta t = 3$$

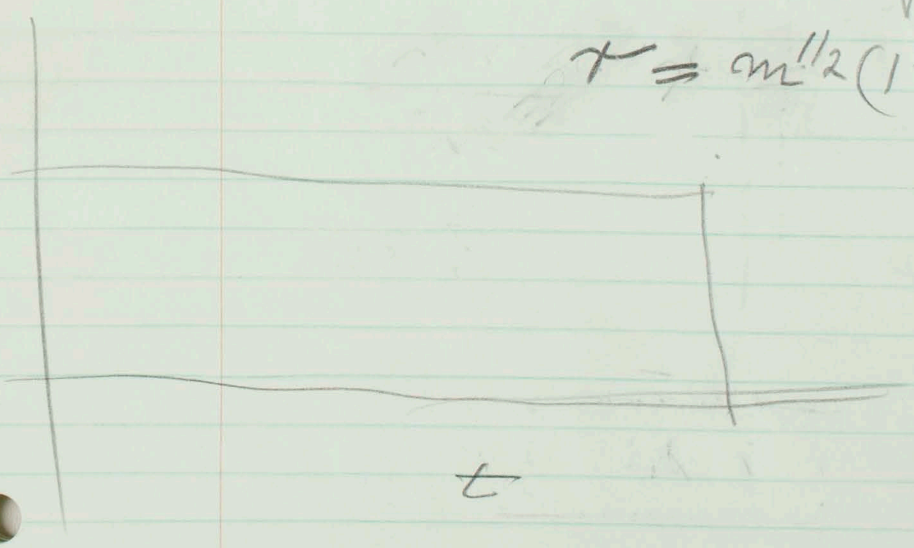
$$\frac{(\alpha t + r)^2}{4m} + \beta t = 3$$

$$(\alpha t + r)^2 + 4m\beta t = 12m$$

$$(\alpha t + r)^2 = [12 - 4\beta t]\, m$$

$$\alpha t + r = \sqrt{(12-4\beta t)\, m}$$

$$r = m^{1/2}(12-4\beta t)^{1/2} - \alpha t$$



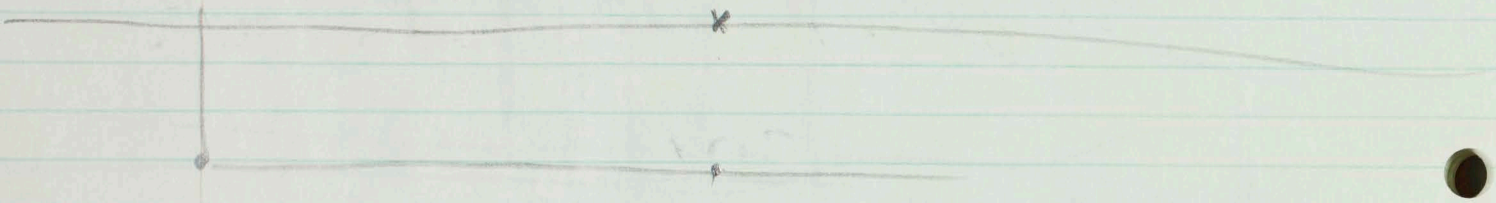
Gaussian

If 8 years factor 2

then 1 year = **1.09**   .3013
0.0376

and this is value for one step of 0.1 St. dev. towards ~~yo~~ lower ages.

Accordingly 1 Stand. dev. 10 years



27 H

$$\begin{array}{r} .500 \\ - .04 \\ \hline 0.46 \end{array}$$

$$\frac{0.3970}{0.46} =$$

$$\frac{8.5}{7.78} =$$

$$\begin{array}{r} 1.06 \\ 1.09 \\ \hline 1.075 \end{array}$$

$$(1.075)^x = 2$$

0.03141 0.30103

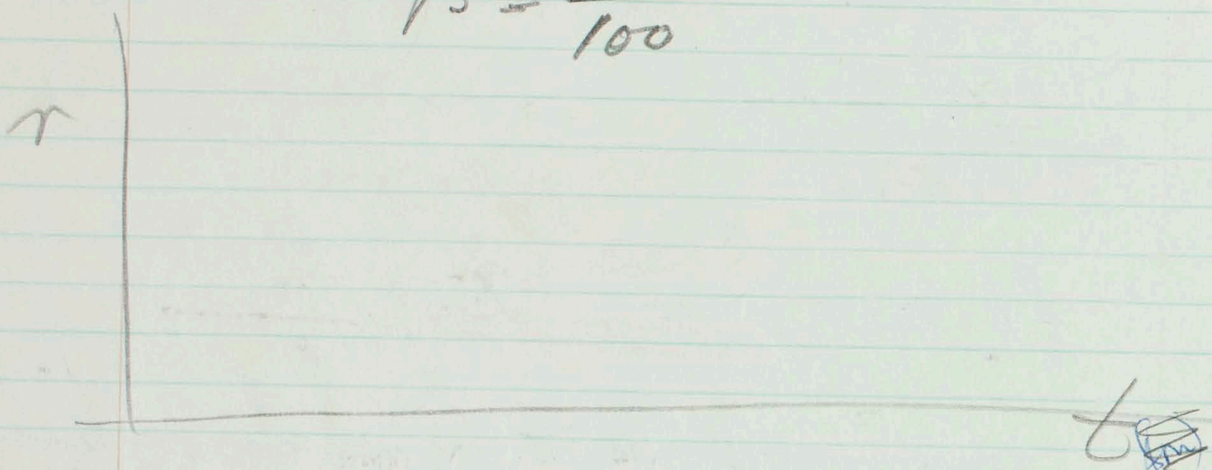
$$\frac{301}{31.4}$$

$$\underline{x = 9.6}$$

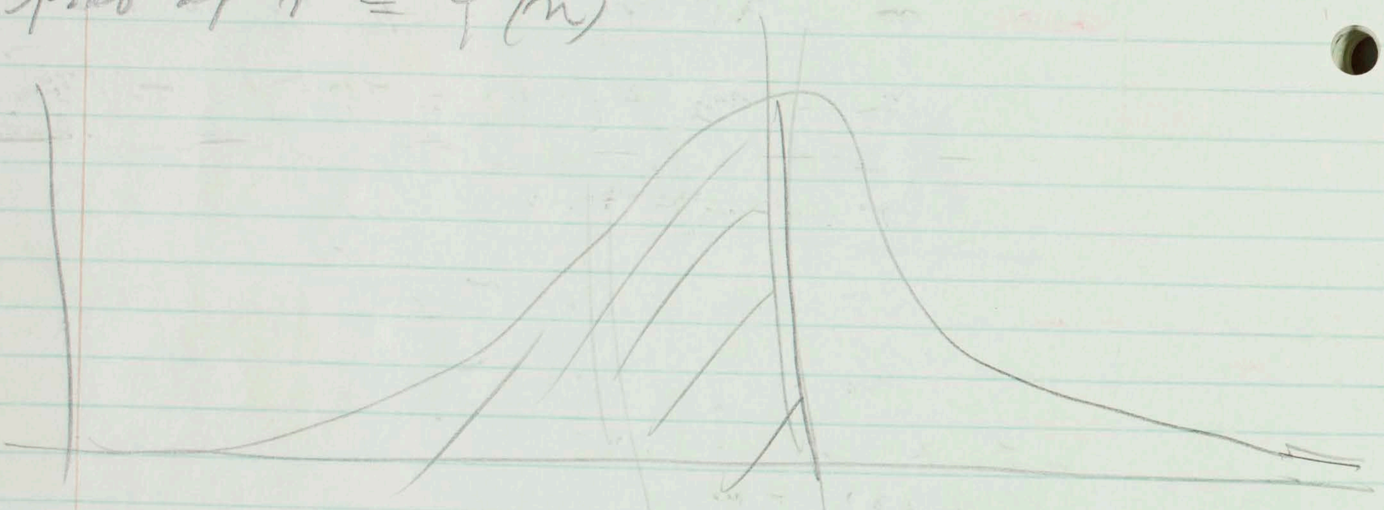
$$\pi_d^2 = 12\,m$$

$$4\,m\,\beta\,100 = \frac{1}{3}\,12\,m$$

$$\beta \doteq \frac{1}{100}$$



prob of $r = \varphi(n)$



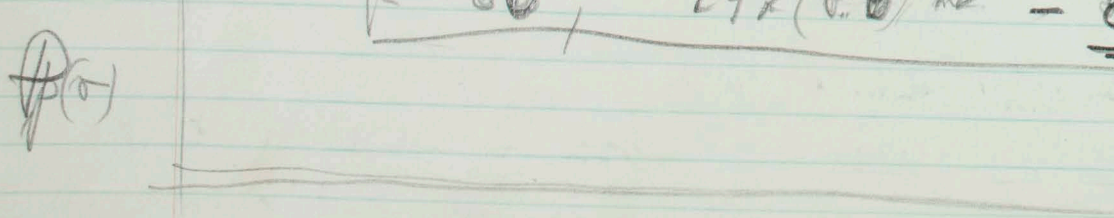
$n = 100$

$m = 834$

$m^{1/2} = 29$

$$r = 29\left(12 - \frac{4}{100}t\right)^{1/2} - t$$

$\boxed{t = 85;\quad 29 \times (8.6)^{1/2} - \underline{85}}$



2 p 28

$$f(t) = e^{-\frac{\pi^2}{4m}} = e^{-3}$$

$$\pi = \alpha t + r$$

$$\frac{\pi^2}{4m} = 3$$

m

$r^2 = 12\,m \quad r_{max} = \sqrt{12}\sqrt{m}$

m

e

$$f(t_d) = e^{-\frac{\pi_d^2}{4m}} e^{-\beta t} = e^{-3}$$

$$\frac{\pi_d^2}{4m} + \beta t = 3 \qquad \boxed{\pi_d = \sqrt{12m} \quad \beta = 0}$$

$$(\alpha t + r)^2 + 4m\beta t = 12m$$

$$r = m^{1/2}(12 - 4\beta t)^{1/2} - \alpha t$$

$$r = m^{1/2}(12 - 4\beta t)^{1/2} - \frac{\sqrt{m}}{10} t$$

← next 5/14/58

~~$r = (12m)^{1/2}$~~

$$\frac{(\alpha t + r)^2}{\cancel{4m}} = 12\,m \qquad \alpha t + r = \pi = (12m)^{1/2}$$

α

$$\alpha t_1 + m = (12m)^{1/2}$$

$$\alpha t_2 + m + \sqrt{m} = (12m)^{1/2}$$

$$\alpha(t_1 - t_2) = \sqrt{m}$$

$$10\alpha = \sqrt{m}$$

$$\alpha = \frac{\sqrt{m}}{10}$$

$\alpha_{max} = 100$

$$\alpha 100 = (12m)^{1/2}$$

$$10\sqrt{m} = \sqrt{12}\sqrt{m}$$

$$\frac{100}{12} = \frac{m}{n} \qquad m = \frac{100}{12} n = 8.34\,n$$

Max Life — over lifts of birth — limits successive lethals = 4 'in fact' cells dead at death

0.011

$\cancel{4\beta t = \frac{5}{100}}$

$$\boxed{4\beta = \frac{5}{100}}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{9}{100}(85)^2 + \frac{75 \times 4}{100} 85 = 900$$

$$r = m^{1/2}(12 - 4\beta t)^{1/2} - \alpha t$$

$$(r - \alpha t)^2 = m(12 - 4\beta t)$$

$$r^2 - 2r\alpha t + \alpha^2 t^2 = 12m - 4\beta m t$$

$$\boxed{\alpha^2 t^2 + [4\beta m - 2\alpha r]t + \{r^2 - 12m\} = 0}$$

$$\cancel{\alpha t^2 + \left[4\beta \frac{m}{\alpha} - 2r\right]t + \frac{r^2}{\alpha} - 12\frac{m}{\alpha} = 0}$$

$$\cancel{\frac{m}{\alpha} = 83.4\sqrt{m} \qquad m = 83.4\,m}$$

$$\cancel{\alpha = \frac{\sqrt{m}}{10}}$$

$$\cancel{\alpha t^2 + \left(4\beta \frac{\sqrt{m}}{10} - 2r\right)t + \left\{\frac{r^2}{\alpha} - 12 \times 83.4\sqrt{m}\right\} = 0}$$

$$t = \frac{2\alpha r - m4\beta \pm \sqrt{(2\alpha r - m4\beta)^2 + 4\alpha^2(12m - r^2)}}{2\alpha^2}$$

$$t = \frac{\frac{6}{10}r - \frac{75 \times 5}{100} \pm \sqrt{\left(\frac{6}{10}r - \frac{75 \times 5}{100}\right)^2 + \frac{4 \times 9}{100}(900 - r^2)}}{\frac{18}{100}}$$

28

M

$$\text{Probab}(r) \text{ and } r+1 = \phi\left(\left(\frac{r-n}{r}\right)^2\right) \times \frac{1}{\sqrt{n}}$$

$$\cancel{m = 9} \quad m = 75 \quad \alpha = \frac{3}{10} \quad \alpha^2 = \frac{9}{100}$$

$$\boxed{r = 8.66(12 - 4\beta t)^{1/2} - \frac{3}{10}t}$$

t

$\theta = 30$ $\quad -30 = 0$

100

$$r = 8.66\underbrace{(12 - 3.4)}_{(8.6)^{1/2}}^{1/2} - 25.5$$

8.66×2.93

$$\left(r + \frac{3}{10}t\right)^2 = \left(75(12 - 4\beta t)\right)^{1/2}$$

$$r^2 + \frac{6}{10}rt + \frac{9}{100}t^2 = 75 \times 12 - 75 \times 4 \times \beta t$$

$$900 - 75 \times 4 \times \beta \cdot t$$

$$\cancel{r^2 + \left(\frac{6}{10}r + 34.6\beta\right)t} +$$

$$\cancel{r^2 + \frac{6}{10}rt + \frac{9}{10}t}$$

$$\frac{9}{100}t^2 + \left(\frac{6}{10}r + 75 \cdot 4\beta\right)t + r^2 - 900 = 0$$

$$(12 - 4\beta t)^{1/2} = \sqrt{12}\left(1 - \frac{4\beta}{12}t\right)^{1/2}$$

$$\cancel{(1 - \alpha)^{1/2} \quad 1 - 2\times} \quad (1-\alpha)^2 = 1 - 2\alpha + \alpha^2$$

$$= \sqrt{12}\left(1 - \frac{\beta}{6}t\right)$$

$$r = 30.0\left(1 - \frac{\beta}{6}t\right) - \frac{3}{10}t = 30 - \frac{35}{100}t$$

De Nova

$$\frac{r^2}{4m} - \frac{\pi^2}{4m} \cancel{AAB} - \beta t = -3$$

$$\cancel{r^2 - (\alpha t + r)^2 = -4\times 3m}$$

$$\cancel{(\alpha t)^2 - 2\alpha t r = -4\times 3m}$$

$$\cancel{(\alpha t^2) - 2\alpha t r +}$$

$$\frac{\pi^2}{4m} - \frac{r^2}{4m} + \beta t = 3$$

$$\pi^2 - r^2 + 4m\beta t = 4\times 3m$$

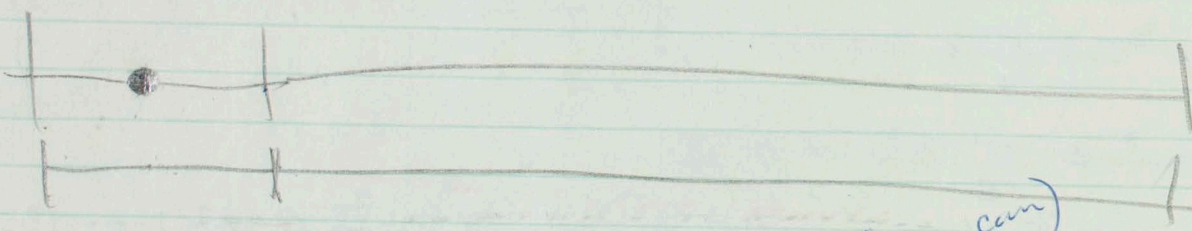
$$\pi = \alpha t + r$$

$$\boxed{(\alpha t)^2 + 2\alpha t r + 4m\beta t = 4\times 3m}$$

for $\beta = 0$ $\quad t^2 + 2tr = 12m = 1200$

$m = 100 \quad t^2 + 200t = 1200 \;\|\; m = 834 \qquad r = n$

$$2\frac{\pi}{2m}\cancel{\frac{\pi}{2m}}$$



$$\frac{2\pi}{2m}\frac{r}{2m} + 2\left(\frac{\pi}{2m}\right)^2$$

cam. (bal, cam)

bal. (cam.)

$$\left\{\cancel{AAA}\,2\left[1-e^{-\frac{r}{2m}}\right]\left[1-e^{-\frac{\pi}{2m}}\right]\right\} \text{escape}$$

$$\times\left(1 - \left[1-e^{-\frac{\pi}{2m}}\right]\left[1-e^{-\frac{\pi}{2m}}\right]\right)$$

30

$r = 9$

$r = \pi$

$r - (\alpha t)$

$e^{-\frac{r^2}{4m}}$ $\quad f = e^{\boxed{-\frac{\pi^2}{4m} + \frac{r^2}{4m}}} e^{-\beta t}$

$\pi = (\alpha t + r)$

$-(\alpha t + r)^2 + r^2$

$-(\alpha t)^2 - 2\alpha t r - \cancel{r^2} + \cancel{r^2}$

$-\alpha t(\alpha t + 2r)$

$e^{-\frac{r^2}{4m}}$

$r = 9$

$t = \underbrace{\frac{54}{10} - 3.75}_{\underbrace{5.4 - 3.75}_{1.7}} + \sqrt{2.9 + \frac{36}{100}(\underbrace{900 - 081}_{819})}$

$1.7 \quad + \quad \underbrace{\frac{6}{10} \times 28.6}$

$7.8 \times \frac{100}{18} = 43.3$

1.7

45 years

Cody

$\left(1 - \left[\frac{\alpha}{2m} \times \frac{\pi}{2m} + \left(\frac{\pi}{2m}\right)^2\right]\right)^m$

$(1 - x\, y)^{\frac{1}{x+y}}$

$\left[1 - \frac{\pi}{(2m)^2}(\pi + r)\right]^{\frac{4m^2}{\pi(\pi + r)}\frac{4m}{\pi(\pi+r)}} = e^{-1}$

$f = e^{-\frac{\pi(\pi + r)}{4m}}$

escape fr. (first factor) =

$$= \left(1 - 2\underbrace{\left(\frac{r}{2m}\cdot\frac{\alpha t}{2m}\right)}_{q}\right)^{m} = e^{-\frac{2(r\cdot\alpha t)}{4m}}$$

$$(1-q)^{m} = A$$

$$A^{\frac{1}{q}} = e^{-m}$$

$$A = e^{-qm}$$

$$q = \frac{2(r\cdot\alpha t)}{(2m)^2}$$

escape fr. (second factor) =

$$= e^{-\frac{(\alpha t)^2}{4m}}$$

escape fr. $= e^{-\frac{[(\alpha t)^2 + 2r\cdot\alpha t]}{4m}}$

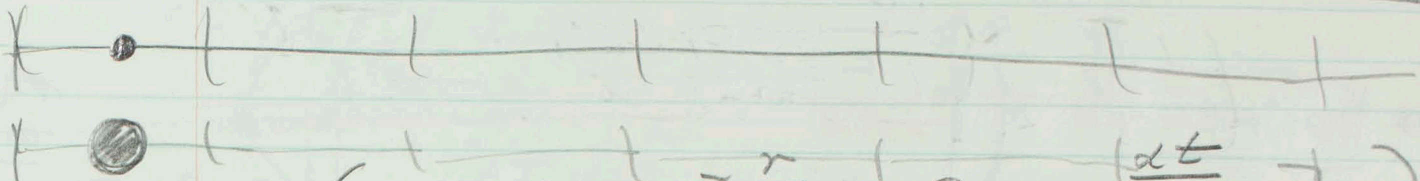
To compare direct formula

escape fr. $= e^{-\frac{(\alpha t + r)^2}{4m} + \frac{r^2}{4m}}$

$$-\frac{(\alpha t)^2 + 2r\cdot\alpha t}{4m} = \frac{-(\alpha t + r)^2 + r^2}{4m}$$

W. Z. B. W.

Second Approximation Paper



escape fr. $= \left(1-2\left[1-e^{-\frac{r}{2m}}\right]\left[1-e^{\frac{\alpha t}{2m}}\right]\right)^m \times$

$$\times\left(1-\left[1-e^{-\frac{\alpha t}{2m}}\right]^2\right)^m$$

$$\left[1-\left[1-e^{-\frac{\alpha t}{2m}}\right]^2\right]^m = \left[1-\left(\frac{\alpha t}{2m}\right)^2\right]^m$$

$$\cancel{\left[1-2\left[r\right]\left[\alpha t\right]\right]^m = \left[1-2\frac{r}{2m}\frac{\alpha t}{2m}\right]}$$

escape fr first order

$$\cancel{1-e^{-\frac{r}{2m}}-e^{\alpha}}$$

$$\left[1-e^{-\frac{r}{2m}}\right]\left[1-e^{-\frac{\alpha t}{2m}}\right]=$$

$$\cancel{1-e^{-\frac{r}{2m}}-e^{-\frac{\alpha t}{2m}}+e^{-\frac{r\times\alpha t}{2m}}} =$$

$$\cancel{-\frac{r}{2m}+\frac{\alpha t}{2m}+\frac{r\times\alpha t}{2m}=}$$

$$1-e^{-\frac{r}{2m}}-e^{-\frac{\alpha t}{2m}}+e^{-\left(\frac{r}{2m}\times\frac{\alpha t}{2m}\right)}$$

$$\cancel{\frac{r}{2m}+\frac{\alpha}{2m}}$$

$$-\frac{1}{2}\left(\frac{r}{2m}\right)^2-\frac{1}{2}\left(\frac{\alpha t}{2m}\right)^2+\frac{1}{2}\left(\frac{r}{2m}\times\frac{\alpha t}{2m}\right)^2 =$$

$$= \frac{r}{2m}\cdot\frac{\alpha t}{2m}$$

$$-\frac{\sqrt{n^2+2n\sqrt{n}+n+12m} - \sqrt{n^2+12m}}{10} =$$

$$= \frac{\sqrt{n^2+12m}}{10} \times \left(\sqrt{1+\frac{2n\sqrt{n}+n}{n^2+12m}} - 1\right) \cong$$

for large $\sqrt{n}$

$$-\frac{\sqrt{n^2+12m}}{10}\ \frac{1}{2}\ \frac{(2\sqrt{n}+1)\ \cancel{n}}{n^{\cancel{2}}+12\frac{m}{n}} =$$

$$-\frac{1}{2}\frac{\sqrt{n+12\frac{m}{n}}}{10}\ \frac{2n+\sqrt{n}}{n+12\frac{m}{n}}$$

$$\alpha \cong \frac{1}{10}\left(\sqrt{n} - \frac{\sqrt{n}}{2}\sqrt{n+12\frac{m}{n}}\cdot\frac{2\sqrt{n}+1}{n+12\frac{m}{n}}\right) =$$

approx for $\sqrt{n} >$

Choose α this gives you m
try different n which gives you
right α

~~Average lifetime is given~~

$$\cancel{(\alpha \bar{t})^2 + 2n(\alpha \bar{t}) = 12m}$$

$$\cancel{\alpha \bar{t}_m = -n + \sqrt{n^2+12m} = n + \sqrt{n}\sqrt{n+12\frac{m}{n}}}$$

$\cancel{\bar{t}_n =}$

$$\alpha \cong \frac{1}{10}\left(\sqrt{n} - \frac{n}{\sqrt{n+12\frac{m}{n}}}\right) \quad \text{for } \sqrt{n} \gg 1$$

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death at Hj

$$\cancel{tt}\ (\alpha t_d)^2 + 2r\alpha t_d = 12m$$

$$r = 0 \quad \| \quad (\alpha t_d)^2 = 12m$$

$$\alpha t_d = \sqrt{12}\sqrt{m}$$

$$\boxed{t_d = \frac{\sqrt{12}\sqrt{m}}{\alpha} = 100 \quad r=0}$$

$$(\alpha t_1)^2 + 2n\alpha t_1 - 12m(\alpha) = 0$$

$$(\alpha t_2)^2 + 2(n+\sqrt{n})\alpha t_2 - 12m(\alpha) = 0$$

$$\cancel{(\alpha t_1)^2 - (\alpha t_2)^2 + 2n\alpha}$$

$$(\alpha t_1)^2 + \Delta_2$$

$$\alpha t_1 = \frac{-2n \pm \sqrt{4n^2 + 48m}}{2}$$

$$\alpha t_1 = -n \pm \sqrt{n^2 + 12m}$$

$$\alpha t_2 = -(n+\sqrt{n}) \pm \sqrt{(n+\sqrt{n})^2 + 12m}$$

$$\underbrace{\alpha(t_1 - t_2)}_{10} = \sqrt{n} + \sqrt{n^2 + 12m} - \sqrt{(n+\sqrt{n})^2 + 12m}$$

$$\alpha = \frac{\sqrt{n}}{10} - \frac{\sqrt{(n+\sqrt{n})^2 + 12m} - \sqrt{n^2+12m}}{10}$$

$$\left\{\begin{array}{l} \alpha = \dfrac{\sqrt{n}}{10} + \dfrac{\sqrt{n^2 + 12m} - \sqrt{(n+\sqrt{n})^2 + 12m}}{10} \\ 12m = \cancel{100}\ 10^4\alpha^2 \end{array}\right.$$

$\alpha = \frac{1}{4}$ $\quad 12m = 10^4 \frac{1}{16} = 625$

$\alpha = \frac{4}{10}\sqrt{\cancel{9}}$

$$\begin{array}{r} 625 \\ 36 \\ \hline 661 \\ 25.7 \end{array} \qquad \begin{array}{r} 625 \\ 16 \\ \hline 641 \\ 25.3 \end{array}$$

$$\frac{0.4}{1.6} = \frac{4}{10}$$

$3 -$

$$\begin{array}{r} 625 \\ 144 \\ \hline 769 \end{array} \qquad \begin{array}{r} 625 \\ 81 \\ \hline 706 \end{array}$$

$$\begin{array}{r} 2.77 \\ 66 \\ \hline 0.11 \end{array} - 2.66$$

$\alpha = \frac{1}{3}$

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Examples for $\alpha, m, n, \underline{H}$,

$\alpha = 1$

$m = \frac{10^4}{12} = 834$

$$\alpha \approx \frac{1}{10}\left(\sqrt{n} - \frac{n}{\sqrt{n + \frac{10^4}{n}}}\right) = 1$$

$$\cancel{m}\ n = 100\ \frac{1}{10}\left(10 - \frac{100}{\sqrt{100+100}}\right)$$

$$\frac{1}{10}\left(\sqrt{200} - \frac{200}{\sqrt{200+50}}\right)$$

$\cancel{\alpha \frac{1}{2}}\ \sqrt{(110)^2 + 10^4} \quad - \sqrt{100^2 + 10^0}$

$\cancel{220}\ \sqrt{2.2}\ 100 \quad -\sqrt{2} \times 100$

1.483

1.413

$\cancel{10}\ 0.070 \qquad 10 - 7$

$\frac{7}{100}$

$$\alpha = \frac{1}{10}\left(\sqrt{n} - \frac{\sqrt{(n+\sqrt{n})^2 + 12m} - \sqrt{n^2 + 12m}}{10}\right)$$

~~Express n from α~~

$$\cancel{\alpha < \frac{\sqrt{n}}{10}}$$

$$\cancel{\alpha t_m = -n + \sqrt{n^2 + 10^4 \alpha^2}}$$

$n = 6$

$$\cancel{t_m = \frac{-6 \pm \sqrt{36 +}}{}}$$

$$(\alpha t_m)^2 + 2n\alpha t_m = 12 \qquad n = 10^4 \alpha^2$$

$$(100 - t_m)^2 \alpha^2 = 2n\alpha t_m$$

$$\frac{(100 - t_m)^2 \alpha}{2 t_m} = n$$

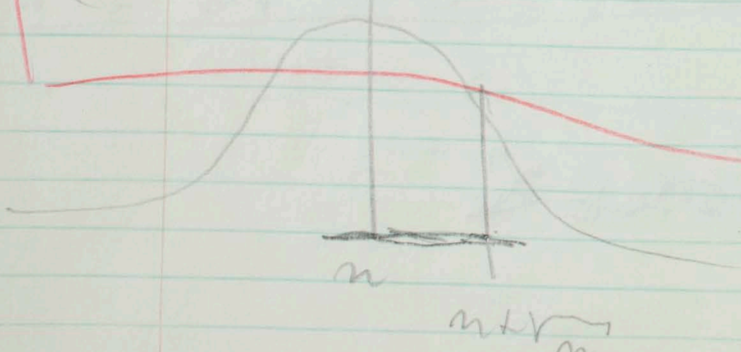
$$n = 834\,\alpha^2$$

better

do not fix t_0 ; fix t_m

$$\boxed{(\alpha t_m)^2 + 2n\alpha \tau_m = 12\,n}$$

$$\frac{1}{\sqrt{n}}$$



34

$\alpha = \frac{1}{3}$ 4

$12m = \frac{10^4}{9}$

$\alpha = \frac{1}{10}\left(\sqrt{n} - \sqrt{(n+\sqrt{n})^2 + 12m} - \sqrt{n^2 + 12m}\right)$

by $n = 9$ $\left(3.5 - \sqrt{(15.5)^2 + \frac{10^4}{9}} - \sqrt{(12)^2 + \frac{10^4}{9}}\right)$

$\frac{21}{10}$ $\begin{array}{r} 240 \\ 1110 \\ \hline 1350 \end{array}$ $\begin{array}{r} 144 \\ 1110 \\ \hline 1254 \end{array}$

~~n = 16~~

$\begin{array}{r} 36.7 - \\ 35.3 \\ \hline 1.4 \end{array}$

$\frac{1}{\ }$

$n = 16$

$4 - \sqrt{\cancel{400}}$

$4 - 2.05 = \frac{2}{10}$

$\begin{array}{r} 400 \\ 1100 \\ \hline 1500 \end{array}$ $\begin{array}{r} 38.85 \\ 36.80 \\ \hline 2.05 \end{array}$ $\begin{array}{r} 256 \\ 1100 \\ \hline 1356 \end{array}$

$n = 25$

$\frac{1}{10}\left(5 - \right.$

$\begin{array}{r} 900 + \\ 1110 \\ \hline 2010 \end{array}$ $-$ $\begin{array}{r} 625 \\ \cancel{1110} \\ \hline 1735 \end{array}$

$\frac{1}{10}$

$\begin{array}{r} 44.8 \\ 41.6 \\ \hline 3.2 \end{array}$

$$\frac{\Delta}{\sqrt{m}}($$

gives life shortening for $r = n+1$

$$t_n + \frac{\Delta}{\sqrt{m}}$$

$$\alpha \bar{\tau}_n = \cancel{\ \ } - n + \sqrt{n^2 + 12 m}$$

$$\frac{d(\alpha\tau)}{dm} = -1 + \frac{1}{2}(\quad)^{-1/2} \times 2n$$

$$= -1 + \frac{1}{2}$$

$$\alpha \frac{d\tau}{dm} = -1 + \frac{1}{\cancel{2}} \frac{\cancel{2}\cancel{n}}{\cancel{n}\sqrt{1 + \frac{12 m}{n^2}}}$$

$$\alpha \Delta\tau = \left(-1 + \frac{1}{\sqrt{1 + \frac{12 m}{n^2}}}\right) dm$$

$$\cancel{\Delta\tau = \frac{\Delta}{\alpha}}$$

$$\Delta\tau = \cancel{\ \ } \frac{1}{\alpha}\left(-1 + \frac{1}{\sqrt{1 + \frac{12 m}{n^2}}}\right)$$

$$\boxed{\frac{\Delta_0}{\sqrt{m}} = \frac{1}{\alpha}\left(-1 + \frac{1}{\sqrt{1 + \frac{12 m}{n^2}}}\right)}$$

$$\alpha \Delta_0 = \sqrt{m}\left(\quad\right) = \sqrt{m}\left(\frac{\sqrt{\ } - 1}{\sqrt{\ }}\right)$$

$$\alpha \tau_n = -n + n\sqrt{1 + \frac{12 m}{n^2}} = n\left(\sqrt{1 + \frac{12 m}{n^2}} - 1\right)$$

$$\cancel{\frac{\Delta_0}{\tau_n}\ \frac{1}{\sqrt{m}}}\ \frac{\tau_n}{\Delta_0} = \sqrt{m}\sqrt{1 + \frac{12 m}{n^2}}$$

$$\cancel{\alpha \tau_n = -n + n\sqrt{1 + \frac{12 m}{n^2}} = n\left(\sqrt{\ } - 1\right)}$$

$$\cancel{d\tau_n =}$$

~~t_2 at the den~~ 35

~~make $n+1$~~

τ_{n+1}

$(\alpha \tau_{n+1})^2$

$$\boxed{(\alpha \tau_n)^2 + 2n\alpha\tau_n - 12m = 0}$$

$$\alpha \Delta t = \underbrace{\sqrt{n} - \left[\sqrt{(n+\Delta n)^2 + 12m} - \sqrt{(n)^2 + 12m}\right]}_{\varphi(n,m)}$$

$\Delta t = 10$

$$\alpha = \varphi(n,m)\frac{1}{\Delta\tau}$$

$a + b + c$

$(a^2 + b)^2 + 2ac + 2bc + c^2$

$$\left(\alpha\varphi\frac{\tau_n}{\Delta\tau}\right)^2 + 2n\varphi\frac{\tau_n}{\Delta\tau} - 12m = 0$$

$$\left(\alpha\frac{\tau_n}{\Delta\tau}\right)^2 \times \varphi^2 +$$

$$\varphi^2 = \cancel{n}\ (n+\sqrt{m})^2 - \cancel{12m} + \cancel{n^2} + \cancel{12m}$$

$$-\cancel{n^2}\ 2n\sqrt{n}$$

$$- 2n\sqrt{m}$$

$$2\sqrt{n}\sqrt{(n+\sqrt{m})^2 + 12m} + 2\sqrt{n}\sqrt{m^2 + 12m}$$

$$+ 2\sqrt{(n+\sqrt{m})^2 + 12m}\sqrt{(n)^2 + 12m}$$

$$(\alpha t_n)^2 + 2n\alpha t_m = 12m$$

$$[\alpha(t+\Delta)]^2 + 2(n+\sqrt{m})\,\alpha(t+\Delta) =$$

Muller

2×10^7 recessive lethals per r

50 r 1 break in Man
~~at~~ Drosh

2000 steps

1 mutation in Man

Man

5 × 6.5 − 25 =

36

M

$\alpha \tau_n = n\left(\sqrt{1+\frac{2m}{n^2}} - 1\right)$

$= \sqrt{n}\sqrt{n}\sqrt{1+\frac{2m}{n^2}} - n$

$\alpha \tau_n = \sqrt{n}\,\frac{\tau_n}{\Delta_0} - n$

$$\boxed{\alpha = \frac{1}{\tau_n}\left(\sqrt{n}\,\frac{\tau_n}{\Delta_0} - n\right)}$$

$$\boxed{\alpha \tau_n = \sqrt{n}\,\frac{\tau_n}{\Delta_0} - n \qquad \alpha \tau_n + n = \sqrt{n}\,\frac{\tau_n}{\Delta_0}}$$

$$\boxed{12m = (\alpha\tau_n)^2 + 2n\alpha\tau_n}$$

$\tau_n = 65 \quad \Delta = 10$

12m	n	$\alpha\tau_n$	α
280	9	20	$\frac{1}{6.5}$
356	12	22.5	
1505	16	26	$\frac{1}{2.5}$
430	25	7.5	
	4	8.8	

$\frac{3\times 6.5 - 9}{\tau_n} = \frac{10}{65} = \frac{1}{6.5}$

$100 + 2 \times 9 \times 10$

280

$5 \times 6.5 - 25 = \frac{12.5}{65}$

$(32.5)^2 - (25)^2$

$\alpha = \frac{1}{5 \cdot 6.5 - 5}$

~~$4 \times 6.5 - 16$~~

$\frac{26}{65}$

1053

$-\ 625$

430

$2 \times 6.5 - 4$

$(26)^2 \qquad 32 \times 26$

26
16
34

$5 \times 6.5 - 25$

~~25~~
~~16~~
1

675
830
1505

$(42)^2 - (16)^2 = 12m \qquad 12m$

~~6900~~
~~860~~
~~40~~

1765
256
1510

$\boxed{[n + \alpha t]^2 - (n)^2 = 12m}$

~~$n\frac{\tau_n}{\Delta_0} - n^2 = 12m$~~

$m\left(\frac{\tau_m}{\Delta_0}\right)^2 - n^2 = 12m$

Δ_0 for $\alpha r = \sqrt{n}$

$$\alpha \Delta_0(\tau) = \Delta_0(\alpha \tau)_{r=n} = \left[-1 + \left(\frac{1}{1+\frac{12m}{n^2}}\right)^{1/2}\right]\sqrt{n}$$

$$\alpha \Delta_0(\tau) = \frac{-\left(1+\frac{12m}{n^2}\right)+1}{\left(1+\frac{12m}{n^2}\right)^{1/2}}\sqrt{n}$$

$$-\alpha \Delta_0(\tau) = \frac{-1+\left(1+\frac{12m}{n^2}\right)^{1/2}}{\left(1+\frac{12m}{n^2}\right)^{1/2}}\sqrt{n}$$

$$\alpha\tau_n = -r + r\sqrt{1+\frac{12m}{r^2}}$$

$$\boxed{\alpha\tau_m = -n + n\sqrt{1+\frac{12m}{n^2}}} = n\left(-1+\left(1+\frac{12m}{n^2}\right)^{1/2}\right)$$

$$\frac{\tau_n}{\Delta_0} = \sqrt{n}\left(1+\frac{12m}{n^2}\right)^{1/2} = \text{fixed}$$

τ_n = fixed

Table for $12m$ $\alpha\tau_n$
Choose n, $\tau_n = 65$ and Δ_0 $\frac{\tau_n}{\Delta_0} = 6.5$

34
16
18

$$\boxed{\alpha\tau_m = -n + \sqrt{n}\,\frac{\tau_n}{\Delta_0} - n}$$

$14.4 = 4\frac{\tau_n}{\Delta_0} - 16$

14.4
1.7

compute $\alpha\tau_m$ from n
compute $12m$ from
$$(\alpha\tau_n + n)^2 - n^2 \cong 12m$$

$12m = (\alpha t + n)^2 - n^2$

$12m = n\left(\frac{\tau_n}{\Delta_0}\right)^2 - n^2$

$n\left(\frac{\tau_n}{\Delta_0}\right)^2$

H

Papers (regressive sanitable lethals) n ~~hits~~ distributed over two ~~[illegible]~~ homologous chromosomes αt hits.

~~the~~ surviving fraction of cells

$$f = e^{\frac{-(\alpha t + r)^2}{4m} + \frac{r^2}{4m}}$$

assume death $t = \tau$ $\quad \frac{-(\alpha\tau + n)^2 + n^2}{4m} \cong -3$

$$(\alpha\tau + r)^2 - r^2 \cong 12m$$

$$(\alpha\tau)^2 + 2\alpha\tau r \cong 12m$$

we fix τ_n for $r = n$

$$(\alpha\tau_n)^2 + 2\alpha\tau_n n - 12m \cong 0 \qquad \text{say } \tau_n = 65$$

$$\alpha\tau_r = \frac{-2r \pm \sqrt{4r^2 + 4 \times 12m}}{2}$$

$$\boxed{\alpha\tau_n = -r + \sqrt{r^2 + 12m}} = -r$$

$$\frac{d}{dr}(\alpha\tau_r) = -1 + \frac{1}{2}(r^2 + 12m)^{-1/2} \cdot 2r$$

$$= -1 + \frac{1}{2}\frac{1}{(r^2 + 12m)^{1/2}} 2r$$

$$= -1 + \left(\frac{1}{1 + \frac{12m}{r^2}}\right)^{1/2}$$

$$\Delta(\alpha\tau_r) = \left[-1 + \left(\frac{1}{1 + \frac{12m}{r^2}}\right)^{1/2}\right]\Delta r$$

for $r = n$

$$\Delta_1(\alpha\tau_r) = \left[-1 + \left(\frac{1}{1 + \frac{12m}{n^2}}\right)^{1/2}\right]\Delta r$$

and for $r = n$ $\quad \Delta r = 1$

$$\Delta_1(\alpha\tau_r) = -1 + \left(\frac{1}{1 + \frac{12m}{n^2}}\right)^{1/2}$$

2

~~Introduction of β term~~

$$f = e^{-\frac{(\alpha t+r)^2 + r^2}{4m} + \beta t}$$

$$+\frac{(\alpha t + r)^2}{4m} + \beta t - \frac{r^2}{4m} = 3$$

~~[illegible]~~

$$\boxed{\begin{aligned} &x^2 + 2xr + fx = 12m \\ &x^2 + \underbrace{(2r+f)}_{2R} x = 12m \end{aligned}}$$

$$2r + f = R$$

$$\frac{R - f}{2} = r$$

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death per year $\quad x = \alpha\tau_r$ $\quad$ hp

$$x^2 + 2xr = 12m \qquad \boxed{\frac{12m - x^2}{2x} = r}$$

$-\frac{dx}{dr} P(r)$ is function of $\underline{\underline{x}}$ and gives death per unit of x

$$-\frac{dx}{dr} = 1 - \left(\frac{1}{1+\frac{12m}{r^2}}\right)^{1/2}$$

death per "year":

$$\left(1 - \frac{1}{1+\frac{12m}{r^2}}\right)^{1/2} \times P(r)$$

$$r = \frac{12m - x^2}{2x}$$

$$= \left(1 - \frac{1}{1 + \frac{12m \times 2x^2}{(12m - x^2)^2}}\right) P(r)$$

$$\left(1 - \frac{(12m - x^2)^2}{(12m - x^2)^2 + 12m\, 2x^2}\right) P(r)$$

$$\left(1 - \frac{(12m - x^2)^2}{(12m)^2 + x^4}\right) P_r$$

$$= 1 - \frac{(12m)^2 + x^4 - 2 \times 12m x^2}{(12m)^2 + x^4}$$

$$= \frac{2 \times 12m x^2}{(12m)^2 + x^4} \text{ — } D \qquad P(r) = \frac{2 \times 12m}{\frac{(12m)^2}{x^2} + x^2} P_r$$

$\sqrt{12 \times 6.5 - 12}$

$12 \times (6.5)^2 - 144$

900 $\quad$ 500
− 81 $\quad$ 144
819 $\quad$ 356

Check by assuming $r^2 << 2rX$
we may then write

$$X^2 + 2rX + \cancel{} r^2 = 12m$$

$$(X+r)^2 = 12m$$

$$X + r = \sqrt{12m}$$

$$X = \sqrt{12m} - r$$

$$-\frac{dx}{dr} = 1$$

$$-P(r)\frac{dx}{dr} = P(r)$$

with βt term;

$\boxed{f = 2R}$ defn.

$$(X+r)^2 + \cancel{f}\, \cancel{X} = 12m$$

$X >> r$

$$(X+r)^2 + 2RX = 12m$$

approx

$$(X+r)^2 + 2R(\cancel{X+r}) \approx 12m$$

$$(X+r) = -R + \sqrt{R^2 + 12m}$$

$$X = \text{Const} - r$$

$$-\frac{dx}{dr} = 1$$

$$-P(r)\frac{dx}{dr} = P(r)$$

Stricter

$$X^2 + 2Xr + fX = 12m$$

$$X^2 + (2r + f)X = 12m$$

$$R = \frac{2r + f}{2}$$

$$X^2 + 2RX = 12m$$

$$X = -R + \sqrt{R^2 + 12m}$$

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Tabelle

H

$$\alpha \tau_n = \sqrt{n} \times \frac{\tau_n}{\Delta_0} - n$$

$$12n = n\left(\frac{\tau_n}{\Delta_0}\right)^2 - n^2 \qquad \frac{\tau_n}{\Delta_0} = 10$$

$$\boxed{n < \left(\frac{\tau_n}{\Delta_0}\right)^2}$$

n	$\alpha \tau_n$	$12n$
4	16	384
9	21	819
12	22.5	1056
16	24	1344
25	25	1875
49	20	2500
81	9	1600

40 − 16

50 − 25

400
16
384

70 − 50 = 20

900
81
819

4900
2400
2500

90 − 81

1200
144
1056

8100
6500
1600

1600
256
1344

1600
256
1344

2500
625

1875

16
1344
$\sqrt{1360} - 4$

1344
64
$\sqrt{1408}$
37.5
8
29.5

1344
256
1600
40 − 16

1344
575
$\sqrt{769} - 24$
27.7 − 24

400
1344
$\sqrt{1744} - 20$
41.8 − 20

~~1344~~
~~400~~
~~$\sqrt{1944}$~~ = 30.8

1744

41.7

1344
575
$\sqrt{1919} - 24$

43.8
24
19.8

1344
780
$\sqrt{2124}$

46
28
18

Arch 3

40

$$\frac{dx}{dr} = \frac{dx}{R}\frac{dR}{dr} \qquad \frac{dR}{dr} = 1$$

$$\frac{dx}{dr} = -1 + R(R^2+12m)^{-1/2} = -1 + \left(\frac{1}{1+\frac{12m}{R^2}}\right)^{1/2}$$

$$-\frac{dx}{dr} = \left(\frac{1}{1+\frac{12m}{R^2}}\right)^{1/2} - 1$$

$$\boxed{-P(r)\frac{dx}{dr} = P(r)\left[\left(\frac{1}{1+\frac{12m}{R^2}}\right)^{1/2} - 1\right]} = D$$

$$R = r + \frac{L}{2}$$

$$R = \frac{12m - x^2}{2x}$$

$$r = \frac{12m - x^2}{2x} - \frac{L}{2}$$

$$D = \left(\frac{R^2}{R^2+12m}\right)^{1/2} - 1$$

$$D =$$

$$R^2 = \frac{(12m)^2 - 2\times 12m\,x^2 + x^4}{4x^2}$$

$$R^2 + 12m = \frac{(12m + x^2)^2}{4x^2}$$

$$\sqrt{R^2+12m} = \frac{12m + x^2}{2x}$$

$$D = \frac{\frac{12m - x^2}{\cancel{2x}}\,\cancel{2x}}{12m + x^2} - 1$$

$$D = \frac{12m - x^2}{12m + x^2} - 1$$

$$\frac{X_0}{X_n} = \frac{\sqrt{n(\ )^2 - n^2}}{\sqrt{n}(\ ) - n} \cong 1.7$$

$$(\ ) = \frac{\Sigma n}{40}$$

$$\frac{X_0}{X_n} = \frac{110}{65} \approx 1.7 \qquad \frac{\sqrt{n}\ 10}{\sqrt{n}}$$

$$n = \underline{\underline{16}}$$

$$\begin{array}{r} 1600 \\ -256 \\ \hline \end{array}$$

$$\sqrt{1344} = \frac{36.7}{24} = 15.3$$

$$\begin{array}{r} 40 \\ 16 \\ \hline 24 \end{array}$$

Production theory

$$(X_n + n)^2 = 12n$$

$$X_n = \sqrt{12n} - n$$

$$X_0 = \sqrt{12n}$$

$$X_n = X_0 - n \qquad \Big| \ X_0 - X_n = n \text{ years}$$

$$(X_n + n)^2 = 12n$$

$$(X_2 + n + \sqrt{n})^2 = 12n$$

$$X_n = \sqrt{12n} - n \qquad 110 \text{ years}$$

$$X_2 = \sqrt{12n} - n - \sqrt{n}$$

$$X_2 - X_n = \sqrt{n} = \underline{\underline{10 \text{ years}}} \qquad \sqrt{n} = 10 \text{ years}$$

$$\left(\frac{X_n}{\Delta}\right) = \frac{X_2 - X_n}{X_n} = \frac{\sqrt{n}}{X_0 - n}$$

41 H

Gen. Philosophy

assume . $n = 16$ in D generation

" X-rays make chromosome breaks and on average 1 chromosome ~~break makes~~

a.) 1 small del.

b.) 1 big deletion

$70\,r = 2$ years

$\boxed{\text{If } x = 36 \text{ for } 110 \text{ years } \tfrac{1}{3} \text{ hits per year}}$

~~[illegible]~~ ~~max~~

$70\,r = 2$ years

$100\,r = 3$ years $= 1$ hit $/ 100\,r$

otherwise $n = 16$ if X-rays make small lesion 10 years 4 hits

1 hit = $2\frac{1}{2}$ years 85.7 r per hit
1 small

in next gen. gives prob. of small lesions. —

Longest life!

$$X_0^2 = 12\,n \qquad X_0 = \sqrt{12 n}$$

most probable X approx. for gaussian

~~$X_n \approx$~~

$$X_n^2 + 2 X_n n \cong 12\,n$$

$$X_n \approx \left(\sqrt{1 + \frac{12 n}{n^2}} - 1\right) n$$

$$12\,n = n\left(\frac{\Sigma_n}{\Delta_0}\right)^2 - n^2$$

$$X_n = \sqrt{n} \cdot \frac{\Sigma_n}{\Delta_0} - n$$

$$X_n = \left(\sqrt{1 + \frac{X_0^2}{n^2}} - 1\right) n$$

$\neq$

$$X_0^2 = n\left(\frac{\Sigma_n}{\Delta_0}\right)^2 - n^2$$

$$X_0 = \sqrt{n\left(\frac{\Sigma_n}{\Delta_0}\right)^2 - n^2}$$

Experiment 4 42

Pa... the.

$f \cdot \quad e^{-\frac{x^2}{4m}}$

$$f(x+1) = e^{-\frac{(x+1)^2}{4m}} = e^{-\frac{x^2}{4m}} \cdot e^{-\frac{2x}{4m}} e^{-\frac{1}{4m}}$$

$e^{-\frac{2x}{4m}}$

$\frac{2x}{4m} = 1$

Messy

$x^2 + 2x\underline{r} = 12m$

$\Delta x = \frac{\Delta x}{\Delta r} \Delta r$

$\frac{P(r)}{\left(\frac{\Delta x}{\Delta r}\right)}$

Gaussian

$\frac{9}{13} \; \frac{9}{14} \; \frac{9}{15} \qquad \frac{730}{2730}$

$9 \; \frac{9}{10} \; \frac{9}{11} \; \frac{9}{12} = \frac{730}{1320}$

falls factor $\frac{1.8}{1.67}$

.3989
2420

next step fall factor 3.75

~~0~~ 2.42
0.54

4.5

$$\frac{x_0}{6.5} = \sqrt{n} - \frac{1}{2}\sqrt{n}\,\frac{1}{\sqrt{12m}}\left(1 - \frac{1}{2}\,\frac{n+\sqrt{n}}{12m}\right)$$

$$\approx \sqrt{n} - \frac{1}{2}\sqrt{\frac{n}{12m}}$$

$$\sqrt{12m} = 6.5\sqrt{n}$$

$$\boxed{12m = 42n}$$

further about m and n

$$X_m = -r + r\sqrt{1+\frac{12m}{r^2}}$$

$$X_n = -n + n\sqrt{1+\frac{12m}{r^2}}$$

$X_m + \sqrt{n} - X_m$

$$\frac{X_n}{X_0} = \frac{-n + n\sqrt{1+\frac{12m}{n^2}}}{\sqrt{n\left(\frac{X_m}{\Delta}\right)^2 - n^2}}$$

m and n

$$x_0^2 + \cancel{2x_0} = 12m$$

$$x_0 = \sqrt{12m}$$

$$\frac{X_m}{\Delta} \approx \sqrt{n}\left(1+\frac{12m}{n^2}\right)^{1/2}$$

$$12m = n\left(\frac{X_m}{\Delta}\right)^2 - n^2$$

$$\frac{X_m}{\Delta} = \sqrt{n}\left(1+\frac{x_0^2}{n^2}\right)^{1/2}$$

$$x_0^2 = n\left(\frac{X_m}{\Delta}\right)^2 - n^2$$

gives $X_0 = f(n)$

43

4

m and n

$n = 0$

$$X_0^2 + 2X_0 n = 12m$$

$$X_0 = \sqrt{12m}$$

$$\left| \left\{ \frac{dx}{dn} \right\} \right| = 1 - \frac{12m - X_n^2}{12m + X_n^2} = 1 = D$$

$n = m$

$$\cancel{X_n = n\left(\sqrt{1 + \frac{12m}{n^2}} - 1\right)}$$

$$\cancel{X_n^2 =}$$

$$\cancel{X = n\left(\sqrt{1 + \frac{12m}{n^2}} - 1\right)}$$

$$X_n = n - \sqrt{n + 12m} = n - \sqrt{12m}\sqrt{1 + \frac{n}{12m}}$$

$$= n - \left(1 + \frac{1}{2}\frac{n}{12m}\right)\sqrt{12m}$$

$$\cancel{X_n = n - \sqrt{n + 12}}$$

$$X_n = n - \sqrt{n + 12m} \qquad X_0 -$$

$$X_{n+\sqrt{n}} = n + \sqrt{n} - \sqrt{n + \sqrt{n} + 12m}$$

$$\frac{X_0}{6.5} = \sqrt{n} - \frac{1}{2}(n + \sqrt{n} + 12m)^{-1/2}\sqrt{n}$$

$$\frac{}{(n + \sqrt{n} + 12m)^{1/2}} = \sqrt{12m}\left(\frac{n + \sqrt{n}}{12m} + 1\right)^{1/2}$$

$$\approx$$

$$\approx \frac{}{\frac{1}{2}\sqrt{12m}\left(\frac{1}{2}\frac{n + \sqrt{n}}{12m} + 1\right)} =$$

$$e^{-\frac{x}{m}} \, e^{-(x+r)^2}$$

$$(x+r)^2 \cancel{+} \frac{x}{2m} = 12m$$

assume 8m instead of $x^2 = 8m$

$$e^{-\frac{x^2}{4m}} \qquad \frac{x^2}{4m} = 2$$

$m = 20$
$n = 4$
$x^2 = 8m$

$= 6.5\sqrt{n}$

16.0

$$\frac{x^2}{\cancel{4m}} = 8 \times 20$$

$x \approx 13 \quad = 100$ zeros

$$\frac{x}{2m} = \frac{13}{40} = \frac{1.3}{4}$$

$7\tfrac{1}{2}$ zeros is one odd bit

0 1 2 3 4 5 6 7 8

$\frac{X_0}{X_m}$ is also forced

plus forces

10 units theory

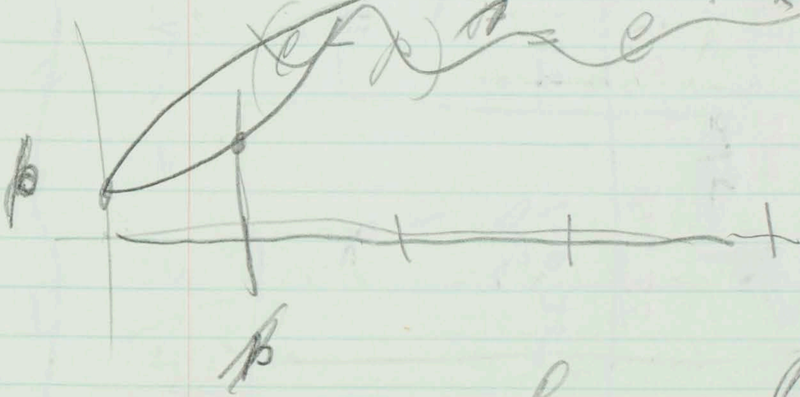
p = probability of dying in year

$\pi = 1-(1-p)^{10} = 1 - e^{-10p} = \pi$

$(1-p)^{10} = e^{-p \cdot 10} = e^{-10p}$

$10p$

$\frac{}{1000}$



$1 - p + \frac{100p^2}{2}$

$p = 1/1000 \quad \pi = 1/100$

$p = \frac{1}{100} \quad \pi =$

$\frac{1}{10} - \frac{1}{2}\frac{1}{100}$

$p = 30$

$\pi = 1 - e^{-30p} =$

$p = \frac{1}{3000} \quad \pi = \frac{1}{100}$

$e^{-\frac{1}{10}} \qquad \frac{1}{10} - \frac{1}{2}\frac{1}{100}$

0 1 2 3 4 5 6 7 8 9 10

1 4.5

25 w = 3 births
12 births for 100 years

0	1	2	3	4	5	6	7	8	9	10
1	3	4.5	4.5	3.35	2	1	0.4	0.161	0.0536	0.016
10^{-1} 0.5	1.5	2.25	2.25	1.67	1	0.5	0.2	0.08	0.0268	0.008
.182	0.73	1.45	1.95	1.94	1.55	1.035	0.59	0.3	0.134	~~0.0051~~
0.681	2.23	3.70	4.20	3.61	2.55	1.535	0.79	0.38	0.1608	0.0131

Time → 1.9 / 3.35   81.5 years   1.14 / 1.24   1.16 / 1.25   1.65 / 1.78   2.55   2.75 / 2.55   50 years

0	1	2	3	4	5	6	7	8	9	10
1	4	8	10.7	10.7	8.5	5.7	3.25	1.63	0.725	0.29
0.182	0.73	1.45	~~2.18~~ 1.95	1.94	1.15	1.035	0.59	0.3	0.134	0.0525

10^{-1}

m 5.5

25 w 1243   1964 $\frac{16\times2}{3}$ $\frac{4^3}{3!}$ $\frac{4^4}{4!}$

$1234 = \frac{16}{24}$ $\frac{256}{24}$ $\frac{16\times4}{6}$ $\frac{64}{6}$ $\frac{144}{12}$

45

-2	-1.5	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1	1.5	2
0.054	0.13	0.242	0.352	0.4	0.352	0.242	0.13	0.054
175	54	13	242	352	4	352	242	13
.0715								

$-2\frac{1}{2}$	-3	3.5
0.0175	0.0044	0.0009
44	09	
.0615	0.0053	

2.5	3	3.5
0.0175	0.0044	0.0009
54	175	44

n = 3 r

	0	1	2	3	4	5	6	7	8	9	10
1/10	0.5	1.5 0.5	2.25 1.5	2.25 2.25	1.67 2.25	1.00 1.67	0.5 1.00	0.2 0.5	0.08 0.20	0.027 0.080	0.008 0.027
1/20	0.5	2.00	3.75	4.5	3.92	2.67	1.5	0.7	0.28	0.107	.035
			81 years				50 years				

add one for specified successive lethal with probab 1/2

n = 4

	0	1	2	3	4	5	6	7	8	9	10
	0.182	0.73 182	1.45 73	1.95 145	1.95 1.95	1.55 1.95	1.03 1.55	0.59 1.03	0.30 .59	0.134 .30	0.052 .134
1/20	0.182 101.	0.912 95.	2.18 90.67	3.40	3.90 ½ = 1.95 (80)	3.50 74.67	2.58 69.33	1.62 63½	0.89 58.67	.434 53.33	0.186 ~~1.06~~ 48
	0.091	0.456 0.182	1.090 .912 182	1.70 2.18 .912 182	1.95 3.40 2.18 0.912 0.182	1.75 3.90 3.40 2.18 0.912 0.182	1.29 3.50 3.90 3.40 2.18 0.912 0.182	0.81 2.58 3.50 3.90 3.40 2.18 0.912 0.182	0.445 1.62 2.58 3.50 3.90 3.40 2.18 0.912 0.182	.217	0.093
	0.091	0.638	2.184	4.474	8.624	12.324	15.364	17.464	18.719		
			1.00	0.68	0.45	0.284	0.17	0.0925	0.0475		

$\frac{390}{x} = 3.66$

2 makes ~~10.6~~

$5.34 = \frac{10.67}{2}$

Rt 25.33

1.5 1.6

Twin-[illegible] Check

46

$\frac{1}{2} P_n(n, r)$

$\frac{1}{2} P_n(n+1, r)$

8_2 $\equiv$ 1.6 is what factor

$$\sqrt[8]{2} = \frac{30103}{17609} = 31.7 = \frac{8}{x}$$

log 150

20 40

3.8

~~4.7 years~~ $\boxed{\text{5 years}}$ = # steps

or 20 steps. —

$X = 20 \qquad X^2 = 12\,m$

$400 = 12\,m$

$m = 33$

1	128.70	114.04
8	114.04	160.24
28	80.12	132.06
56	43.62	74.50
35	18.06	28.00
128	5.60	7.20
256	1.20	1.12
	0.16	0.08
	0.01	
	391.51	517.24
		~~128.71~~

1.32 — mean distance

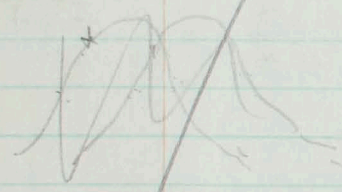
of two curves
added

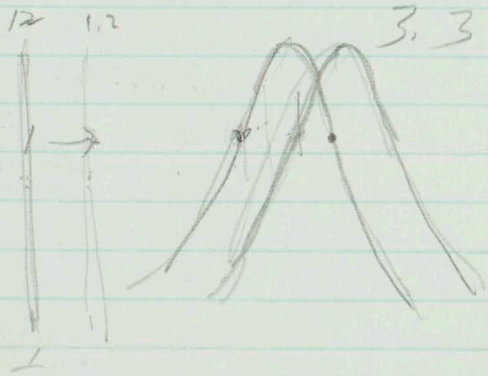
$5 \times 1.3 = 6\frac{1}{2}$ years

add $\frac{1}{2}$

$\frac{n^n}{n!} e^{-n}$ $\qquad \frac{4^4}{4!}\ \frac{4}{5} \times \frac{4}{6}\ \frac{4}{7} \times \frac{4}{8}$ $\qquad \frac{16}{30} \times \frac{16}{56} = \frac{256}{1680}$

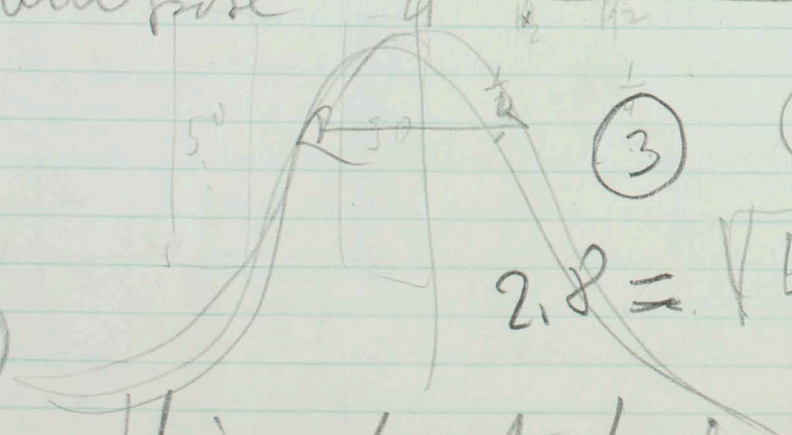
$\frac{64}{210}$





1000

$\frac{1}{4}$ $\frac{1}{2}$ $\frac{1}{4}$ to compose



3 2

$2.8 = \sqrt{4^2+4}$

this about twice

47 H

1

1 1

1 2 1

1 3 3 1

1 4 6 4 1

1 5 10 10 5 1

$\boxed{1 \quad 6 \quad 15 \quad 20 \quad 15 \quad 6 \quad 1}$ n=6

1 7 21 35 35 21 7 1

.1 .8 2.8 5.6 7.0 5.6 2.8 .8 .1

0	1	2	3	4
.01	.08	0.28	0.56	0.70
.64	2.24	4.48	5.60	4.48
7.80 .5	15.70	19.60	15.65	7.70
31.4	39.00	31.40	15.65	4.48
49	15.70	19.60	5.60	0.70
31.4	2.24	4.48	0.56	
7.8	0.08	0.28		
0.64				
0.01				
128.7.05	114.04	80.12	43.62	18.06
0	114.04	160.24	132.08	74.50

5	6	7	8
0.56	0.28	0.08	0.01
2.24	0.64	0.08	
2.24	0.28		
0.56			
5.60	1.20	0.16	0.01
28.00	7.20	1.12	0.08

somatic recessive lethals
$n \approx 3$

---

another way of estimating n is to increase the mutation ~~rate by~~ load by a known amount, ~~by~~ and ~~observing the individual of the offsp~~ ~~the muta~~ observing the effect on longevity. The offspring of X-rayed animals have an increased mutation load.

~~From the~~
~~It follows from the above~~

From the theory here presented it follows that increasing the mutation load by $\frac{1}{4}$ should ~~shorten life expectation~~

According to the theory here presented the mutation load is responsible for the difference of about 25 years between $t_0 = 100$ years and $t_m \approx 75$ years. Increasing the mutation load by 25% should ~~de~~ decrease t_m by $\frac{25}{4} \approx 6$ years

From [illegible] observed. Paper. If we choose n we ~~get x_0~~ ~~[illegible]~~ find ~~[illegible] x_n~~ how many years, 1 bit represents.— (From t_0 we get total number of bits x_0) n bits represent then sn years and we should have $t - t_n = sn$.—

~~We could determine n [illegible] in [illegible] two ways, siblings or even [illegible] better [illegible] non [illegible] twins~~ Let us) ~~If we~~ consider a population which has been freely interbreeding and which is in a stationary condition, ~~and~~ let us ~~know~~ determine g_1 from the mortality curve of say females the mean ~~life~~ difference between length of life of two randomly selected pairs (above age of 10). ~~g~~ Let us further determine g_2 the mean difference for sisters or preferably ~~even better~~ sisters who are non-identical twins. If n is a small number if we have $g_2 < g_1$ and we may estimate n from the ratio $\frac{g_1}{g_2}$.— ~~this may be see~~ In order to see that this must be so we may consider for the sake of argument a population free of special and general

In the case of man on the basis of data obtained in mice this life shortening ~~is~~ appears to be of the order of magnitude of 10 days per ~~r.~~ Rontgen. —

~~If~~ We assume that X-rays act in this manner because they cause chromosome breaks leading to the loss of a large piece of the chromosome or to a substitution with a small deletion.

The dose of X-ray which causes one such damage should then lead to a life shortening corresponding to one hit. — assuming that $n = 4$ one additional hit should shorten life by about 6 years or ~~about~~ 2200 days, ~~according~~ ~~If one~~

And if one rontgen shorten life by 10 days it would follow that 220 Rontgen given at a low dose rate would cause 1 hit.

If ~~organisms~~ mammals are X-rayed ~~the off~~ ~~[illegible]~~ at a low dose rate the mutation load of the offspring may be increased ~~possibly~~ ~~also~~ ~~perhaps~~ ~~without~~ ~~causing~~ by causing ~~sev~~ chromosome breaks ~~wi~~ which result ~~with a~~ with the deletion of one or several genes. By keeping the dose rate low one may avoid causing double chromosome breaks leading to inversions translocations and other chromosomal anomalies. ~~may be~~ ~~One~~ ~~For an X ray dose that causes in one deletion in the offspring we should expect~~ ~~we get~~

From the life shortening Δt_0 that results from an X ray dose given to the parents which causes 1 deletion we may then compute $\frac{t_0}{\Delta t}$ the number of hits that ~~corresponding~~ to the life span ~~of the~~ $t_0 = 100$ years. ~~and thus obtain n~~ We may thus obtain n from

$$\Delta n \cong t_0 - t_n$$

~~One obtains also a life shortening by irradi~~

The life of individuals mice or man is shortened by exposing them to X-rays given at a low dose rate or ~~0.1~~ mutation

~~4x~~ $\frac{0.1}{4}$ mut in 55

~~they~~

0.1 per gen

over many gen:

$$\frac{\text{Rönt.}}{{}_{\shortparallel}220^{\shortparallel}} \quad \frac{n}{4}$$

~~Oz~~ $\frac{1}{40} = \frac{\text{Rontg}}{{}_{\shortparallel}220^{\shortparallel}} \frac{n}{4}$

$$R = \frac{{}_{\shortparallel}220^{\shortparallel}}{40} \frac{4}{n} = \frac{{}_{\shortparallel}220^{\shortparallel}}{10} \frac{1}{n}$$

permissible for $n = 4$

22 Röntgen per gen

will give 6 years life shortening. →

50

~~If we assume that~~
Would be better

25% increase in mutation
would decreases life expectancy
by 6 years. * ~~assuming~~

~~The~~ Effect of X-rays on irradiated animals indicates extrapolated for ~~[illegible]~~ many generations of the order of magn. of 10 r/day per roentgen ~~This~~ or 25% of the mutation load for $\frac{6 \text{ years}}{\text{10 r/day}} = \frac{2200 \text{ r}}{10 \text{ r/day}}$ ~~we may assume is~~ if given at a low dose rate.) — This one may assume is due to chromosome breaks followed either by the loss of a chromosome or a part of a chromosome or a restitution with ~~the~~ deletion of a gene or several genes. assuming ~~that it is the~~ for the sake of argument that the effect on the germ cell is of the same order of magnitude and further that the chromosome breaks are followed by a restitution with ~~mostly~~ a deletion which in the heterozygous condition is not "lethal" ~~to the egg or the embryo~~ we would then get in a population a 25% increase in the mutation load

If the mutation load is n
~~This~~ would amount to $\frac{n}{4}$
mutation. If $n = 4$
we get 1 mutation per 220 r
1 " per $\frac{220}{4}$ r

220 r/day

51 H

Selection. —

mother 20 40

3 years

1 m

$\frac{1}{3}$

15 cm

$\frac{(x+n)^2}{4n} = A$

$x+n \quad \sqrt{4nA}$

6

$\frac{1}{6}$ $\frac{1}{12}$

$0 \quad \cancel{\frac{dp}{dt}} = s - \frac{n}{12}$

$\cancel{s = \frac{n}{12}}$ $s = \frac{1}{3}$

$\cancel{s = \frac{2}{10}}$

$s - \frac{n}{6} = 0$

$s = \frac{4}{6}$

$n = 25$ years

0.66

$\frac{n}{25 \text{ years}} = 1$ mutation

out of 15 years

$0 = s - \frac{1}{2}\,\frac{\text{mutation}}{1}\,n \quad \frac{n}{25} \quad \frac{15 - \frac{n}{25}\frac{25}{n}}{15}$

$s - \frac{1}{2}\,\frac{15 - \frac{n}{25}\frac{25}{n}}{\cancel{4} \times 30} = \frac{1}{2}\left(1 - \frac{25}{15}\frac{1}{n}\right.$

$n = \infty$

$s = \frac{1}{2}$

$n = 4$

$s \approx \frac{1}{4}$

~~Paper~~ ~~donate~~ the

~~6~~

~~Wt of~~ Life shortening ~~by~~ in days if both parents are irradiated by

1 R unit | ~~b~~ ~~lp~~ 6 years = 2,200 days

What dose per generation given would ultimately lead to a life shortening of the pop. of ~~the~~ 6 years?

If "mutation" load is ~~as~~ ~~~~ that will lead to life shortening of $\frac{25}{n}$ years.

$Dose_1 = \frac{2200}{d_1}$ is dose that gives one mutant per generation. (for d_1 = 10 days

~~A very optimistic value~~ Dose x gives ~~~~ on me ~~~~ per day, 6 years' shortening.

~~the point ~~ ~~very~~ ~~optim~~

If mutation rate per gen is μ then raising this rate by $\frac{\mu n}{4}$ would shorten life by 6 ~~~~ about years. ~~A very optimistic~~

Muller gives OK $\mu < \frac{1}{2}$

a very optimistic view is $\mu = 1$

causing D_1 gives 6 year shortening

causing $\frac{n}{4}$ mutations

$\frac{D_1}{F}$ is dose which in the long run causes 6 years shortening

$\frac{1}{4}\mu = \frac{n/4}{F}$

Paper

Paper 4 52

$$f = e^{-\frac{(x+r)^2}{4m} + \frac{r^2}{4m} - \frac{f}{4m}x}$$

$$e^{-\frac{\beta}{\alpha}\delta t} = x$$

$$e^{-\frac{\beta}{\alpha}4m\frac{\delta t}{4m}}$$

f

$$\boxed{f = \frac{1}{6}}$$

$$x^2 + (2r+f)x = A\,4m$$

$$x = -\frac{2r+f}{2} + \sqrt{\left(\frac{2r+f}{2}\right)^2 + A\,4m}$$

for $r^2 \ll x$ $\quad \boxed{x = e^{-A}}$

$$\cancel{(x+r)^2} + fx = A\,4m$$

$$x + r = \sqrt{\left(\frac{f}{2}\right)^2 + A\,4m} - \frac{f}{2}$$

$$\cancel{\frac{(x+r)^2}{4m}} A$$

for $\frac{f}{2} \ll A\,4m$

$$\boxed{\frac{1}{2} < A < 3}$$

Identical twins difference 3 years
over 60 Kallmann

H. J. Muller Science Vol 121 p. 837-40 (55)
200 reps Mutat.
should shorten life by 6 years
~~H. J. Mu~~
i.e. 200 days I
1 r = 11 days yes but 200 reps causes [illegible] in hospital

a bearing on quantitative genetical theory, for one of the premises of this theory is that there is random union of gametes.

This investigation was supported by a grant from the Committee for Research in Problems of Sex, National Academy of Sciences—National Research

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Survival Curves for Male and Female House-Flies (*Musca domestica* L.)

DURING the course of a study on the biochemical changes accompanying ageing in the adult house-fly, the attention of the senior author was directed to the differential longevities of the male and female members of the common house-fly, *M. domestica* L. Paradoxically enough, a search of the literature revealed only scattered and inconclusive information on the longevity of this species under controlled laboratory conditions. Several authors have been cited by Roubaud[1] to the effect that the longevity of the house-fly can be extended to as much as 90 days by exposure to temperatures of 15° C. (59° F.); West, on the other hand[2], states in no convincing terms that the longevity of the house fly varies from two to three weeks, at most, during the summer and up to three months during the winter months. A side study was therefore undertaken to obtain reliable vital statistics for the male and female members of this species, bred, reared and maintained under standardized laboratory conditions. This report will summarize briefly one phase of this study to be published, in extenso, at a later date.

The flies studied represent offspring from many generations of inbreeding of (standard laboratory strain) NAIDM flies from the Technical Development Laboratories of the United States Public Health Service (through the kind co-operation of Dr. Albert S. Perry). Results summarized in this communication cover more than 4,000 members of each sex (more than 8,500 flies in all), through nine successive generations; all were maintained, bred and reared (and permitted to age) at 80° F. and 45 per cent relative humidity in our laboratory as described earlier[3]. Eggs were collected from a standard medium when the parents were 4½–5 days old. Offspring were reared on this medium[3] and, under these conditions, emerged as adults exactly 14 days after the first appearance of the parent flies. Parents, as well as ageing flies, were maintained on a powdered whole-milk, sucrose and water diet (*ad libitum*) in bronze screen cages 7½ in. × 7½ in. × 16 in., under temperature and humidity conditions indicated above, in numbers of 150–200 of each sex per cage.

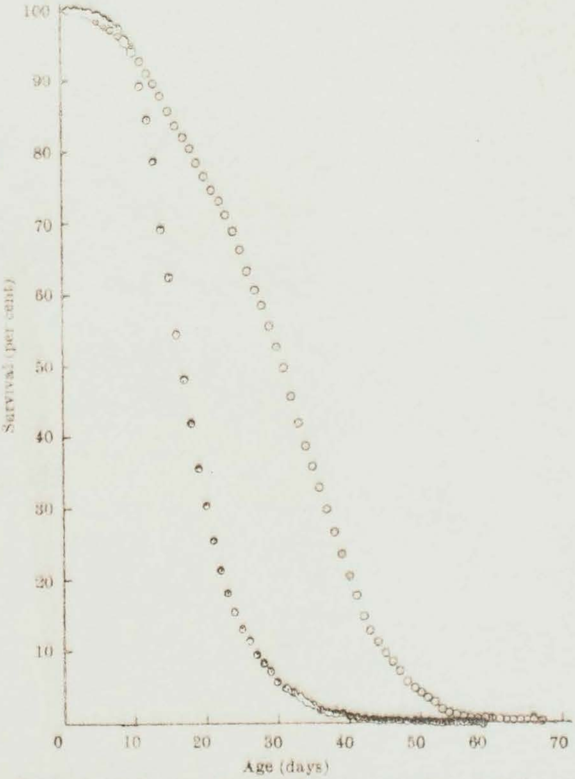


Fig. 1. Survival curves of male and female house-flies. ●, Males; ○, females

Fig. 1 shows the survival curves for each sex. These clearly suggest a typical, rectangular form of survival curve representative of animal populations showing senescence (that is, slow rate of death of youthful members of the population followed by an acceleration of mortality during a specific period of the life-history). However, during the final days of adult life this species exhibits a logarithmic-like survival curve with a markedly retarded rate of dying off (40–60 days for the male and 55–70 days for the female). The marked difference in average and maximum longevities of the two sexes is apparent from an examination of the two curves. Thus, about 90 per cent of the males die between ten and thirty days of age, whereas the females die off to the same extent between the tenth and fiftieth day of adult life. What had been observed earlier for only 600 pairs of flies[3] has held true for more than 4,000 flies of each sex through nine successive generations; namely, that at thirty days of age 50 per cent of the females have survived; by the end of this same period of time only about 5 per cent of the males are still alive (indeed, 50 per cent mortality for males occurs at about 16 days of age). In actual longevity figures, males had a mean longevity of 17·4 and a maximum of 54 days; females had a mean longevity of 29·4 days and a maximum of 63 days. Such data clearly confirm the rather widespread occurrence of higher female longevity in animal species discussed elsewhere by Hamilton[4] and Rockstein[3].

Stockpiles Seen A-Control Bar

By Robert Goldenstein

CHICAGO, Oct. 22 (AP) The stockpiling of nuclear weapons by the East and West has made an effective system of nuclear disarmament controls extremely difficult and perhaps impossible, an international gathering of scientists has decided.

The scientists also feel a climate of mutual trust for implementing any nuclear disarmament agreement does not now exist.

But they said that since any nuclear war would result in the destruction of most centers of population in the belligerent countries, and the risk of localized wars' spreading is so great, "mankind must therefore set itself to the task of eliminating all wars, including local wars."

The scientists are from 20 Western, Communist-bloc and other nations, including the United States, Soviet Union, India and Japan, but not Communist China. The Chinese excused themselves because of the press of new scientific assignments.

Vienna Declaration

Their declaration on the dangers of the atomic age was made public tonight by Eugene Rabinowitch, editor of the Bulletin of the Atomic Scientists and one of the conferees.

Known as the Vienna declaration, it was drafted after four days of meetings last month in the Austrian resort of Kitzbuhel. It marked the third international meeting of the scientists, which started with the Pugwash conference in Nova Scotia in 1957.

Rabinowitch, in a talk describing the conference, said only one scientist of the 70 present abstained from endorsing the declaration. He did not identify the scientist.

The United States had 18 scientists present; the Soviet Union, 10; Great Britain and Japan, 5 each. Other countries represented included Australia, Austria, Bulgaria, Canada, Czechoslovakia, Denmark, France, East Germany, West Germany, Hungary, Italy, Netherlands, Poland, Norway and Yugoslavia.

Knowledge to Remain

The declaration said nuclear destruction will remain a potential all-time threat because the knowledge of how to produce such weapons will never be destroyed, even if they are banned by agreement. It added:

"For (nuclear) disarmament to become possible, nations may have to depend, in addition to a practical degree of technical verification, on a combination of political agreements, of successful international security arrangements, and the experience of successful cooperation in various areas. Together, these can create the climate of mutual trust, which does not exist, and an assurance that nations recognize the mutual political advantages of avoiding suspicion."

Boy Admits 4 Bomb Threats

PEORIA, Ill., Oct. 22 (AP) Police held without charge today a high school freshman who they said admitted making four anonymous phone calls saying bombs had been planted in Peoria schools.

Gale McFarland, 15, a freshman at Woodruff High School, told police he made the calls "just for the fun of it." Seven such calls, resulting in closing of schools while police searched the premises, [illegible]

Teachers Stumped, Boy Solves Complex Physics Equation

An 11-year-old Ft. Belvoir schoolboy surprised a missiles and rockets expert Tuesday when he explained the meaning of a complicated aeronautical physics equation which had stumped a roomful of teachers and fellow pupils.

Lt. Col. C. M. Parkin Jr., project officer for the scientific course on rockets and missiles at Ft. Belvoir, presented the puzzling equation, which describes the minimum escape velocity for space vehicles, to an assembly of seventh and eighth grade students at the post's elementary school.

He offered a silver pin as a prize for the youngster who, after the expected research, could interpret it.

Col. Parkin then proceeded with his talk on the basic physics of space exploration. At the end of the lecture, Frank Newett walked up to the Colonel and shyly offered him the solution to the equation.

Frank explained that Col. Parkin had mentioned the symbols of the equation during his speech.

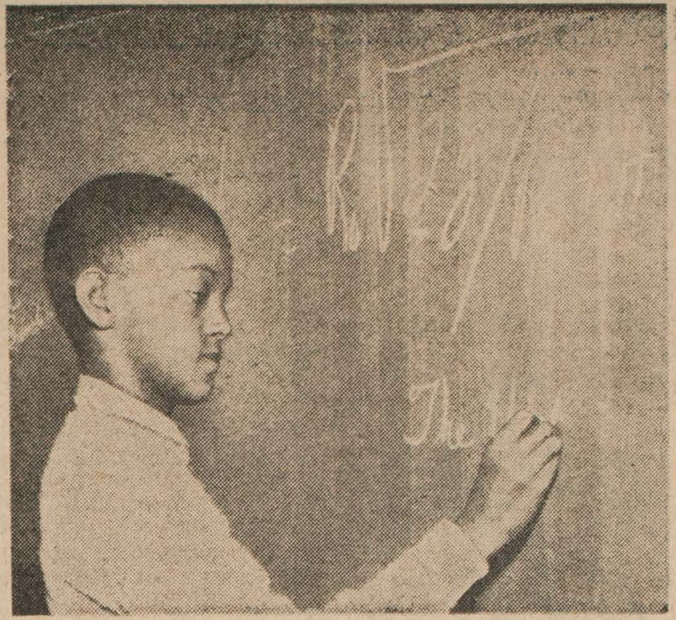
"It was easy," Frank said. "I just listened to what he said while he was talking and when he asked the question I knew the answer."

The equation stated: Ve (velocity needed to overcome the earth's gravitation) equals Ro (radius of the earth) multiplied by the square root of 2g (twice the force of gravity) divided by Ro plus h (the altitude of the vehicle).

Col. Parkin spoke to an assembly of the two grades and eight teachers. None of them could immediately solve the equation. School officials said physics was not taught in Frank's class, and the boy apparently had never seen the equation before.

Frank is the son of Sgt. 1/cl Harry Newett, of the 588th Engineer Battalion (Construction).

The boy left the assembly with a shiny silver pin, the equation engraved on it.



FT. BELVOIR'S STUDENT FRANK NEWETT
... his solutions to an equation won him a silver pin

Memorial at Home Planned for Linker

The Amity Club of Washington has given $2000 to the Hebrew Home for the Aged as a memorial to the late Carl J. Linker, who served as club secretary for 25 years.

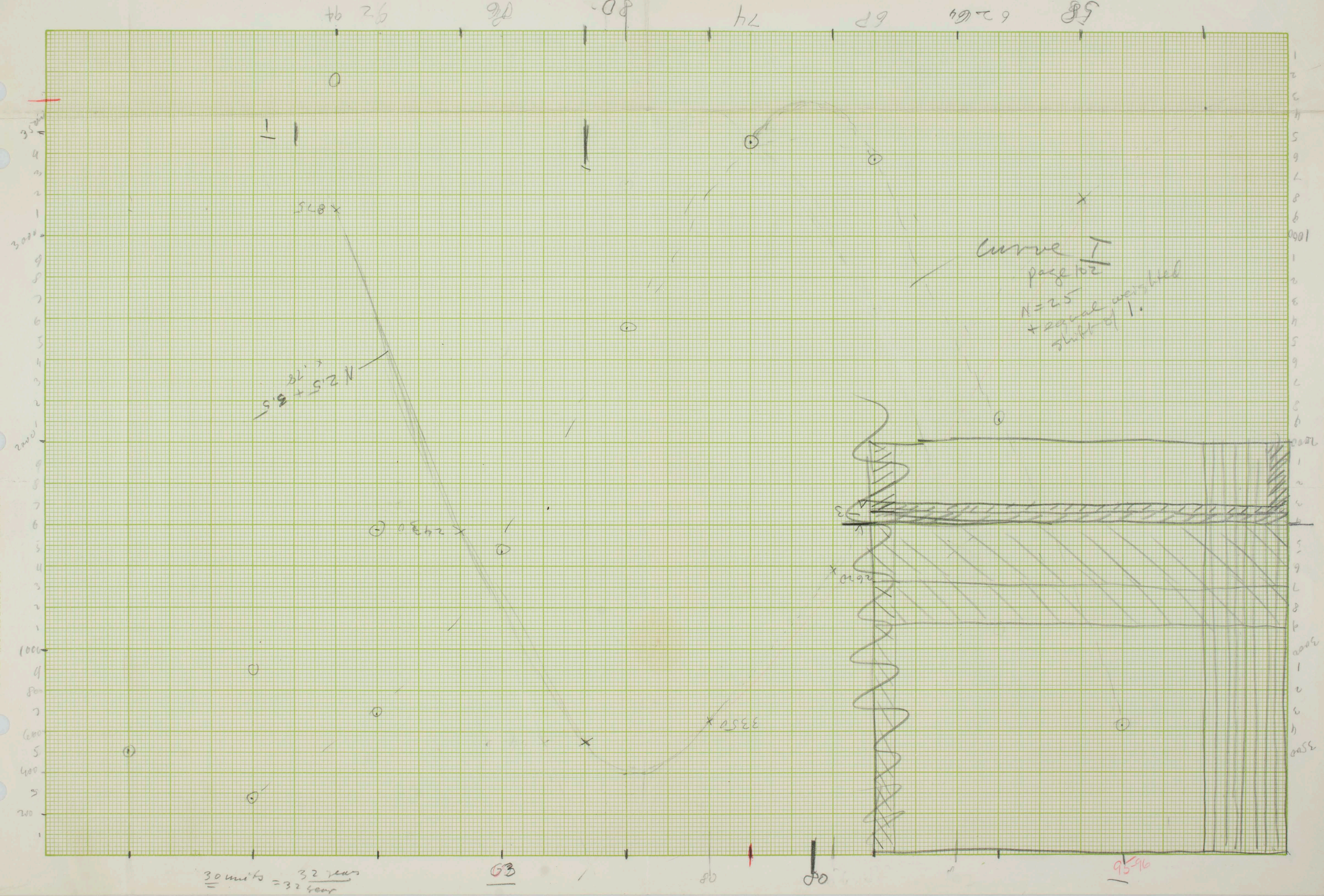
Linker, who died in 1956, will also be memorialized by a plaque in the foyer of the Home. The money wil be used for equipment.

Residential UGF Unit Hits 37 Pct.

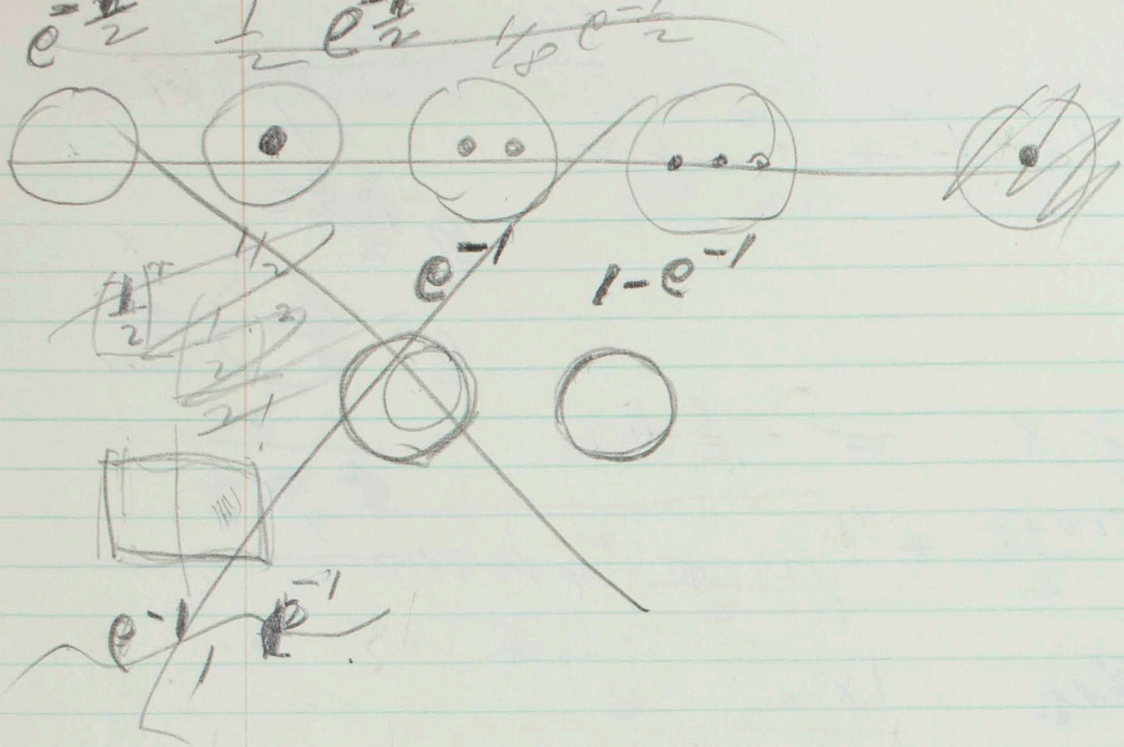
Residential units of the United Givers Fund have received pledges of $346,825, or 37.10 per cent of the $935,000 goal of the current drive, according to the results of report luncheons held yesterday.

A UGF spokesman gave the following breakdown of amounts pledged to date: Alexandria, $7985; Arlington, $19,288; Fairfax, $15,905; Montgomery, $47,401; Prince Georges, $8816; District of Columbia, $247,430.

A "Halloween" report luncheon for the District residential unit will be held at 12:15 p. m. Wednesday at the Presidential Arms. Among the speakers will be Mrs. William P. Rogers, wife of the Attorney General, Martin Agronsky of NBC news, and Bill Gold of The Washington Post.



Curve I
page 102
N=25
+ equal weighted shift of 1.
30 units = 32 years
63
80



Look at approximation

$n = 4$

$X_0 = \cancel{200}$ ~~shift~~ ~~16.6~~

$X_0^2 = 12m = 16.7$

$$\begin{array}{r} 13.4 \\ \hline 3.3 \end{array}$$

330 ~~280~~

by 5.5

~~15.65~~

$X_0 = -0 + \sqrt{12m}$

$X_m = -n + \sqrt{n^2+12m}$

$X_m = -4 + \sqrt{n^2+12m} = 4$

-4

18.6

$\cancel{280}+16$ $\quad$ 330 16 $\quad$ ~~346~~

$X_m = 18.6\ \cancel{19.4} - 4 = \cancel{13.4}\ \ 14.6$

4 bits $45.5 = 22.5$

53 H

6 years

$F = \dfrac{\cancel{\ldots}\, n}{\mu}$

$D_1 \cong 200$

$\mu = 1$

$D_{\phi}/\text{gm} = \dfrac{D_1\, \mu}{M}$

$D_{\phi}/\text{gm} = 50$ R units if $n = 4$

$\mu = 1$ $\quad$ $0.1 < \mu$ 0.5

54 H

Basic assumptions

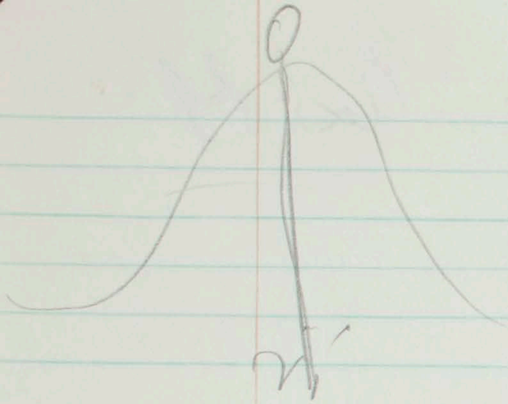
$$e^{-\frac{x_0^2}{2m}} = \frac{1}{20} \qquad \frac{x_0^2}{2m}$$

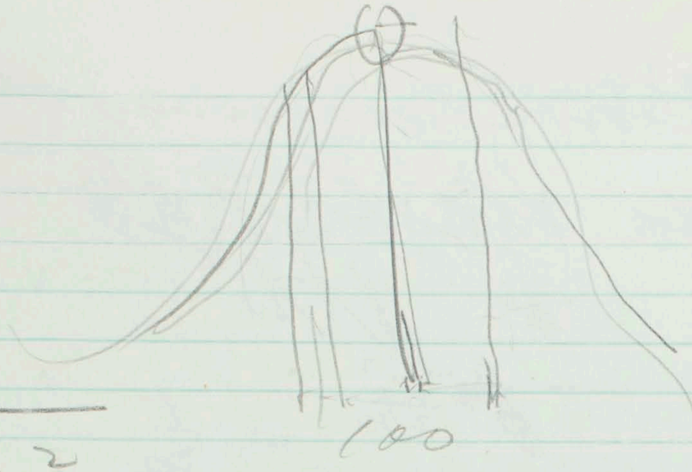
$$e^{-\frac{(x_0-1)^2}{2m}} = e^{-x_0} \; e^{\frac{2x}{2m}} =$$

$$= \frac{1}{20}$$

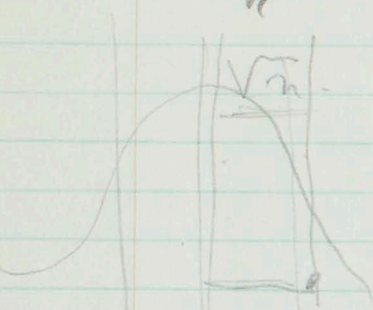
18

$12m = 280 \qquad \frac{18}{23}$

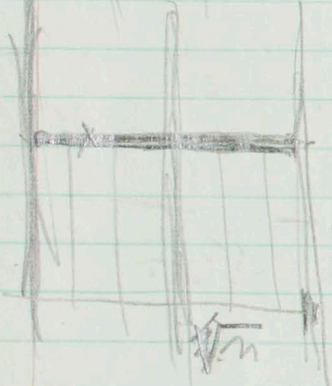




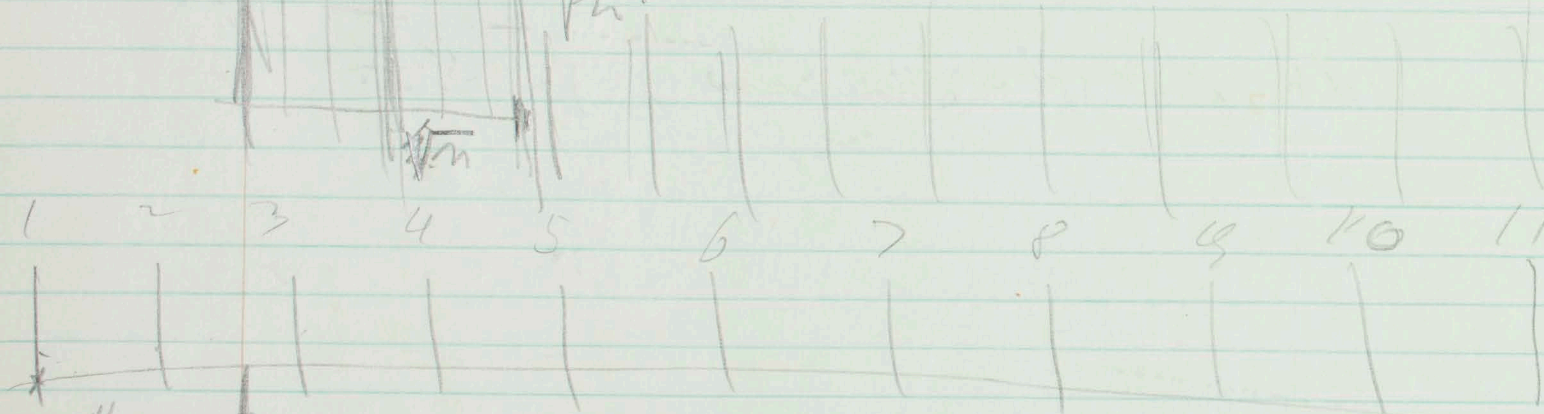
$(v_1 - v_2)^2$



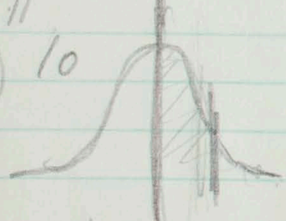
$\underline{n}$



$\frac{1}{\sqrt{n}}$



$\left(\frac{1}{n}\right)^{11}$ 10



25

5.

$\frac{25}{26}$ $\frac{25}{27}$ x $\frac{25}{28}$ $\frac{25}{29}$ $\frac{25}{30}$

14.6

$\frac{57}{170}$ $\frac{244}{170} = 1.43$

Twins   females 55

a X

$\sqrt{a^2 + X^2} = b^2$

$a^2 + x^2 = b^2$

$b^2 - a^2 = x^2$

30.6 month = 2.55 years

$940 \text{ month}^2 = a^2$

$5500 \text{ month}^2 = b^2$

$(4560)^{1/2}$

64.5
79.1
148.6

6.16 years 74.3 month

Stand dev of brothers

$\sqrt{x^2} = 68$ months

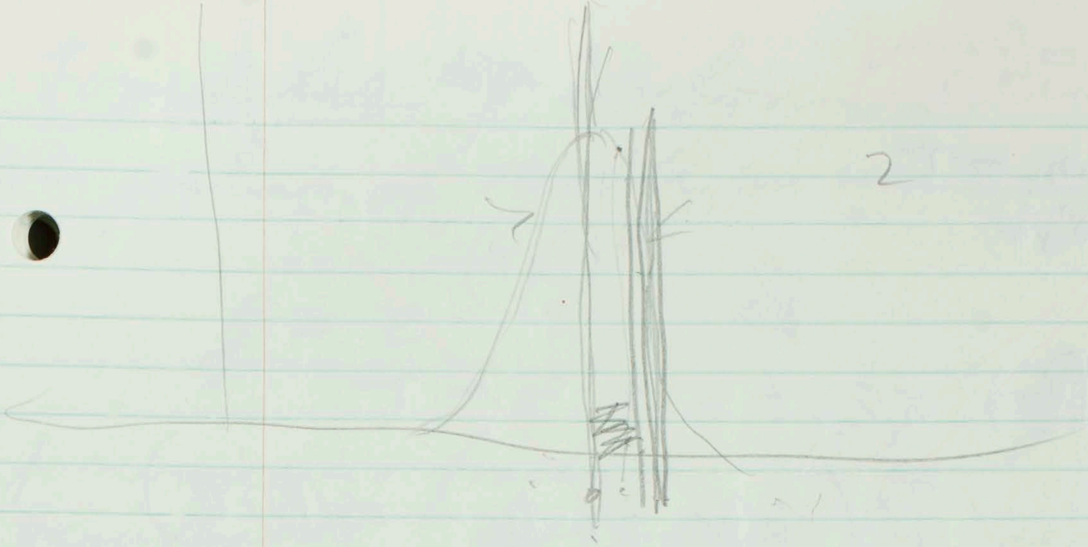
5.65 years

mean difference of brothers due to variation of n

$5.65 : 1.3 = \boxed{4.35 \text{ ev}}$

probably

H 56



$$\frac{\sigma\sqrt{2} \times 0.68}{2} = 0.95\sigma$$

or if $\bar{n} = 4$ $\cancel{\sqrt{4 \times 3}}$ =

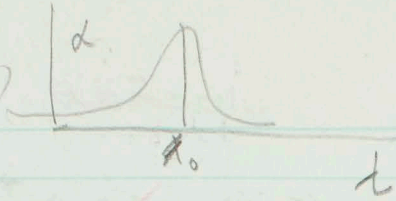
$$\frac{0.95\sigma}{} = 2 \times 0.95 = 1.9$$

I took 1.3 because of binomial instead of 1.9

The value of 4 year per bit corresponds to 1.4

$\alpha(\lambda)\, t_d + r = [12\ m]$

$$t = \frac{12m - r}{\alpha(\lambda)}$$



$$-d_x = \frac{1}{\alpha(\lambda)} P(r) \qquad \alpha(\lambda)\, t = 12\ m - r$$

$$d_x = \int \frac{P(12m - \alpha(\lambda)\, t)}{\alpha(\lambda)}\, d\lambda$$

$$\frac{20-2l_0}{t} = \alpha_1$$

$$\frac{20-2}{t} = \alpha_2$$

$$\frac{20-3}{t} = \alpha_3$$

$$20-4 = \alpha_4$$

$$P(1)\,\varphi(\alpha_1) + P(2)\,\varphi(\alpha_3)\ P(3)\,\varphi(\alpha_3)$$

$$d_x(t) =$$

Formulae of information; Paper

g: probab. of death in unit time

$$g = e^{-(kf)^{Q}}$$

f: surviving fraction Q and ~~k~~ k are constants ~~...~~ If ~~...~~ we assume k = 20 and Q >>> 1 then ~~...~~ g ~~will remain zero~~ if we decrease f from 1 g will remain zero until f approaches $\frac{1}{20}$ and then g will suddenly go up from zero to 1. — We shall use for our purposes here this crude approx.

A better ~~app~~ ~~approx~~ could be obtained using the $\frac{1}{20}$ $g = 90\%$ ~~and~~ ~~and~~ following considerations f is a known function of t choose k and Q so that

1.) $g = 0.9$ for $f = \frac{1}{23}$

and that average time interval ~~built~~ of death between 2 ~~...~~ previous females is 2.55 years

~~$f(x, m) = f = 1 - \{1 - e^{-\frac{x}{2m}}$~~

$$f = \left(1 - e^{-\frac{x}{2m}}\right)\left(1 - e^{-\frac{\alpha t}{2m}}\right)$$

Gompertz-dan

$\alpha t = 12m - r$

$t = \frac{12m-r}{\alpha}$ $\alpha = \frac{12m-r}{t}$

$-\frac{dt}{d\alpha} = \frac{12m-r}{\alpha^2}$ $-\frac{d\alpha}{dt} = \frac{12m-r}{t^2}$

$dt = \frac{12m-r}{\alpha^2} d\alpha$ $d_x = \frac{\phi(\alpha)\, d\alpha}{dt}$

$d_x\, dx = \phi(\alpha) \frac{\alpha^2}{12m-r}$

$\frac{d\alpha}{dt} = \frac{\alpha^2}{12m-r}$

$$\boxed{d_x = \phi(\alpha) \frac{(12m-r)}{t^2} P(r)}$$

$d_x = \phi(\alpha) \frac{12m-r}{t^2}$

$\alpha = \frac{12m-r}{t}$

$\cancel{D_x = \frac{\phi(\alpha)}{t^2} \sum_r \left(12m-r\right) P(r)}$

$\cancel{P(r) = \frac{n^r}{r!} e^{-n}}$

$\cancel{D_x = \frac{\phi(\alpha)}{t^2} \left(12m - \sum r P(r)\right)}$

$$D_x = \sum_r \phi(\alpha[r,t]) \frac{12m-r}{t^2} P(r)$$

$$= \frac{1}{t} \sum_r \phi(\alpha)\, \alpha\, P(r)$$

$\alpha = \frac{12m-r}{t_{years}}$

44

$\alpha(\lambda_1) t_1 + \cancel{t} = 12m - r$

$\cancel{\alpha(\lambda) t}$

$\cancel{\alpha(\lambda) d\lambda\, t + dt}$

$\alpha(\lambda + \Delta\lambda)(t + \Delta t) + rt = 12m - r$

$\cancel{(\alpha(\lambda) t, \alpha(\lambda) + \alpha' \lambda\, d\lambda\, (t + \Delta) \Delta t = 12m - r}$

$\cancel{\alpha(\lambda) t + \lambda)} \quad \cancel{\alpha(\lambda) t + r}$

$\alpha(\lambda)\, \cancel{t} + \alpha(\lambda) \Delta t$

$(\alpha(\lambda) + \alpha'(\lambda) \Delta\lambda)(t + \Delta t) = 12m - r$

$\cancel{\alpha(\lambda) t} + \alpha'(\lambda) t \Delta\lambda + \alpha(\lambda) \Delta t = \cancel{12m - r}$

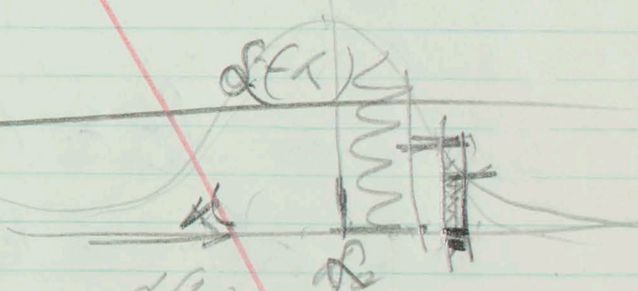
$\frac{12m - r}{\alpha}$

$-\frac{\Delta t}{\cancel{\Delta\lambda}} = \frac{\alpha' t}{\alpha} \cancel{\Delta\lambda} \Delta\lambda$

$\frac{P(r)}{\alpha}$

$\cancel{\frac{P(r)}{\Delta t}}$

$\frac{P(r)}{\Delta t} \neq P_r \frac{\alpha' \Delta\lambda}{\alpha}$



$\alpha t = x$

$x + r = 12m$

$$\alpha = \frac{12m - r}{t}$$

$\cancel{t \Delta t} \quad x = 12m - r$

$\alpha(\lambda)$

$t = \frac{12m - r}{\alpha} \qquad \alpha = \frac{12m - r}{t}$

$\cancel{d\alpha}$

$\cancel{t + \Delta t} \qquad \frac{d\alpha}{dt} = \frac{12 - r}{t^2}$

$-\frac{dt}{d\alpha} = \frac{12m - r}{\alpha^2}$

$d_x = \frac{12m - r}{\alpha^2} \cancel{d\alpha} \qquad P(r)\, \Phi(\alpha) \frac{d\alpha}{dt} \Delta t$

a and c are mean age differences

~~X-ray effect~~
~~chromosome break~~ ~~at low dose rate~~
~~heals with dislocation~~
~~At high dose rate~~

$$(\delta t)^2 = (1.08\, a)^2$$

$$\cancel{\delta t^2 = \delta t^2 + (\text{comp})^2} \qquad (\delta t)^2 + (\delta t)^2 = (\text{comp})^2$$

$$\delta t^2 = (\text{comp})^2 - (\delta t)^2$$

we want to compute δt ~~c from δt~~
from a and c

$$(\delta t)^2 = (c \cdot 1.08)^2 - (a \times 1.08)^2$$

$$\delta t = \sqrt{(c \times 1.08)^2 - (a \cdot 1.08)^2} = 1.08\sqrt{c^2 - a^2}$$

$a = 30.6$ months $\qquad a^2 =$

$c = 74.3$ months $\qquad c^2 = 5500$

$$\begin{array}{r} 975 \\ \hline 4525 \end{array}$$

$$\delta t = 1.08\sqrt{4525} \text{ months} =$$

$$\delta t = 1.08 \times 67.2 \text{ months}$$

$$\delta t = 1.08 \times \frac{67.2}{12} \text{ year} = 1.08 \times 5.6 \text{ years}$$

mean diff b

$$b = \frac{\delta t}{1.08} = 5.6 \text{ years}$$

for $n = 4$ binomial gives

1.3 $\qquad$ and $\dfrac{5.6}{1.3} = 4.3$ years

59

H.

Discussion

If 80 years has maximum
we set

$$\frac{80_x}{4} + 4 = x_0$$

24.

$$x_0 = \sqrt{12m}$$

$$12m = 575$$
$$m = 48$$

$$x_0 = \frac{1}{4}$$

~~[illegible]~~ Twins and dizygotic
twins 1 –

St Mean difference for identicals a
Stand dev: $\cancel{\frac{a}{0.68}\sqrt{2}}$
$\sqrt{2}(st) \times 0.68 = a$
$$st = \frac{a}{\underbrace{\sqrt{2} \times 0.68}_{0.96}}$$
$0.96\,St = a$

St Mean diff for non-identical twins due to r alone and.

~~St~~ ~~[illegible] = b~~

$$St = \frac{b}{\sqrt{2} \times 0.68} = \cancel{1.08}\ \frac{b}{\ } \quad \frac{St}{1.08} = b$$

comp ~~[illegible]~~ Standard dev. for composit distribution of non identical twins and mean diff c

$$\sqrt{2}\ \text{Comp}\ 0.68 = c$$

$$\text{Comp}^2 = st^2 + St^2$$

$$\text{Comp}^2 = \left[\frac{c}{0.96} = c \times 1.08\right]^2 =$$

~~[illegible]~~

~~If one assume that of the dose D_1 is given to both parents at a low dose rate the life shortening of the off~~

~~We may designate the life~~

Irrad. of parents shortens life of offspring. Let us designate the life shortening effect due to irradiation of both parents at low dose rate with d_2 (in days) per r. On the assumption that the gonads ~~are~~ as well suffer the same number of chromosome breaks followed by restitution ~~we would then~~ as the somatic cells we would have to expect $d_2 = d_1$.

~~and a life shortening of the offspring by 4 years~~

i.e. the life shortening of the offspring is the same as the life shortening of the

~~X rays~~ Vga 462 G2 Upton N.Y. 60

4

~~there~~ at low dose rate
chromosome
Howard ? Boyz Klein

At low dose rate chromosome
breaks which may restitute
~~If we assume that a break~~ with a
deletion. –
Life shortening effect about ~~15~~ 15
days per $\underline{r}$
4 years $\cong$ 1500 days (1460)

~~4 years~~ $\frac{1500}{d}$ $\frac{1460}{d} = D_1$

d is life shortening by 1 r

$d = 15$ $\underline{D_1 = 100\ r}$

~~If some effect on offspring
when father and mother are
both irradiated by ~~the dose~~
1 r the of life shortening
of offspring is $d_2 = d$~~

If our view is correct ~~one~~ this
dose D_1 should cause in the
somatic cell just one chromo-
some break followed
by a rest. with deletion.

~~If Since the maximum death rate in females occurs at 80 years of age it is thus also as follows from our the theory here presented!~~

~~but~~ $\alpha \frac{80}{\cancel{2}} + n = 12 n$

$\alpha =$

~~Since If 1 mutation represents 4 years life shortening in and since then~~

~~if we indeed~~ If mans mutation load is ~~so~~ 4 and thus 1 ~~sum~~ additional mutation causes 4 years ~~of~~ shortening than it takes an increase in the mutation load by 25% to shorten mans life ~~of~~ by 4 years.

The mutation load (in man arises) is the result from spontaneously recurring mutations at some rate μ/generation and selection against the mutant genes, ~~and~~ thus an increase in the ~~spont.~~ natural mutation rate by 25%, should result in a life shortening of 4 years when the stationary condition is approached

~~parents if those~~ offspring ~~is~~ would
be the same as the life
shortening of the parents, if
both parents are irradiated
at a slow dose rate with
the same dose, provided
~~the~~ conception. ~~of the~~
~~offspring~~ ~~Muller estimates~~
~~This would~~ ~~that above 80 r~~
~~roentgen one parent~~
~~will cause 1 mutation~~
~~in Man, i.e. we ought~~
~~to expect 1 mutation of~~
~~both in the offspring if both~~
~~parent are irradiated with~~
the effect of X-ray dosage
of parents on the longevity
of the offspring.
~~If the rays are~~ If both
parents are irradiated at
a low dose rate the
mutation level will rise
and approach after a number
of gen a new stationary
level. ~~This dose~~

This frightening picture results from the low nat. mutation rate and the cutback would be more rather than better if we assume that the mut. load is greater than hours.
From the actual

~~Life shortening of 100 R is 4 years.~~

~~If life shortening of 1 mutation were~~

Let D_2 be the Dose that shortens life of offspring by 4 years (of offspring at a stair rate to both parents). This dose might be 100 Rontgen. — [Muller] If n is mutation load this dose must shorten life by $t_0 - t_m = 16$ years

$t_m = 78$

$t_0 = 94$

1 mutation $\frac{16}{n}$ years

an increase by $\frac{n}{4}$ or 25%

is shortening life by 4 years

62

~~H. J. Muller est~~ 4/

If the X-ray dose ~~causing~~ given at a low dose rate to both parents which causes 1 mutation in the offspring is designated by D

d ~~the~~ Dose / given which ~~given~~ one will lead to a 25% rise in the mut. load or 4 years life shortening will ~~be~~ one that cause

$\cancel{\frac{\mu}{4}}$ $\frac{1}{4}$ mutations

Muller $0.1 < \mu < 0.5$

~~at the~~ Assume that ~~....~~ $D \cong 100R$

~~$d = \frac{\cdot}{4}$~~ $d = \mu \frac{100}{4} = 25\mu$

taking $\mu = 0.1$ we obtain

2.5 Roentgens/year, and taking $\mu = 1/2$ we obtain 12½ Roentgens/year as the dose rate that ? would, in the long run lead to a life shortening of mean by 4 years. —

~~105~~ ~~100~~

$$\begin{array}{r} \cancel{1}05 \\ 78 \\ \hline 27 \end{array}$$

$$\frac{80}{n} \times n = 12\,m$$

$$X_0 = \sqrt{12m} = \sqrt{12m\left(\frac{80}{n} + n\right)}$$

~~If say 80 due to~~

If we assume $D_{25} = 100$ Rad

D_{25} $2.5 \leq d_{25} \leq 12.5$ Rontgen

If the lower number should perchance be correct the dose of 80 r which ~~number estimates in modern life~~ would ~~would life shorten~~ in the long run life shorten by 16 years and premature senility.

Acquisition ...

... dose, el. factor

$$\frac{dn}{dt} = \mu - \frac{n}{t} \quad \varphi(x)$$

$$\varphi = \frac{\mu}{n}$$

$1 - e^{-\frac{\mu}{n} t_0}$

number at ten for 63% of final change

De Novo

M

Let us designate with
~~If~~ D ~~is~~ the dose which shorten life of offspring by 4 years — (i.f. ...)
If $n = 4$ this is then the dose which increases the mutation load by one (i.e. by 25%) We may now ask what dose d per generation would in the long run increase the mut load by 25%, and thus shorten life of man by 4 years. —

The mutation load correctly ~~seen results from~~ ~~in an asymptotic~~ ~~represents~~ results from mutations which occur spontaneously at a ~~rate~~ certain rate and selection against the mutant genes. We may now ask ~~what~~ to what ~~long dose D~~ radiation dose d must one expose the population per gen in order to raise the mutation load by 25%. Clearly

$$d_{25\%} = \cancel{D} \, D_{25} \frac{\mu}{4}$$

where μ denotes the (mutation rate at which mutation arise per gen) ~~rate~~ and ~~if~~ D is the dose that given to parents at a low dose rate

According to Muller

$$0.1 < \mu < 1/2$$

for $\mu = 0.1$ $d_{25} = \frac{D_{25}}{40}$ / $\mu = 1/2$ $d_{25} = \frac{D_{25}}{8}$

23.5

~~4 Δα =~~ $= \alpha_0 = \frac{\cancel{5} - 4}{78} = \cancel{\tfrac{...}{...}} = 5.12$

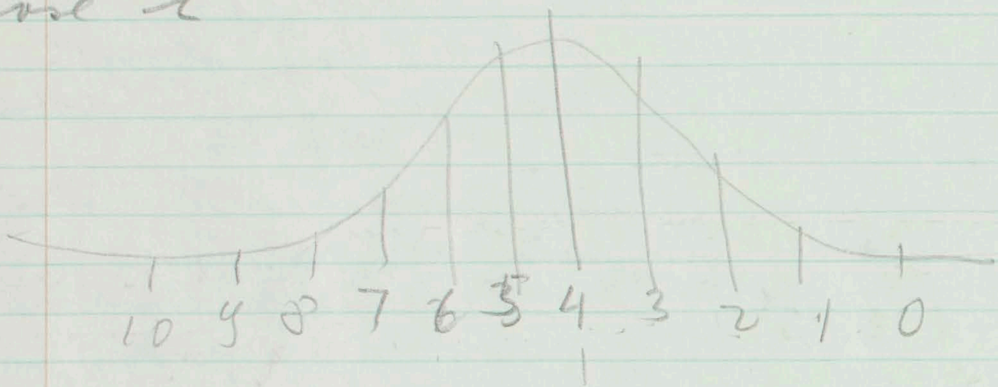
α_0

We have to choose what we want to make $\Delta\alpha$ in terms of standard dev

$\Delta\alpha = \frac{1}{t}$ if $t = 78$ $\Delta\alpha = \frac{1}{78}$

$\frac{1}{78} = l \times$ standard dev,

choose l



$l = 1$

Number of gen = $\frac{n}{\mu}$ H

for $n = 4$, $\mu = 0.1$ } 40 generations

$n = 4$
$\mu = ~~\text{[illegible]}~~ \frac{1}{2}$ 8 generations

Gompertz curve

$$D_x = \frac{1}{t} \sum_r \phi\left[\alpha\right] \alpha\, P(r) \approx \frac{1}{t}\sum$$

α is a function of r and t

$$\alpha = \frac{\cancel{12m - r}}{\cancel{t}} = \frac{x_0 - r}{t} = \frac{23.5 - r}{t}$$

m to compute from

$$\frac{78}{4} + 4 = x_0 = \sqrt{12m}$$

$$x_0 = 19.5 + 4 = 23.5 = ~~\text{[illegible]}~~$$

$$x_0^2 = 550$$

Number dying at ~~[illegible]~~ 78 = 3.203
Length of Life Louis I. Dublin, Alfred J. Lotka, Mortimer Spiegelman
The Ronald Press Co N.Y.
p. 14 to 15 Life tables for Wh. Females in the U.S. 1939-41

→ corrected for those living at age 10 Number dying at 78 per 10^5 = $\frac{3.203}{0.949}$ = 3.370 or 3.37%

$$\frac{78+16}{X_m+16} = 1.58$$

$78+16 = 1.58 X_m + 25.3$

$$\begin{array}{r} 94 \\ 25.3 \\ \hline 68.7 \end{array} \Big/ 1.58 = 43.5 \text{ év}$$

mol of pentrad

~~Mutation~~ ~~[illegible]~~ rate

Assume for man $\mu = \frac{1}{50000}$

and 1000 genes in fruit.

2000 genes in man –

$2 \times \frac{1}{50} 10^{-3} \times 2000 = \frac{4}{50} \approx \frac{1}{10}$

If 4 mutations are covered

Mutation [illegible] would double

If selection is switched off in

40 generations or 1000 years. —

In order to maintain stationary mother[illegible]

must matter. assume 4 years earlier at

$\frac{1}{3}$ fertility (loss of time in) $\frac{1}{15}$

~~[illegible]~~

4 5

$\frac{2 - 5 \cancel{[illegible]} \frac{1}{15}}{2} = \frac{1}{6}$

$\frac{1}{20}$ from mother ×

$\frac{1}{20}$ from father

$\frac{\Delta}{2}$ $\frac{1}{15}$ loss

65

4

De novo

$X_0 = 23.5$

$\alpha t = X_0 - 4$

~~$\alpha_0 = \frac{78}{19.5}$~~

$\alpha_0 = \frac{19.5}{78} = 0.25$

$\cancel{69} = \frac{19.5}{\alpha_1} = \quad \alpha_1 = 0.282 \quad \boxed{\sigma_\alpha = 0.032} \quad 78 = \frac{19.5}{\alpha_0}$

.25
.116
.134

$\frac{19.5}{0.134} =$

Estimate of spread of α

$\frac{4}{5} \times \frac{4}{6} = \frac{16}{30} \approx 0.56 \quad \frac{1}{0.56} = 1.75$

~~$\frac{25}{26} \times \frac{25}{27} \times \frac{25}{28} \times \frac{25}{29} \times \frac{25}{30}$~~

$\left.\begin{matrix}0.4\\0.242\end{matrix}\right\} = 1.65$

σ for Poisson = 8 years

$n = 4$

Life curve $\frac{3.2}{1.65} = 1.94$ in 66 years

~~86.5~~

~~20.5~~

$\sigma = 12$ years

σ for $(\alpha t) = \sqrt{12^2 - 8^2} = \sqrt{144 - 64} = \sqrt{80} = 8.95$

σ for $\alpha = \frac{8.95}{78} = 0.116$

?

Begin of ~~senescence~~ Alterdrudder

$\frac{(X_{old} + 4)^2}{4m} \neq 2\frac{1}{2}$ old age

$\frac{(X_m + 4)^2}{4m} = 1$ middle age

$\frac{(X_{old} + 4)^2}{\cancel{X}} = 10m$

$\frac{X_{old} + 4}{X_m + 4} = \sqrt{\frac{10}{4}} = 1.58 \quad (X_{mid} + 4)^2 = 4m$

or

Degenerative conditions of the aged:—

$$e^{\frac{(x_0+r)^2}{2m}} \qquad x_0^2 + 2x_0 r$$

$$x_0 = 23\tfrac{1}{2} \qquad \frac{2 \times 23\tfrac{1}{2}}{2m}$$

$$x_0^2 = 12m$$

$$\frac{550}{12} = \underline{\underline{46}} = m$$

$$e^{-\frac{1}{2}} = \underline{\underline{1.65}} \qquad e^{-\frac{1}{4}} \simeq 1.3$$

organ specific

of function because of withdrawal is $\frac{1}{2}$ to begin with and in addition an organ is knocked out by 1.65 times more than the rest of body then that organ is 2 × 1.65 = 3.3 times more weakened and this would correspond to more than two bits or 8 years

2 bits gives e^{-1} $\qquad 3.3 = e^{-1} \times \frac{1}{1.24}$

$2\tfrac{1}{2}$ bits = 10 years

so organ is 10 years older than body.—

$$e^{2.5} = 12$$

66

Note to Muller

Drosophila 3 rec. lethal per generation
in X-chromosome
per cell of rec. lethal (in X chromo-
some — $\frac{18}{1000}$ in all and
in offspring $\frac{18}{1000}$
in Man 10 times would give
$\frac{180}{1000}$
rec. lethals and probably
less rec. somatic lethals. —

Muller estimates
1:1 to
$\frac{2 \times \cancel{1000}\ 10,000}{50000}$

Remarks on different mutant forms, ~

for somatic lethals 1000 genes
specific reces

for organ specific somatic lethals 1000

developmental rec. lethals 6000

" " detrimentals 30000

X-ray causes break ~~deletion~~ ~~[illegible]~~

small deletion

$2\left(\frac{1}{50}\ 2000\ 10^{-4}\right) = \frac{4}{50}10^{-1}$

Muller assumptions

Fly $\mu = 10^{-5}$ $l = 10^{4}$ $= \frac{1}{10}$

per gamete per gen and

thus $V = 2\mu = \frac{2}{10}$ $V^* = 4\%$

if one in four is rec. lethal

Man twice rate and

$l = 10^4$ genes ($\mu = 5\,10^{-4}$)

$\mu_t = \mu l = \frac{2}{10}$

and $V = 2\mu_t = \frac{4}{10}$,

If man has 20000 loci

$V = \frac{8}{10}$ ($\mu_t = \frac{4}{10}$)

Mahler Problem H 67

$1 \quad \frac{4}{5} \quad \frac{16}{30}$

$3\,\cancel{\tfrac{4}{4}}\left(1+\frac{1}{5}\right) \quad 4 \quad 5 \times \frac{4}{5}\left(1-\frac{1}{5}\right) \quad 6 \times \frac{16}{30}\left(1-\frac{2}{5}\right)$

$\frac{4}{2} \quad \frac{4\left(1-\frac{1}{5}\right)}{2}$

$4 \ \varepsilon \ \varepsilon \quad 4 \quad 5 \times \frac{4}{5}\left(1-\frac{1}{A}\frac{4}{8}\right) \quad 6\,\frac{16}{30}\left(1-\frac{2}{A5}\right)$

$\frac{\varepsilon}{2} = \frac{1}{10}$

$4 \quad 5\,\frac{4}{5}\left(1-\frac{A}{20}\right)$

$4 + - \varepsilon^{\varepsilon} \quad 4 \quad 5 \times \frac{4}{5} \quad \frac{A}{20}$

e^{5}

ε

Continuous theory

68

If we should by sex

to get rec. lethals we

find that $\frac{1}{6}$ of the

genes (or about 2 000

in the fly) are sex-linked rec

lethals. –

– Sex-linked rec. lethals are

less say $\frac{1}{2}$ genes

~~ump~~ upper limit for

n $\left(\frac{78}{\alpha}+n\right)^2=\left(\frac{105-?}{\alpha}\right)^2$

$78+\alpha n = 105-?$

Tay twins and $n=25$

twin distance $5\times\sqrt{2}\,0.68 = 5\times 0.96$

~~5.0 years~~

~~1xx~~ = one unit 1.1 years

~~[illegible]~~ 0.91 hits per year

78 years 71 hits

$X_0 = 71+25$

$\begin{array}{r}78\\27.5\\\hline 105.5\end{array}$

$\frac{\cancel{78}}{4.3}\times\cancel{4.3}+4 = 22 = X_0$

$(22)^2 = \{10m\} \; e^{-\frac{2X_0}{2m}}$

$m = 48\tfrac{1}{2}$

Probab that segment 1 is hit by a large one but homologous segment is not hit by small one or large one

$$\left(1-e^{-\frac{\pi}{2m}}\right) e^{-\frac{\pi}{2m}} e^{-\frac{r}{2m}}$$

Lethal escape of Segment 1

$$e^{-\frac{\pi}{2m}} + \left(1-e^{-\frac{\pi}{2m}}\right) e^{-\frac{\pi}{2m}} e^{-\frac{r}{2m}} =$$

$$e^{-\frac{\pi}{2m}} + e^{-\frac{\pi+r}{2m}} - e^{-\left(2\frac{\pi}{2m}+\frac{r}{2m}\right)}$$

$$1-\frac{\pi}{2m}+\frac{1}{2}\left(\frac{\pi}{2m}\right)^2 + 1-\frac{\pi+r}{2m}+\frac{1}{2} \quad -1 + 2\frac{\pi}{2m}+\frac{r}{2m}+\frac{1}{2}\left(\quad\right)$$

$$\frac{\pi^2}{2m} = 1$$

$$\pi^2 = 2m \qquad 10^6$$

$$\pi = 1000$$

special case $r = 0$

$$2e^{-\frac{\pi}{2m}} - e^{-2\frac{\pi}{2m}} = -\left[\quad\right]^2$$

$$2\left[1-\frac{\pi}{2m}+\frac{1}{2}\left(\frac{\pi}{2m}\right)^2\right] - 1 + 2\frac{\pi}{2m} - \left(\frac{\pi}{2m}\right)^2$$

$$\left[e^{-\frac{\pi}{2m}} + e^{-\frac{\pi}{2m}} - e^{-2\frac{\pi}{2m}}\right]$$

$$2\left(1-\frac{\pi}{2m}+\frac{1}{2}\left(\frac{\pi}{2m}\right)^2+\dots\right) - \left[1-2\frac{\pi}{2m}+\left(\frac{\pi}{2m}\right)^2\right]$$

$$\left(1-e^{-\frac{\pi}{2m}}\right)^2 = 1-2e^{-\frac{\pi}{2m}}+e^{-2\frac{\pi}{2m}}$$

Continuous theory

first factor

$$\left(1-2\left[1-e^{-\frac{r}{2m}}\right]\left[1-e^{-\frac{\bar{u}}{2m}}\right]\right)^{m}$$

$$1-2\left[1-e^{-\frac{r}{2m}}-e^{-\frac{\bar{u}}{2m}}+e^{-\frac{r+\bar{u}}{2m}}\right]$$

---

probab at 1 event $\left(1-e^{-\frac{r}{2m}}\right)\left(1-e^{-\frac{\bar{u}}{2m}}\right)$

probab of two events:

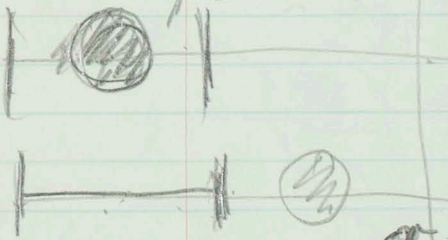
prob 1w $q e^{-q}$ $\qquad \frac{q^2}{2} e^{-q}$

Try to guess: $q(1-q)$

$q-q^2 \quad | \quad \frac{q^2}{2}(1-q)$

---

escape



escape =

$$\cancel{\left(1-e^{-\frac{\bar{u}}{2m}}\right)\times e^{\left(\frac{\bar{u}}{2m}+\frac{r}{2m}\right)} + \left(1-e^{\frac{r}{2m}}\right)}$$

escape

$e^{-\frac{\bar{u}}{2m}}$ = Probab that segment (1) is not hit by a large one

16 years = n

~~[illegible]~~ ~~per~~ for 1 ~~[illegible]~~ $5\sigma l$

$\frac{16}{n}$ years

average diff. between brothers due to Binomial

$\frac{16}{n}\sqrt{n} = 5.5$ ~~$\frac{16}{\sqrt{n}}$~~ ~~5.5~~

~~n~~

~~$n = 5.5$~~

$\frac{16}{5.5} = \sqrt{n}$

$\approx n$

$\boxed{n \cong 8.5}$

$\boxed{\text{but } n = 4}$

Rainer

sector 3

$\frac{2}{2!}$ $\frac{2}{3}$ $\frac{2}{4}$ $\frac{2}{5}$ $\frac{2}{6}$

78 70 62 54 46

$\frac{3}{3!}$ $\frac{3}{4}$ $\frac{3}{5}$ $\frac{3}{6}$ $\frac{3}{7}$

78 5.3 62 57

③

$\frac{4}{4}$ $\frac{4}{5}$ $\frac{4}{6}$ $\frac{4}{7}$ 45.3 $\frac{4}{8}$ $\frac{4}{9}$

78 74 70 68 64 60

$$2e^{-y} - e^{-2y} = y$$

$$(1-e^{-y})^2 = 1 - 2e^{-y} + e^{-2y}$$

$$-(1-e^{-y})^2 = -1 + 2e^{-y} - e^{-2y}$$

$$\boxed{1-(1-e^{-y})^2 = 2e^{-y} - e^{-2y}}$$

$$\left(1-(1-e^{-y})^2\right)^m \cong (1-y^2)^m$$

$$\cancel{\pi} \quad (1-e^{-y})^2 = y^2$$

$$\cancel{y} \quad (1-y^2)^{\frac{1}{y^2}} = e^{-1}$$

$$(1-y^2)^{\frac{my}{y^2}} = e^{-my^2}$$

$$y = \frac{\pi}{2m} \qquad my^2 = \cancel{\pi}^2 \; \frac{\pi^2}{4m}$$

If $(4m) = 10^6$ $\sqrt{m} = 500{,}000$

$$\frac{\pi^2}{4m} =$$

$$\pi = 10^3$$

$$\frac{\pi}{2m} = 2\frac{1}{1000} = \frac{1000}{500{,}000} = \frac{2}{1000}$$

how I bit to make an appreciable

difference $\parallel$ $\cancel{\frac{\pi}{2m}}$ $\frac{(\pi+1)^2}{2m} - \frac{\pi^2}{2m} \cong 1$

$$\frac{2\pi}{2m} + \frac{1}{2m} \cong 1/2 \qquad \pi \approx m$$

SRB

represent Z years

If I assume n two conditions must be fullfilled

$$\frac{\text{(in poisson) probabilit } n}{Z} = 3.20\%$$

and in ~~Binom~~ Binomial average difference between sisters $\times Z = 5.5$ years

closest fit for $n = 3$

this gives about $Z = 6.5$ years

$n = 3$

~~3.2~~

$$\frac{0.14}{Z} = \frac{3.2}{100}$$

$$\frac{14}{Z} = 3.2$$

$$Z = \frac{14}{3.2} = 4.2$$

but $0.36\sqrt{8} \times 4.2 = 11.3$ or not $5\frac{1}{2}$

71

~~n = 2~~

H

1	2	1
1_0	4 1_1	1_2

$n = 2$

~~lo~~ minimal

4

1 4 6 4 1

0	1	2	3
1	4	6	4
16	24	16	4
36	24	6	
16	4		
1			
70	56	28	8
0	56	56	24

70
56
28
8
162

56
56
24
136

$\frac{136}{162} = \boxed{0.84}$

$\times 8 = 6.7$ ev

$0.84 \times X = 5.5$

$X = 6.5$

~~m~~

$3 \times 6.5 = 19.5$ ev

$n = 4$

B. maximum

$\frac{.1953}{4} = 4.76$

$\frac{20''}{n}$ $\frac{n}{20''}$

2	3	4	5	6	7	8
0.54	0.67	0.78	0.875	.96		

$Z = 6 \cdot 5$ years

Calculate X_0

$\cancel{X_0} = 3x$

$\cancel{X_0} - \frac{78}{6.5} + 3 = X_0 = 12 + 3 = \underline{\underline{15}}$

better probably

$\frac{78}{6} + 3 = \underline{\underline{16}}$

$\frac{x^2}{\cancel{\ }} = 10 m$

~~12~~ fallout 12

$m = \underline{25 \cdot 5}$

$\underline{\underline{23}}$

$\frac{(x_0 + 1)^2}{51} = \frac{2x}{51}$

$2 \times e =$

[illegible] for 1 [illegible]

$\underline{3.2\ 03}$ %

$3 \cdot 3\ 8$

72

we shall use ;

$n = 3$

~~z / years per fault~~ $\frac{3.38}{100} = \frac{P(n)}{z} = \frac{0.224}{z}$

~~$z = \frac{72.4}{3.2} = 7$ years~~ $z = 6.5$ years

why not be more precise, – take n =

$0.84\,z = 5.5$

$\frac{3}{3}$	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{3}{6}$	$\frac{3}{7}$
(78)	(71)	64	5.7	50

	0	1	2	3	4	5	6	7
0.050	150	224	224	168	101	.050	.022	.008
	0.050	0.150	0.224	.224	.168	.101	.050	.022
		0.050	.150	.224	224	.168	.101	.050
0.050	.200	.424	.598	.616	.493	.319	.173	.080
19.5	0.11	0.217	3.01	3.1	70.5 2.5	65 1.63	58.5 0.88	52
6.5×3							55	

84.5

91 84/2 78 71.5 65 58.5 52

Lexicographic [illegible]

			$P(n)$ $r=3$	
~~for 8~~	14	1.9	—	
	13	1.8		
for 7	12	1.7		
for 11	11	1.6		
for 6	10	1.5	0.0008	0.0012
	9	1.4	0.0027	0.0038
for 5	8	1.3	0.0081	0.0104
for 4	7	1.2	0.0216	0.0252
	6	1.1	0.0504	0.0555
	5	1.0	0.1008	0.1008
	4	0.38	0.1680	0.06384
	3	0.29	0.2240	0.06496
	2	0.14	0.2240	0.03136
	1		0.8004	0.85706

1 3 3 1

0	1	2	3
1	3	3	1
9	9	3	
9	3		
1			
20	15	6	1

20
15
6
1
42

15
12
3
30

$r=3$
$4 = 0.715$

$r=2$
$4 = 0.545$

How would n = 4 fit

$$\frac{P(n)}{Z} = \frac{3.2}{100} \quad \frac{}{0.949} = \frac{1}{4.8} \quad \frac{3.38}{100}$$

$$\frac{0.195}{Z} = \qquad Z = \frac{19.5}{3.38} = \underline{\underline{5.75}}$$

1.3 × 5.75 is too much!

$$\int_0^1 \left(\frac{y}{2} + 1 - \frac{y}{2}\right) dy = \underline{1}$$

$$\frac{y^2}{4} + y - \frac{y^2}{4} \qquad 1$$

$$\frac{0.32}{0.9} \% = 3.55\% \text{ at } \underline{20}$$

$$\frac{3.55}{100} = \frac{0.224}{X} \qquad \frac{22.4}{3.55} = 6.32$$

$\underline{\underline{\text{years}}}$

X = 4.2

0.86 × X = 5.5

$X = \frac{5.5}{0.86} =$

$\underline{6.4 \text{ years}}$

n = 2

$$\frac{3.55}{100} = \frac{0.27}{X}$$

X = 27

$(2n=6)$ $(2n=8)$ $(2n=10)$

$n=3$ | $n=4$ | $n=5$

$\frac{3.55}{100}=\frac{0.224}{X_3}$ | $\frac{3.55}{100}=\frac{0.1953}{X_4}$ | $\frac{3.55}{100}=\frac{0.175}{X_5}$

$X_3=6.3$ years | $X_4=5.5$ | $X_5=4.9$

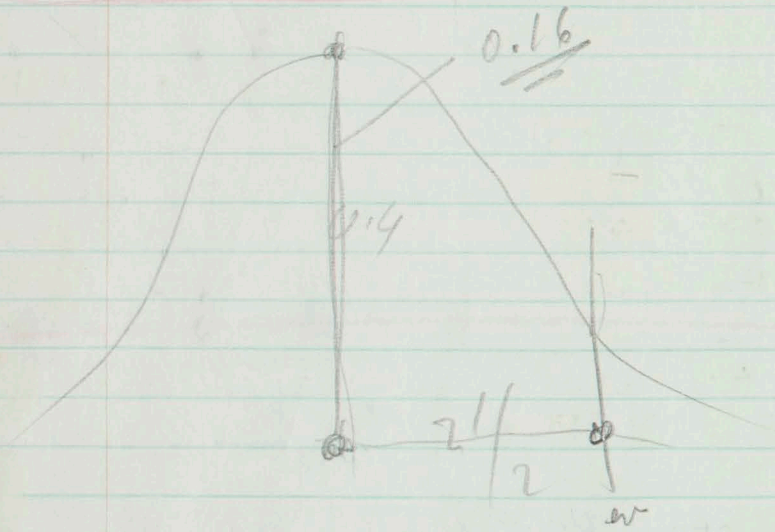
$1.1\times 6.3=6.85$ | $1.3\times 5.5=7.2$ | $1.5\times 4.9=7.35$

$n=2$ | $n=2.5$

$\frac{3.55}{100}=\frac{0.27}{X_2}$ | $\frac{3.55}{100}=\frac{0.25654}{X_{2\frac{1}{2}}}$

$X_2=7.6$ years | $X_{2\frac{1}{2}}=7.22$

$0.9\times 7.6=6.85$ | $X_{2\frac{1}{2}}=1\times 7.22=7.22$



$\frac{0.4}{2.5}=$

$.16\%$

$3.55=16\times X$

$\frac{3.55}{16}$

Upt 5 years

$n=2.5$ Hutr

at 2 = 0.2565

at 3 = 0.2138

0.4703

.235

A $n=3$, $2n=6$ weighted 74 4

	$2n=6$				
0	.002	0			
1	.015	0.5	0.007	0.5	0.0075
2	.045	0.54	0.024	0.75	0.0034
3	.089	0.71	0.063	0.94	0.0838
4	.134	0.86	0.115	1.08	0.1455
5	.160	1.00	0.160	1.28	0.2045
6	.160	1.10	0.176	1.35	0.2160
7	.138	1.21	0.167	1.465	0.2020
8	.103	1.32	0.136	1.57	0.1535
9	.069	1.41	0.097	1.67	0.1152
10	.041	1.50	0.061	1.76	0.0721
11	.023	1.61	0.037	1.84	0.0423
12	.011	1.66	1.043 / .980	1.93	0.0214
13	.005				1.2772 / .990 = $\boxed{1.29}$
14	.002				
	.990				

	$2n=8$		$2n=4$	
0	.000	0	.018	—
1	.003	0.50	.073	.036
2	.010	0.54	.146	.078
3	.029	0.71	.195	.138
4	.057	0.86	.195	.167
5	.092	1.00	.156	.156
6	.122	1.10	.104	.112
7	.140	1.21	.060	.072
8	.140	$\boxed{1.32}$	.030	.039
9	.124	1.41	.013	.018
10	.099	1.50	.005	.075
11	.072	1.59	.002	.003
12	.048	1.66	0.997	0.894
13	.029			46
14	.017			
15	.009			
16	.004			
17	.002			

$$\sum \frac{\cancel{A}^{5}}{5!} e^{-\cancel{A}} \quad e^{\frac{(\cancel{x}+r)^2 - r^2}{4m}} \approx e^{-\frac{\{(\cancel{x}+r)^2 - r^2\}}{4m}}$$

For paper

$$X = -r + \sqrt{r^2 + 12m}$$

$$X \cong \sqrt{12m}\left(1 + \frac{1}{2}\frac{r^2}{12m}\right) - r \qquad r^2$$

neglect $\frac{1}{2}$

$$\cancel{X \cong \sqrt{12m} - \frac{r^2}{\sqrt{12m}} - r}$$

If we neglect $\frac{1}{2}\frac{r^2}{\sqrt{12m}}$

$$X \cong \sqrt{12m} - r$$

$$\frac{1}{2}\frac{9}{15}$$

f / numbers of hits and faults

$$f = \frac{\left[1 - \left(1 - e^{\frac{-x}{2m}}\right)^2\right]^m}{\left[1 - \left(1 - e^{-\frac{r}{2m}}\right)^2\right]^m} \approx$$

$$\cancel{= e^{-\left(\frac{x^2}{2m} - \frac{r^2}{2m}\right)}} \quad \cancel{= e^{-x}}$$

$$= e^{\cancel{-\frac{(x+r)^2 + r^2}{2}}} \cancel{\left(\frac{r}{2m}\right)^2 = \left(\frac{x+r}{2m}\right)^2}$$

$$= e^{-\left[\left(\frac{x}{2m}\right)^2 + \left(\frac{2xr}{2m}\right)^2\right]}$$

	0	1	2	3	4	5	6	7	8	9	10
	.049	.149	.224	.224	.168	.101	.0504	.0216	.0081	.0027	.00081
		49	149	224	224	168	101	504	216	81	27
		.198	.373	.448	.392	.269	.151	.0720	.0297	.0108	.0035
Ave lay (12)		.0165	.0286	.0373	.0326	.0224	.0126	.0058	.0025		

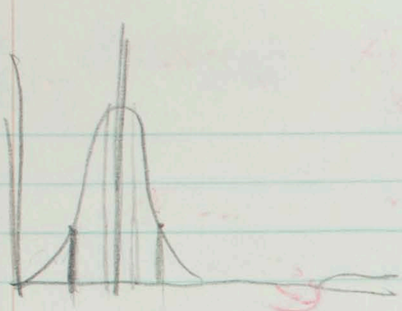
78 72 66 60 54 48

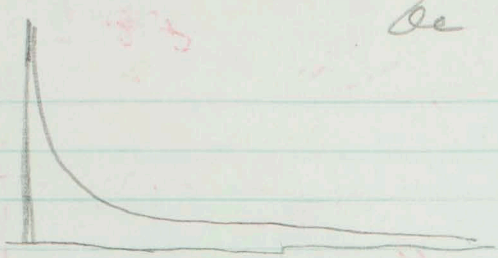
3730

5800

80

oe 3100z





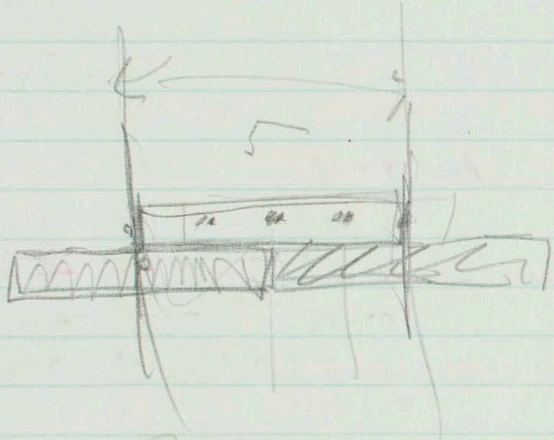
$\int\int \sqrt{(x-y)^2}\; f(x)\, f(y)$ $\int f(x) \sqrt{(x-y)^2}\, dx$

1 hd+

lennes $\frac{1}{e}$ unlist

$\frac{1}{2.7}$ + $\frac{2.7}{12}$

$\frac{1}{2}$ $\frac{1.7}{12}$ hold



$+ \ldots = x_0$

1 hd = 5 yards

78 x 2 1/2 x 5

68

$(2.5)^2 + X^2 = (6.5)^2$

$$f \approx e^{\frac{r^2}{2m} - \frac{(x+r)^2}{2m}} = e^{-\frac{1}{2m}\left[(x+r)^2 + 2xr\right]}$$

$$f \approx e^{-\frac{1}{2m}(x+r)^2 + 2xr} \qquad e^{-B}$$

$$B = 2.5$$
$$f \cong \frac{1}{12}$$

$$x = \sqrt{r^2 + 10m} - r \rightarrow x_0 = \sqrt{10m}$$

$$x \cong \sqrt{10m}\left(1 + \frac{1}{2}\frac{r^2}{10m}\right) - r$$

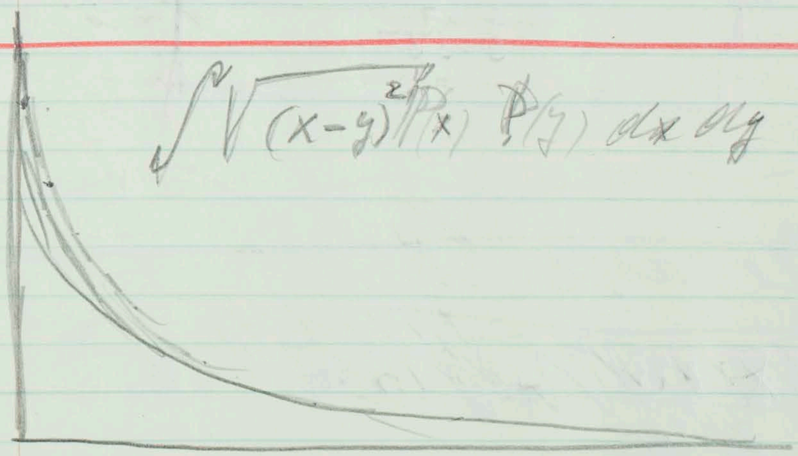
$$x \cong \sqrt{10m} - r + \frac{1}{2}\frac{r^2}{\sqrt{10M}}$$

$$x \approx \sqrt{10m} - r$$

$$\sqrt{10m} = x_0$$

$$x = x_0 - r$$

$$\int \sqrt{(x-y)^2} P(x) P(y)\, dx\, dy$$



loss of life as a function of n

$\frac{78}{\tau}$ [illegible] $+ n = X_0$

$\frac{P(n) \times 100}{3.55} = \text{"}\tau\text{"}$

$78 + n\tau = X_0\tau - 78 = n\tau$

$n = 3$ | $n\tau = 18.5$

$n = 4$ | loss of life $\tau X_0 - 78 = n\tau$

$n = 5$

$n = 6$ | $n = 3$ $\tau = \frac{22.4}{3.55} = 6.3$

$n = 7$

$n = 8$ | $n\tau = 30$ years | $\frac{78}{6.3}$

$$\boxed{\frac{n P(n) 100}{3.55}} = 18.5$$

8 0.14 x

~~middle age~~

$\cancel{X^2 + n} \ldots 10 m = X_0^2$

$n = 3$

$\frac{78}{5.63} + 3 = X_0 = 17$

$\frac{(X + n)^2}{2m} = 2.5$

78 middle

$\frac{X_{78} + n}{X_{middle} + n} = \sqrt{2.5} = 1.58$

$X_{78} + 3 = 1.58 (X_m + 3)$

82 H

$n = 2\frac{1}{2}$

~~28.68~~ 25.65 20.52

20.95 21.38

$\frac{46.60}{2} = 2330$ $\frac{41.90}{2} = 20.95$

$\frac{2330}{3.55} = $ 6.5 years

Tabelle

n	X humn prison	Δ ~~X~~ ~~harm~~ sisters
$2\frac{1}{2}$		x
3		x
4		x
5		x
6		x
7		x

---

100   50   25 $12\frac{1}{2}$

50 + 10 = 60   30   15

$X_{78} - 4.75 + 3 = 1.58\, X_m$

$\frac{X_{78} - 1.75}{1.58} = X_m$

$\frac{\cancel{5.63 \times X_{78}} - 10}{1.58} = X_m, 5.63$ 78

$\frac{68}{1.58} = 43$

Outline

Assumptions,

On aging

on X-rays

$\tau \quad \frac{\chi d^2}{4m} = 2.5$

~~from biosurvival~~

~~Cause of survival — genetics~~

~~We must choose $n \cong 3$ in~~

~~order for $\Delta = f(n)$ $\tau =$~~ 6 years

~~and~~

→ formulae

approximation

~~Lifetable~~

~~compute m from w~~

Approximation $\tau \ll$

The

τ from max death rate

the loss of life

Compute Δ from this τ Δt_d

$n = 3$ about right

T.W. curve max death rate +

the fit at old ages

~~Life table compute m~~

~~The loss of life~~

~~compute~~ compute m

The effect of one fault

the effect of a specific fault

$\overline{n=0}$ 83 ld

Effect of one more bit

from aging same as from K says

introducing fraction $\quad \bar{s} = x = \frac{t}{\tau}$

$$\sum_s P(s)\, e^{-\left(\frac{s}{4m}\right)^2} \approx e^{-\frac{(x)^2}{4m}}$$

what is effect of one more bit

let us assume $\frac{x^2}{4m} = 2$

$X_0 =$

$n = 3 \quad x_0 = \frac{78}{5.63} + n =$

$$\frac{80}{\cancel{5.5\tau}} + n = x_0 \quad = 80 + n\tau = x_0\tau$$
$$x_0\tau - 80 = n\tau$$
$$\cancel{x_0\tau = 80 + n\tau}$$

$$X_0 = \frac{80}{5.65} + 3 = 14 + 3 = 17$$

$$(X_0)^2 = 10m \quad = 290$$

$$m = 29$$

might be well one

23 would be one dimensions

3.5%

0.35%

or $\frac{3.5}{1000} \times 100$

$\frac{3.5}{1000}$

350

Maternal ~~st~~ selection

mens tables l_x at 29-30

$$\begin{array}{r} 95700 \\ 94{,}080 \\ \hline 1{,}620 \end{array}$$

$$\begin{array}{r} 96400 \\ 95204 \\ \hline 1200 \\ 470 \\ \hline 730 \end{array} \times 10^{-5}$$

~~600~~

700

300 outs of 5 years out of $\underline{\underline{20}}$
eliminates ~~5~~ ~~fad~~ faults with $300 \times 10^{-5}\ \frac{1}{5}$

~~6~~

3×10^{-3}

$\frac{3}{2}\,10^{-3}$ $\frac{1}{300}$

$$\frac{X_2^2}{4m} = \underline{\underline{2}}$$

$$X_2 = \sqrt{8m}$$

$$\frac{(X_2+1)^2}{4m} \qquad X_0 = \sqrt{10m} \quad X_2$$

$$\frac{X_2^2 + 2X_2 + 1}{4m} = \text{what}$$

$$\frac{X_2^2}{2m} \qquad 2 + \frac{2X_2+1}{4m} \simeq 2 + \frac{4}{X_2}$$

<u>The male</u>

The limits of approximations

The effect of X-rays on subsequent generations. — 1 mutation per D_2 ~~of grandparents~~, —
rel between D_1 and D_2
5.5 years

The mutation rate
doubling the dose

Natural mutation rate
Muller

$\mu \leq 0.4$
per gamet

μ death $< ~~\leq~~$ 0.8

of this $\frac{1}{6}$ rec. lethal $\mu_{rl} \leq \frac{0.8}{6}$

$\mu^* < 0.133$

an X ray Dose of D_2 $\frac{0.8}{6}$ doubles rate
an X ray dose of D_2 $\frac{0.8}{6}$ would cut off from
it could be however that X ray causes
deletions and that this includes life
in a substantial fraction of 5.5
how long would it take? years

Concern Congress Why should I do
anything for post.

~~How long~~

X

~~e~~ ~~xx~~ = 14

$\frac{(x+3)^2}{4m}$

m = 23 | 4m = 92

				e^{-x}	
9		$0.013 * e^{-\frac{(9+3)^2}{4m}}$			
10		0.			
11	6	$0.009\, e^{-\frac{(6+3)^2}{4m}}$	−0.88	.41	
12	7	$0.017\, e^{-\frac{(7+3)^2}{4m}}$	−1.09	.33	.006
13	8	$0.030\, e^{-\frac{(8+3)^2}{4m}}$	−1.32	.27	.008
14	9	$0.047\, e^{-\frac{(9+3)^2}{4m}}$	−1.56	.21	.010
15	10	$0.066\, e^{-\frac{(10+3)^2}{4m}}$	−1.84	.16	.010
16	11	$0.084\, e^{-\frac{(11+3)^2}{4m}}$	−2.14	.12	.010
17	12	$0.098\, e^{-\frac{(12+3)^2}{4m}}$	−2.45	.086	.008
	13	$0.106\, e^{-\frac{(13+3)^3}{4m}}$	−2.8	.060	.006
	$\boxed{14}$	$0.106 \times e^{-\frac{(14+3)^2}{4m}}$	−3.04	.047	.005
	15	$0.099 \times e^{-\frac{15+3}{4m}}$	−3.54	.029	.003
	16	$0.087 \times e^{-\frac{16+3}{4m}}$	−3.92	.020	.002
	17	$0.071 \times e^{-\frac{17+3}{4m}}$	−4.35	.013	.001
	18	$0.055 \times e^{-\frac{18+3}{4m}}$	−4.77	.0082	.0004
					.069

3

.07

$\frac{1}{14.3}$

55 .8 / 100 / 1000

4 / 184 / 4

m = 23

to compare

85

s hits r faults

$$\sum_s P(s)\, e^{-\frac{(s+r)^2 - r^2}{4m}}$$

~~$s = 16$~~

$$\frac{(16+3)^2}{\cancel{4m}} = 2.5$$

$$\left(\frac{(16+3)}{2.5}\right)^2$$

how much is $(12+3)^2$

$$\frac{(16+3)^2}{2.5}$$

5.5

$$2.5\,\frac{(12+3)^2}{(16+3)^2}$$

$$2.5 \cdot \frac{225}{360} = 2.5\,\frac{22.5}{36}$$

$$\frac{80}{5.5}+3 =$$

X_0

18

$$\underline{16+3}$$

$$\frac{(14+3)^2}{4m} = \cancel{2.5}\ 10m$$

$$(16+3)^2 = 10m \qquad m = 36$$

$$(12+3)^2 = 10m \qquad m = 22\tfrac{1}{2}$$

$$X_0 = \frac{80}{5.5}+3 = 14.58$$

$$\begin{array}{r} 14.58 \\ 3 \\ \hline 17.58 \end{array}$$

0

9 0..

a y_m is a function of n
and we get
τ is a function of n and we
get

86

μ

width $e^{-\frac{(\Delta \tau)^2}{4m}} = \frac{1}{14.3} = \frac{7}{100}$

$\frac{(\Delta \tau)^2}{4m} = 2.66 \times 4m$

$\frac{280}{10.6}$

$m = 26.5$

m somewhat larger

Paper

$\bar{\Delta}$(id) ~~[illegible]~~

$\bar{\Delta}$(~~[illegible]~~ non id)

st. dev.(id) $\approx \bar{\Delta}$(id) =

st. dev(non id) $\approx \bar{\Delta}$ (non id)

st. dev (gen) $\approx$ ~~[illegible]~~ $\bar{\Delta}$(gen)

~~st. dev (gen) =~~

st. dev

$(\Delta\, gen)^2 = [\bar{\Delta}$ ~~id~~ (non id)$]^2 - [\bar{\Delta}$ id$]^2$

$\bar{\Delta}$(gen) = years

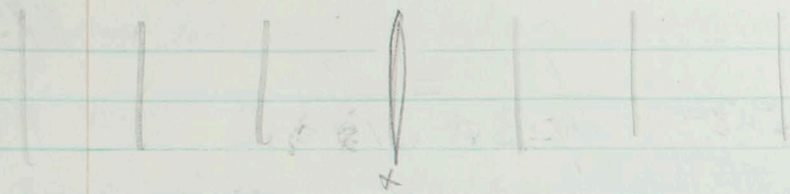
$\bar{\Delta}$ (gen) = function of m

$\bar{\Delta}$ gen $= \tau\, \overline{\Delta m}$

Poisson distribution for the four chromosomes centering around 2n

Individual genes probab of of spring $\binom{n}{r}$ having r

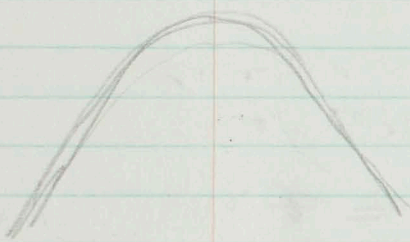
$\frac{\tau\, r\binom{n}{r}}{}$ = $\bar{\Delta}$(generation)



☒ scatter wide
mort. ≪ $\frac{O.P(m)}{\tau}$

τ mort ≪ Pm

$\sqrt{m}$



$\frac{25.}{\tau}$

~~3.45~~ $\frac{3.6}{100} = \frac{P(m)}{\tau}$

$\tau < \frac{P(m) \times 100}{3.6}$

determine
m $(2.5)^2 + x^2 = \frac{\text{obs square}}{(12)^2}$

14 90 144 -

12 in

$\frac{12}{\tau} = \sqrt{m}$ $\tau\sqrt{m} = 6$

87

H

for table

multiply with $\frac{1}{550} = 0.182$

result multiply 0.958
age 29 (new lifetable survivors

and multiply with $0.182 \times 0.958 = 0.175$

~~3428~~

80–81 d_x $\frac{3{,}448}{.9571} = 3.600$

29–30 l_x 0.9571

$\tau = \frac{20.182}{3.6} = \cancel{6.07 \text{ years}}$
$= 5.6 \text{ years}$

$\frac{1}{5.6}$

$\frac{3{,}448}{594} = \frac{3448}{1206} = \cancel{2.85} \boxed{2.85}$ 3.4

5.5

$\frac{80}{-28.5}$
51.5

2.32 to give 64 to 65

$\frac{20.18}{2.32}$ .087

0.03

$\frac{16}{14} \times 5$ 64–65 $\frac{3448}{1487} = \boxed{2.32}$

$\boxed{0.087}$

14 unit = 16 cm

$\frac{5 \times 16}{14}$ 1 unit $\frac{16}{14} =$

0	1162.3	—
1	1521.0	1521.0
2	1155.9	2370.0
3	746.0	2240.0
4	411.7	1643.0
5	197.3	987.0
6	82.8	496.0
7	31.1	218.0
8	10.4	83.3
9	3.16	28.4
10	0.85	8.5
	5332.51	9595.2

− 581.

4751

1.8 $\boxed{2.02}$ $\frac{2.02}{1.35} = 1.5$

Drop for 1 st. dev.

$\frac{0.4}{0.242} = 1.65$

from other book

Life table

1 st. dev towards ~~old~~ younger age = 11 years

$\frac{3,446}{1,650} = 2,085$ 69½ years

80½ years

difference 11 years

1981
2138
4119
2060

toward older ages diff - 9. years

88

mean diff of Poisson 4
for $\frac{3}{2}$

(3)

111
251
226
112
36.3
8.2
1.3
.2

746.0

(0)

24.7
223.
500
500
282
102
25.4
4.6
.6

1662.3

(1)

196

74.2
338.
500.
376.5
169
50.6
11.
1.7

1521.0

(2)

108
335
376
226
84.6
21.8
4
0.5

1155.9

(4)

83.5
151.0
112.0
48.5
13.6
2.7
.4

411.7

(5)

50.2
75.1
48.5
18.2
4.5
.8

197.3

(6)

25.0
32.3
18.0
6.0
1.3
.2

82.8

(7)

10.7
12.1
6.1
1.8
0.4

31.1

(8)

4.0
4.1
1.8
0.5

10.4

(9)

1.34
1.21
.49
.12

3.16

(10)

0.40
0.33
0.12

0.85

$r = r_m + r_f$

$$\overline{\Delta}_s = \sum_i \frac{\sum_i i \binom{2r}{i}}{\sum_i \binom{2r}{i}} \times P(r, 2n)$$

$$p(r, 2n) = \sum \frac{(2n)^r}{r!} e^{-2n}$$

for $n = 3$ $\overline{\Delta}_s \approx 1.1$

$$\Delta_p = \sum \frac{n^r}{r!} e^{-n}$$

$n = 3$ $\Delta_p \cong 1.8$

for large n $\Delta_s = \Delta_p$

89

mean diff $= \underbrace{0.68\sqrt{2}}_{0.96} \times$ stand dev

mean diff for life curve $<$

$11 \times 0.96 \rightarrow 10.26$ years

$$\left(10.56\right)^2 - \left(\frac{2.6}{0.96}\right)^2 = \left(10.56\right)^2 - \left(\frac{2.6}{0.96}\right)^2$$

$$\begin{array}{r} 111.5 - \\ - \quad 7.1 \\ \hline 104.4 \end{array}$$

$\sqrt{104.4} = \underline{10.2 \text{ years}}$

corr. mean diff for life curve at old ages

corr mean diff for brothers 5.65

ratio should be. for $n = 3$

$\frac{1.8}{1.1} =$ ratio $\frac{10.2}{5.65} = \underline{\underline{1.8}}$

$\boxed{n = 2.5}$

3.6 $=$

Poisson max 0.2565

$\tau \leqq \frac{0.2565}{3.6} \leqq 7.15$ years

$1 \cdot 7.15 = 7.15$

$\tau \geqq 5.65$

$n = 3$

$n = 3 \quad \tau \leqq \frac{22.4}{3.6} = 6.24$

Tabel of faults in both parents r

~~Distribution~~

Distribution of faults in daughter

$$\cancel{q_r(\ldots)} = \binom{r}{i}\left(\frac{1}{2}\right)^i$$

Paper

Mean difference $S'_r(\cancel{\ldots})(r)$

~~$S(\ldots) = 1$~~

Mean difference in Population. ~~For~~ ~~is~~ Probability for a given ~~$p(r)$~~ r is given by Poisson

$$p(r) = \frac{(2n)^r}{r!} e^{-2n}$$

$\overline{S(n)}$ (mean of mean difference S_r

$$\overline{S}(n) = \sum \cancel{p(r)\,S_r}\; p_r S_r$$

or ~~daughter~~

$$\overline{S_\Delta}(n) = \sum \left(\frac{2n}{r!}\right)^r e^{-2n} S_{\Delta r}(r)$$

~~Approx.~~

~~$\overline{S'_\Delta}(n) \approx S'_\Delta\ (r = 2n)$~~

~~for $r \geq 3$~~

~~For $n = 3$ for instance correct value $1.05 = S_\Delta(n)$~~

~~$\overline{S_\Delta}(r = 2n) =$~~

p. 47
79

reinstate

~~In~~ The mean ~~of~~ difference of r in the Population

90

H

$\cancel{\Delta\binom{r}{i}}$

$e^{-2n}\ \bar{\Delta}$ ~~(binomial of r and i)~~

$\bar{\Delta} = \sum_r \frac{(2n)^r}{r!} e^{-2n}\ \Delta_B(r)$

$$\bar{S}(n) = \sum_r \frac{(2n)^r}{r!} e^{-2n} \times S(r)$$

$\bar{P}(n)$ for population

$\bar{P}(n)$ for large n

$\bar{S}(n)$ for large n $\longrightarrow 0.96\sqrt{n}$

$\bar{S}(r)$ is mean difference for distribution where probability for i is

$$p_i = \binom{r}{i}\left(\frac{1}{2}\right)^i \text{ ; mean diff } S(r)$$

most probable value for $\bar{r} = 2n$

$S(r) \approx S(2n)$

if probable for a given r is

$$P_{2n}(r) = \frac{(2n)^r}{r!} e^{-2n}$$

work out

$$\bar{S}(n) = \sum_r \frac{P_n(r) S_1(r)}{S_2(n)} \quad S(2n)$$

n determines τ ... by using
~~dt~~ maximal dx

maximal d_x is at 80 years

80–81 $d_x = 3{,}446 / 10^5 = \frac{3.446}{100}$

since death prob for 30 is not due to aging ~~we get~~ and out of 100,000 born only at 95,709 = l_x are alive between 29-30

correction factor 0.957

accident 49/100,000 at 25 – 29

42/100000 30 – 34

55.5/100,000 50 – 54

also subtract accidents for greater accuracy.

1.) leaving accidents uncorrected

$$10^{-5} d_x^{max} = 3.60 = \frac{3.446}{100} \frac{1}{0.957} / 100{,}000 \text{ alive at } 30$$

2.) or

$$10^{-5} d_x^{max} = 3.66 = \frac{3.446}{100} \frac{1}{0.943} / 100{,}000 \text{ alive at } 40$$

~~A~~ $\frac{1}{\tau} \frac{n^n}{n!} e^{-n} = 10^{-5} dx$

for $n = 3$

$\tau_1 = 6.225$

$\tau_2 = 6.13$

$\frac{n^n}{n!} e^{-n} = 0.2240$

$\frac{22.4}{3.6}$

probably smaller because

of "scatter"

Paper 91

$\overline{P}$

~~$\overline{P}(n)$ is derived from~~

~~It~~ The distribution of r in the population is given by No ( )

and we shall designate the mean difference of r in the population with

$\overline{P}_\Delta(n)$

for large values of n

$\overline{P}_\Delta(n) = \overline{S}_\Delta(n)$ so that we have $\frac{\overline{P}_\Delta(n)}{\overline{S}_\Delta(n)} = 1$

~~If~~ If we reduce n then $\frac{\overline{P}_\Delta(n)}{\overline{S}_\Delta(n)}$ will increase as n goes down

for $n = 3$ ~~we have~~ $\frac{\overline{P}_\Delta(3)}{\overline{S}_\Delta(3)}$

we have

for $n = 4$ $\frac{\overline{P}_\Delta(3)}{\overline{S}_\Delta}$

~~[illegible]~~

n	$\frac{\overline{P}_\Delta(n)}{\overline{S}_\Delta(n)}$
3	$\times$
4	$\times$

If we enlarge "scatter" ~~of times~~ "in all"
to 2 × 2.6 = 6.2 years. — 3σ

population

~~x0~~ $(9.6)^2 = (5)^2 = [\quad]$

92
25
———
67

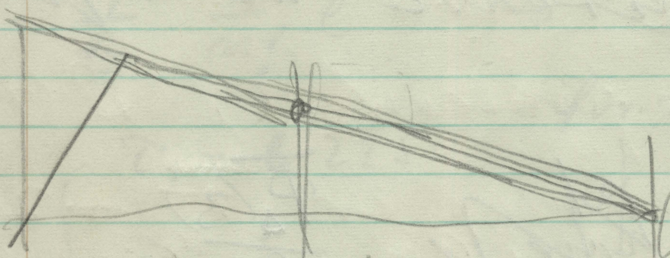
$$\boxed{\frac{8.2}{6.2} = 1.32 \qquad n = ?}$$

~~ΔA~~

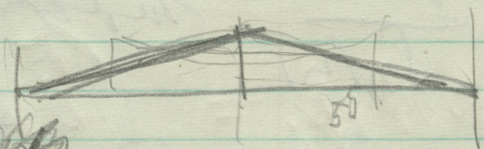
Life tables ~~3282~~ 3446 3379

$4.75\% \quad \frac{164}{3446} =$ $\qquad \frac{67}{3446} = 2\%$

$n = 6$ $\qquad \frac{16}{3.6} = \tau$



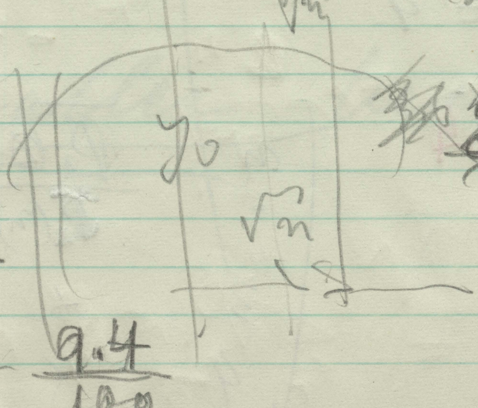
16



$\frac{\sqrt{n}}{\sigma} = \frac{3.6}{100}$

$\frac{\sigma}{\sqrt{n}} \cdot \frac{68}{100} = \frac{1}{2}$

1.1 ×



$\frac{y_0}{\sigma}\sqrt{n}\ 0.68 = \frac{1}{24}$

$\boxed{2.6 \text{ years} = \tau}$

~~3.6~~ $\frac{P(nm)\,100}{3.6} = 2.5$

$P(nm) = \frac{9.4}{100}$

~~mean age difference~~
mean of age difference at
death - absolute

st dev of life curve $\quad \begin{array}{r} 11 \\ 9 \\ \hline 20 \end{array}$

$\frac{20}{2} = \underline{10 \text{ years}} = \text{st. dev}$

mean age diff 0.96×10 year $= \underline{9.6 \text{ years}}$ mean

$(9.6)^2 - (2.6)^2 = \left(\overline{\Delta}\,\text{pop}\right)^2 = \left(\text{mean of diff due to genetic causes}\right)^2$

$92 - 6.75$

$\begin{array}{r} 6.75 \\ \hline 85.25 \text{ years} \end{array}$

mean of gen

$\overline{\Delta}\,\text{pop} = \sqrt{85.25} = \underline{9.24 \text{ years}}$

to compare with

$\Delta_{sis} = 5.65$

$(6.2)^2 - (2.6)^2 = (\overline{\Delta}\,\text{sis})^2$

$\frac{\overline{\Delta}\,\text{pop}}{\overline{\Delta}\,\text{sis}} = 1.635$

Compare with

$n = 3$ $\qquad \frac{1.8}{1.1} = 1.63$

Compute stand dev i of the curve from individual dx

assume $n = 25$

stand dev $\sqrt{25} \times \tau = \underline{\underline{5\tau}}$

$$\frac{P(nn)}{\tau} = \frac{3.6}{100}$$

$$P(nn) = 0.079$$

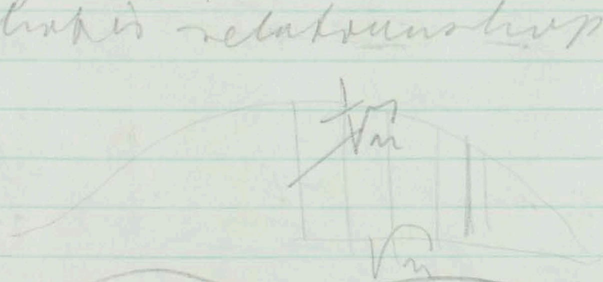
for $n = 25$

$$\tau = \frac{100\, P(25, 25)}{3.6} \quad (= 2.2 \text{ year})$$

stand dev. $= 5\,\frac{7.9}{3.6} = 11$ years

mean of diff $=$ ~~2~~ 11 years $\cdot\, 0.96$
$= 10.55$ years

In general what is relationship between τ and n?



Approximations:

$n = 3$ $\quad \frac{\sqrt{3}}{1.1} \simeq 1.575$ in place of $= \frac{1.8}{1.06}$

$n = 4$ $\quad \frac{\sqrt{4}}{1.3} = 1.54$

$n = 5$ $\quad \frac{\sqrt{5}}{1.5} = 1.49$

Ld

$\frac{100\ r}{15\ day\ L}$ 15oo dy =

4 years — h breaths af most

or — 3 rec. subtrials

$\tau\sqrt{n} = \underline{10}$

$\frac{100P(m)}{3.6} = \tau = \frac{10}{\sqrt{n}}$

$n = 25$

$P_{m} = \frac{3.6 \times 10}{100} \frac{1}{\sqrt{n}} = \frac{36}{100} = \frac{0.36}{\sqrt{n}}$

$0.0795 = \frac{.36}{5} = 0.072$

3.6

$$\boxed{0.079 = \frac{3.6/100}{5}}$$

$X = 11$ years

Stand dev of lrf tables

~~or with 0.366~~

from $\frac{100\ P(m,n)}{3.6} = \tau$

$\frac{P(m,n)}{\tau} = \frac{3.6}{100} = \frac{1}{\sqrt{n}}$

$\sqrt{n}$

M F

Stunn

$n = 0$

Dose

$\boxed{1 \text{ fault}}$

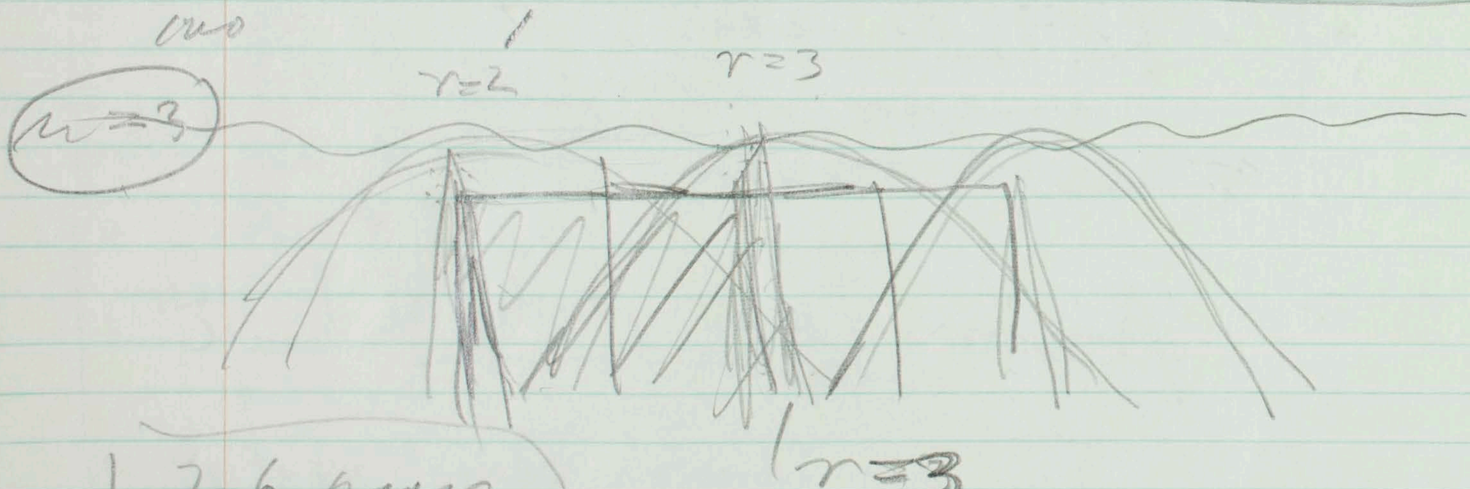
τ

$f \approx$

$$e^{-\frac{(x+r)^2}{4m}} = 2\%$$

$$(x_0 + r)^2 = 2.65 \times 4m = 10.6\ m$$

$$x_0 + r = \sqrt{10.6m}$$



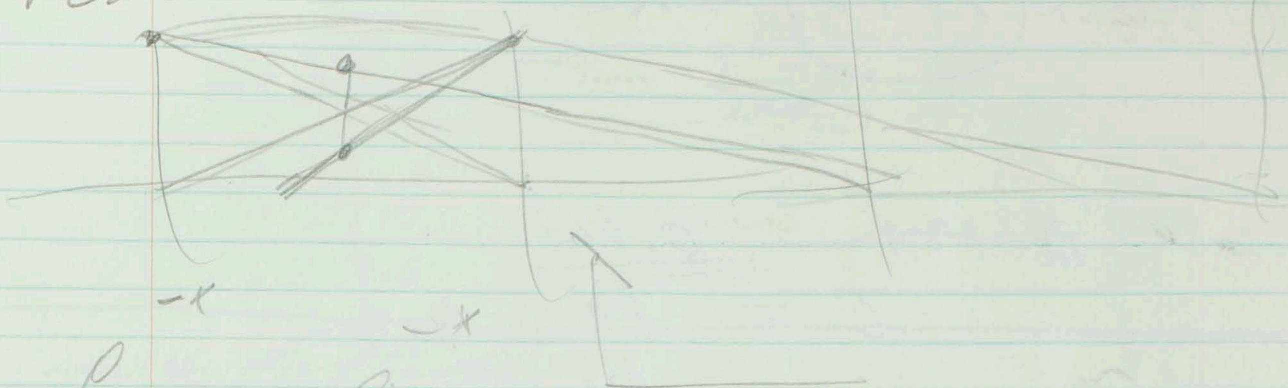
1 2.6 years

$r = 3$

$$\frac{0.224}{\tau} = \frac{3.6}{100}$$

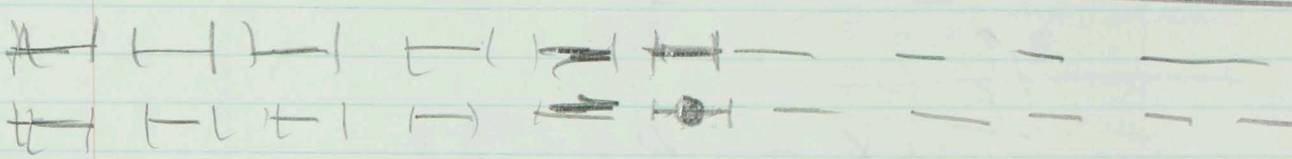
$$\frac{22.4}{3.6} = \tau = 6.2 \text{ years}$$

Further



e^{-x} e^{-x}

Lai



2m $\quad$ x $\quad$ n

$$f = e^{-\frac{(x+r)^2 - r^2}{4m}} \qquad \frac{x}{2m} < 1$$

$$f = \sum_{\xi} \frac{x^{\xi}}{\xi!} e^{-x} e^{-\frac{(\xi+r)^2 - r^2}{4m}} = e^{-\frac{(x+r)^2 - r^2}{2m}}$$

$$\overline{\xi} = x$$

r small

$$f \simeq e^{-\frac{(x+r)^2}{4m}}$$

$r = 3$

7%

$80 \times 18.6 = X$

~~0.130~~ 0.14

$\tau = \frac{.14}{3.6} = 3.9$

$\frac{80}{3.9} + 8 = \frac{X}{3.9}$

$X = 80 \times 31$

.8

.133

100

13 n

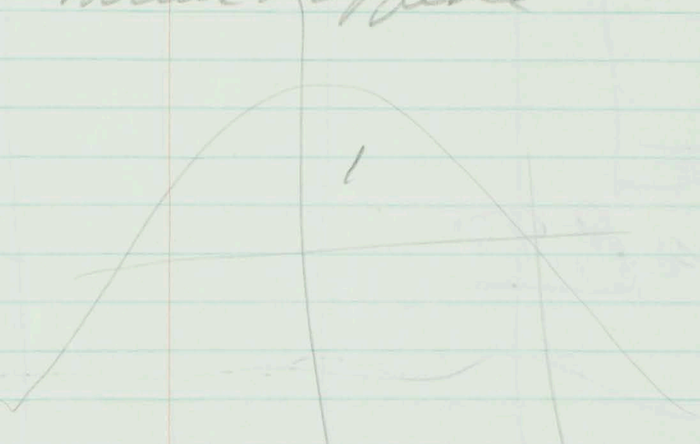
William Russell

$n = 25$

$$\frac{0.0295}{\tau} = \frac{3.6}{100}$$

$$\frac{7.9}{3.6} = 2.2 \text{ years}$$

mean difference



0.96 x st. dev.

10.2 years

~~10.2~~

$$(X)^2 + (2.6)^2 = (10.2)^2$$

$X =$

$$\frac{80}{\tau} + n = \cancel{(X\,\cdot\,n)}$$

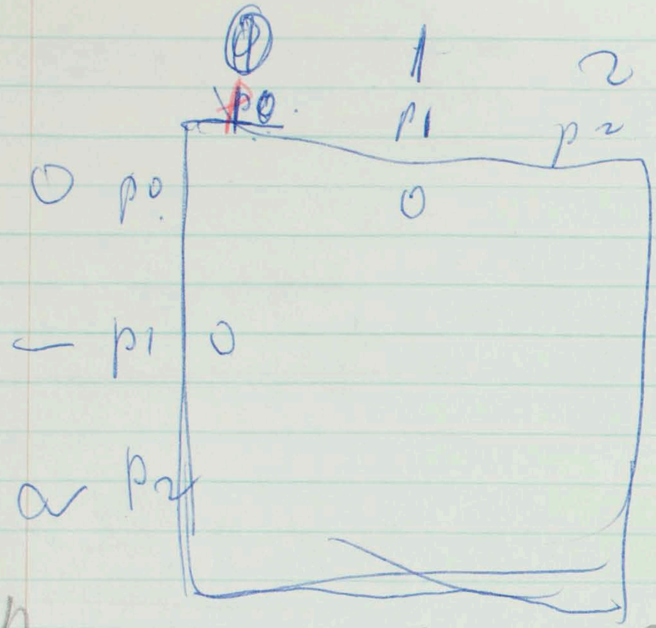
$$e^{\frac{\left(\frac{80}{\tau} + n\right)^2}{4n}}$$

$$\left(\frac{80}{\tau} + n\right)^2 = A$$

$$\left(\frac{X}{\tau}\right)^2 = A$$

6.2

$$\left(\frac{80}{6.2} + 3\right) = \left(\frac{X}{6.2}\right)$$



Binomial au P. 47

$n = 3$

22 40
10 → 2.24

~~2.5~~
2.1

~~6.3~~

$n = 4$

1953
1042 | 1.9

proche 33

$n = 5$

1755

~~2.7~~ 1.7

96

~~1 6 15 20 15 6 1~~

	0	1	2	3	4	5	6
1							
6							
15							
20							
15							
6							
1							

$2n = 5$ — med j[illegible] Sisters

0	0067	0	—
1	0337	0.5	.017
2	0842	0.75	.063
3	1404	0.94	.132
4	1755	1.085	.190
5	1755	1.28	.223
6	1462	1.35	.198
7	1044	1.465	.153
8	0653	1.57	.094
9	0363	1.67	.061
10	0181	1.76	.032
11	0082	1.84	.015
12	0034	1.93	.007
13	9.979		1.185
14	464		0.997
15			
16			
17			

$\frac{1.185}{0.997} = 1.19$

Prison mean difference

$n = 2.5$		0	1	2	3	4	5	6	7
0	.0821	67	168	210	175	109	55	23	8
1	.2052	420	526	438	274				
2	.2565	660							
3	.2138	456							
4	.1336	172							
5	.0668	44							
6	.0278	8							
7	.0099	1							
8	.0031								
9	.0009								
10	.0002								
11	.0000								
12									

12

see T. Wakeat

Determination of n from shape of curve. —

$n = 2.5$

~~at~~ Poisson at 2   2.565
4   1.336 $>$ 1.92

$n = 3.5$ Poisson at 3   2158
5   1322 $>$ 1.63
6   0771 — 2.8

1.23

$\frac{3.446}{2.8} = 1230$

$n = 3$ $\frac{2440}{1.008} = 2.425$

$\frac{3446}{2.425} = 1422$

for $n = 2.5$

p	q
2.6	0.7

$$\boxed{\tau = \frac{25.65}{3.66} = 7 \text{ years}}$$

probably larger somewhat

Poisson

1.65

$\frac{3.446}{1.65} = 2.09$

10.1 years

corrected

$(10.1)^2 - \left(\frac{2.6}{0.96}\right)^2 = (9.75)^2$

St. dev. 9.75

101
$-$ 6.2
94.8 ~ 95

Curly 2 x 34% of health

around neck of those still alive at 40

2 std dev. = 22 years

~~11.0~~ 11.6 years

or more accurately

~~25% of the std dev on health sides.~~

~~7.28~~

88.4

72.8 years

7.7
7.8
15.6
/2 = 7.8 years

$\frac{7.8}{.7}$ = 11.1 years for

per std dev.

$$\left(11.1\right)^2 - \left(\frac{2.6}{1.1}\right)^2 = \cancel{117} \left(10.8\right)^2$$

$\sqrt{\cancel{117.70}}$

128
5.20
117.70

std dev of pops for few reasons $\boxed{10.8}$

$$\frac{10.8}{\tau} = \sqrt{5} = 2.24$$

$$\tau = \frac{10.8}{2.24} = 4.84$$

values for males 5.76 for women diff 4.84 . 1.19

variance for poisson $n = 5$ is

5 $\quad \sqrt{5} =$

$$\boxed{\left(\frac{10.1}{\tau}\right)^2 = 5} \quad \sqrt{5} = 2.24$$

$$\frac{10.1}{\tau} = \sqrt{5} \qquad \tau = 4.5$$

twins $\frac{(1.19 \times 4.5 = 5.35 \times 0.96}{=5.14}$ .96)

~~10.5~~
11.9
(1.4)

~~Carly~~

4.9 ~~years~~ mean

10.1
1.4
11.5

$$\frac{11.5}{\tau} = \sqrt{5} \qquad \text{Mean}$$

4.7
5.14
9.84 /2
= 4.92
6.12 years

τ = 5.14 years

~~1.2 × 5.15 = 6.3 years~~ ← for twins

~~for land~~

~~3,660~~

~~25.65 / 3.66 = 7.01 less 4%~~

~~224 – 24~~

~~corrected for 4%~~

~~$\frac{23.00}{3.66} = 6.3$~~

Or from twins

5.65 = 1.19 τ

τ = 4.75

$$\frac{80.5}{4.84} \times 2.5 = X_0$$

$$\cancel{16.63}$$
$$2.5$$
$$\cancel{19}.0$$ births to death

$$e^{-\frac{x_0^2}{4m}}$$

for $m = 23$ $\quad e^{-\frac{360}{92}} = e^{-3.93}$

$$\boxed{m = 36}$$

$$e^{-\frac{361}{80}} = e$$

$$\frac{1}{2}$$

$$\frac{360}{x} = 2.5$$

$$\frac{360}{2.5} = \frac{x}{4m}$$

~~$\sum f_r = \sum_r \frac{(16.5)^r}{r!} e^{-16.5} e^{-\frac{(r+2.5)^2}{4m}} \cong e^{-19}$~~

$$f_r = \frac{19^r}{r!} e^{-19} \quad e^{-\frac{r^2}{4m}} \approx e^{-\frac{(19)^2}{4m}}$$

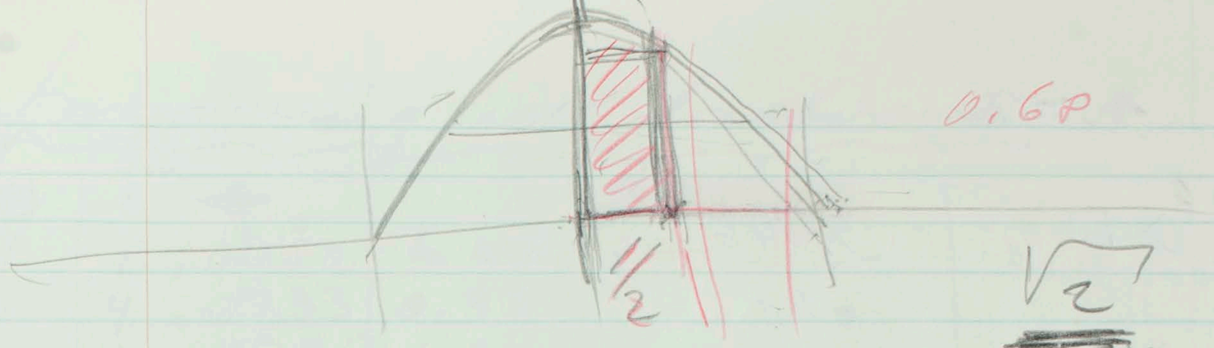
$r = 0$

m

$$(19)^2 = 12m$$

$$m = \frac{361}{12} = \underline{30}$$

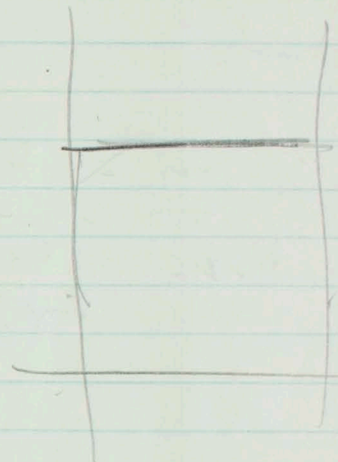
0.68



$\sqrt{2}$

$$\frac{\int x f(x)\,dx}{\int f(x)\,dx} =$$

$\frac{1}{2}$



.4	x	0	—
.39	x	0.2	.078
.37	x	0.4	.148
.33	x	0.6	.198
.29	x	0.8	.234
.24	x	1.00	.240
.19	.	1.2	.228
.15		1.4	.210
.11		1.6	.176
.08		1.8	.144
.05		2.0	.100
.04		2.2	.088
.02		2.4	.048
.01		2.6	.026
.008		2.8	.0224
.004		3.00	.012
2.69			1952
			67

0.5

2.5

$\frac{1.952}{2.5} = 78\%$

$\frac{0.1952}{...} =$

2.5 + .2 = 1/2

.1.13

p. 85 Brinkley ... Mag

$\boxed{0.8}$

$80 \times \sqrt{2} =$

Mean diff is 1.13x st. dev.

Try $n=2$

$\frac{271}{180} > 1.5$ $\qquad \frac{3446}{1.5} = 2300$

$\frac{3446}{1780} =$

$\frac{2706}{1353}$

$\frac{10.8}{\tau} = \sqrt{4}$

$\tau = 5.4$

$X_0 = \frac{80.5}{5.4} + 1.5 = 16$

14.8
1.5

$\frac{(16)^2}{4m_2} = \frac{(19)^2}{4m_1}$

$m_2 = \frac{(16)^2}{(19)^2} m_1$

$\frac{256}{361}$ 30

~~20.5~~ $\boxed{m_2 = 21.2}$

$n=2$

Compute ~~other~~ situation for $n=2$

Smearing out problem

try to model

$(11.1)^2 - (5)^2 = X^2$

X $\qquad 123$
$\qquad 23$

$X = \cancel{100}\ 10$

$\tau = \frac{10}{2} = 5$

Superdwing cell fractions 100

r	$\frac{r^2}{4m}$			$x_0=19$	
0	0	~~0~~			
1	1	.0083	1.00	—	—
2	4	.0333	0.97	—	—
3	9	.0775	0.92	—	—
4	16	.133	0.88	—	—
5	25	.208	0.81	.0001	—
6	36	.300	0.74	.0003	.0002
7	49	.409	0.66	.0009	.0006
8	64	.533	0.59	.0024	.0014
9	81	.677	0.51	.0050	.0025
10	100	.833	0.44	.0095	.0042
11	121	1.01	0.36	.0164	.0059
12	144	1.20	0.30	.0259	.0078
13	169	1.41	0.24	.0378	.0091
14	196	1.63	0.20	.0514	.0120
15	225	1.87	0.15	.0650	.0097
16	256	2.14	0.12	.0772	.0092
17	289	2.41	0.09	.0863	.0078
18	324	2.70	0.07	.0911	.0064
19	361	3.02	0.05	.0911	.0045
20	400	3.34	0.04	.0866	.0035
21	441	3.68	0.03	.0783	.0023
22	484	4.04	0.02	.0676	.0013
23	529	4.41	0.01	.0559	.0006
24	576	4.80	0.008	.0442	.0003
25	625	5.21	0.005	.0336	.0002
26					
27					

22

.0895

115

78

.0895

to compare $e^{-\frac{(19)^2}{4m}} \cong 5\%$

$X = \frac{19}{2}$ | *periodicitance* $e^{-\frac{90}{120}} \sim e^{-0.75} = \underline{0.45}$

$$e^{-\frac{x^2}{4m}+\frac{3^2}{4m}}$$

$$3 = \frac{x^2+5}{4m}$$

$$12m = x^2 - 5$$

$$m = \frac{x^2}{12} - \frac{1}{2}$$

$$e^{-\frac{(16+1)^2}{4m}} = e^{-\frac{(16)^2}{4m}} e^{-\frac{32}{4m}}$$

$$\frac{32}{4m} = \frac{32}{92} = .348$$

$$e^{-.348} = 0.705$$

$$\frac{1}{2} \quad \frac{1}{1.42} \quad -$$

3

$3\frac{1}{3}$ bits = 20 years

Origin ~~prop~~ specific 8%

~~[illegible]~~

$\frac{1}{3}$

1/2 ~~Δ~~(0)

1/2 $q(0) = p(0)$

$q(0)=0$

0

	0	1	2	3	4	5	6	7	8	9	10	
m=3	.049	.149	.224	.224	.168	.100	.0504	.0216	.0081	.0027	.00080	
m=2	.135	.270	.270	.180	.0902	.036	.0120	.0034	.0008	.0002	.00004	
m=4	.018	.073	.146	.195	.195	.156	.1042	.0595	.0297	.0132	.00530	
	.202	.492	.640	.599	.453	.292	.1666	.0845	.0386	.0161	.00614	× 5.4
	92	86	80	74	68	62	56	50				
	1100	2650	3450	3250	2450	1500	900	456				

$\tau = 6$

$\frac{80}{6} + 3 = 16.3$

$m = \frac{265}{361} \times 30 = 22$

$m = 2.5$, $n = 3.5$

0	1	2	3	4	5	6	7	8	9	10	11	12	13
.0821	.2052	.2565	.2138	.1336	.0668	.0278	.0099	.0031	.0009	.0002	—		
.0302	.1057	.1850	.2158	.1888	.1322	.0771	.0385	.0169	.0066	.0023	.0007	0.002	.001
.112	.3109	.4415	.4296	.3224	.1990	.1049	.0484	.0210	.0075		× 0.780		
.0875	.243	.345	.335	.262	.155	.082	.0377	.0164	.0058				

at two stand deviation

$$\begin{array}{r} .5000 \\ 4773 \\ \hline \boxed{227} \end{array}$$ 5%

20					25				
.0519	.0618	.0702	.0763	.0795	.0795	.0764	.0708	.0632	.0544
.0415	.0519	618	702	763	795	795	764	708	632
934	1137	1320	1465	1558	1590 max	1559	1472	1340	1176
207	259	309	351	381	398	398	382	354	316
726	877	1011	1114	1176	1193	1162	1090	986	860
151	134	103	62	17	31	72	104	126 →	

~~5%~~

2½% of total

of 38,000

$b_x = 2.5 \times 380 = 950$

Determination of u

$$\frac{0.224}{\tau_1} = \frac{0.079}{\tau_2}$$

at 97 above 1,077 this should be two stand dev. –

at 2½ Stand dev.

$$\begin{array}{r} .5000 \\ 4938 \\ \hline \boxed{62} \end{array}$$

out of $\frac{620}{105} \times .38$

should be above at 1011½ ‖ $620 \times .38$ $\boxed{23.5}$

we find in fact $\boxed{294}$

$n = 2.5$

0	1	2	3	4	5	6	7	8	9	10	11	12
.0821	.2052	.2565	2138	1336	0668	0278	0099	0031	0009	0002	~~0001~~	
.0000	0821	2052	2565	2138	1336	0668	0278	0099	0031	0009	0002	
.0821	.2873	4617	.4703	3474	2004	.0946	0377	0130	0040	0011	X	
.0603	.2110	.3380	.3460	.2550	.1470	.0695	.0277	.0095	0029	.0008		

$\frac{345}{470} =$

0.569

1390

curve I

$\frac{34.5}{36.6} = 0.942$

$\tau = 6\frac{32}{36} = 6.4$ years

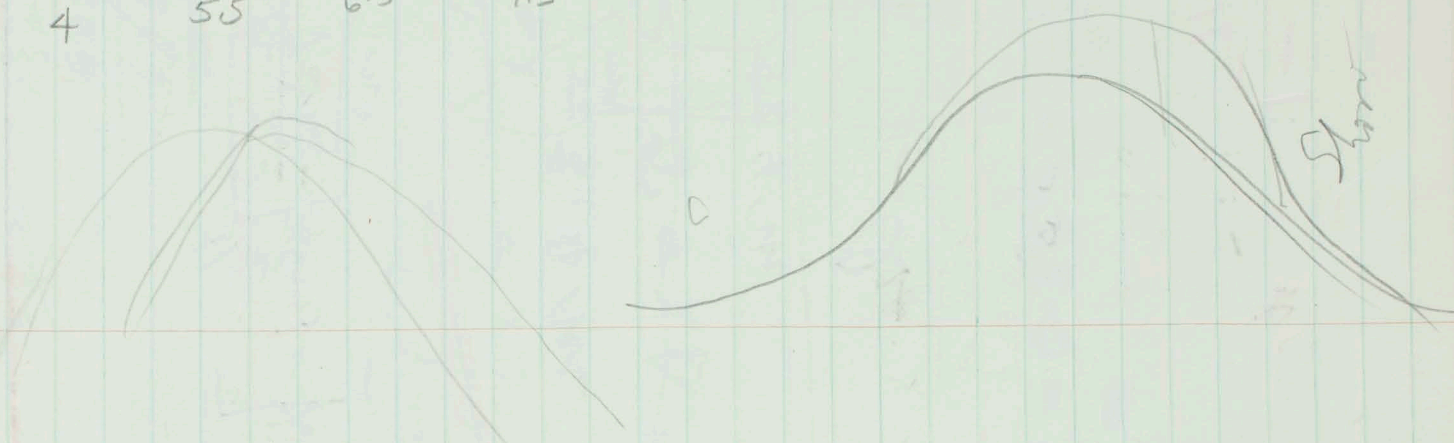
$n = 3\frac{1}{2}$

0302	1057	1850	2158	1888	1322	0771	0385	0169	0066	0023	0007	0002
	0302	1057	1850	2158	1888	1322	0771	0385	0169	0066	0023	0007
0302	1359	2907	4008	4046	3210	2093	1156	0554	0235	0089	0030	0060
254	1140	2440	3370	3400	2700	1760	0970	466	0198	0075	0025	0008
96	92.5	87.5	82	78	72.5	66	58.5	50.5				

.84

80

5.5 5.0 5.5 4 5.5 6.5 7.5 8.0



Life shortening effect of one test

$n = 25$ Poisson $= .0795$

$$.0795 = \frac{A}{\sqrt{5}}$$

$$A = \cancel{2.24}\ 5 \times .0795 = 0.395 \approx 0.4$$

$A = 16$ Poisson should be

$$\frac{0.4}{4} = 0.1$$

check $n = 4$ Pois 0.2 0.K

$$\tau_x = \frac{0.4}{\sqrt{n}} \frac{100}{3.66}$$

$$\underbrace{\tau \Delta X}_{\text{years per test}} = \frac{0.4}{\sqrt{n}} \frac{100}{3.66} \left[\left(\frac{1}{1 + \frac{12m}{n^2}} \right)^{1/2} - 1 \right] \Delta r$$

$$= \left(\frac{80}{\tau} + n \right)^2 - n^2 = 3 \times 4 m$$

$\tau = 2$ years

$$(40 + n)^2 - n^2 = 3 \times 4 m$$

$$2 = \boxed{\frac{11}{\sqrt{n}} \left(1 - \frac{1}{1 + \frac{12m}{n^2}} \right)} - Q$$

try $n = 10$; $\frac{12m}{n^2} = \frac{1}{24}$, $Q \simeq \frac{11}{\sqrt{10}} = 3.5$

See page 40

~~[illegible]~~

$$-P(r) \frac{dx}{\cancel{dx}} = P(r) \left[\left(\frac{1}{1 + \frac{12m}{r^2}} \right)^{1/2} - 1 \right] dr$$

$n = 25$

$$\frac{(X+r)^2 - r^2}{4m} = 3$$

$$\boxed{\tau = \frac{8}{3.66} = \underline{2.2 \text{ years}}}$$

$$x = \frac{t}{\tau}$$

$$625$$

$$\left(\frac{80}{2.2} + r\right)^2 - (25)^2 = 12m$$

$$\cancel{36.2}$$

$$\frac{\begin{array}{r}1300\\625\end{array}}{675/12} = \boxed{\cancel{m = 56}}$$

$$X = \sqrt{(25)^2 + 12m} + r$$

see p 37

$$\Delta x = \left(\frac{1}{1 + \frac{12m}{n^2}}\right)^{1/2} - 1$$

$$\tau \Delta X = \tau \left[\left(\frac{1}{1 + \frac{12m}{n^2}}\right)^{1/2} - 1\right]$$

$$\left[\left(\frac{1}{1 + \frac{675}{625}}\right)^{1/2} - 1\right]\tau$$

$$\tau \Delta X = 0.3\tau$$

$$\frac{1}{2.04} \quad \frac{1}{1.43}$$

$$0.7 - 1 = 0.3$$

m calc. out of lobe shortening

effect of 1 bit

$\cancel{I}_x \propto \tau$

$$\left[\frac{80}{T_x} + \left(\frac{11}{T_x}\right)^2 \right]^2 - \left(\frac{11}{T_x}\right)^4 \cong 12\, m \quad \text{for } n \gg 1$$

more accurately

Mutter p 52

p 136

p 65

minimum n from minimum

m = 23 or slightly less, —

gives $\left(\frac{80}{\tau} + n\right)^2 - n^2 = \cancel{4 \times 23}\ 4 \times 3\, m$ P(nm)

$\boxed{\tau_x = \frac{n^n e^{-n}}{n!} \cdot \frac{100}{3.66}}$

$\tau = \tau_x$

n	P(nm)	τ_x		τ_x	$\sqrt{12m}$	m
n = 2	= 0.270	7.4	~ 0.282		13	14
n = 3	= 0.224	6.1	~ 0.231		16	21.5
n > 4	= $\frac{0.4}{\sqrt{n}}$	$\frac{11}{\sqrt{n}}$	(n > 8)			

$n \geq 4$

< n

n = 4 = $\cancel{4}P/44$ = 0.195367 and $\tau_x = \frac{0.195367}{3.66} = \boxed{5.35}$

maximum at r = n shifts by τ_x for each additional n

for $\left(\frac{80}{\tau} + n\right)^2 =$ 100

n = 3   n = 2.5

$\cancel{\Delta x} =$

$$-\tau\,\Delta x = \left[\left(\frac{1}{1+\frac{12m}{r^2}}\right)^{1/2} - 1\right] dr$$

life shortening by one hit $= T_x$

$$T_x = |\tau\,\Delta x| = \tau\left[1-\left(\frac{1}{1+\frac{12m}{r^2}}\right)^{\frac{1}{2}}\right]$$

$\frac{\text{Poisson}}{T_x} = \frac{3.66}{100}$

Poisson $\simeq \frac{0.4}{\sqrt{m}} = \frac{0.395}{\sqrt{m}}$

$$\tau = \frac{T_x}{1-\left(\frac{1}{1+\frac{12m}{r^2}}\right)^{1/2}}$$

$T_x = \frac{0.4}{\sqrt{m}}\,\frac{100}{3.66} = \frac{11}{\sqrt{m}}$

$$\left(\frac{80}{T_x}\underbrace{\left[1-\left(\frac{1}{1+\frac{12m}{r^2}}\right)^{1/2}\right]}_{\text{factor} < 1} + r\right)^2 - r^2 = 12m$$

therefore

$$\left(\frac{80}{T_x} + r\right)^2 - r^2 = 12\,m^* \qquad m^* > m$$

$$m = \left(\frac{11}{T_x}\right)^2 \qquad T_x = 2.2 \text{ years}$$

$m = 25$

$$m^* \quad \left(\frac{80}{2.2} + 25\right)^2 - (25)^2 = 12\,m^*$$

36.3
25
$(61.3)^2$

625

3750
625
3125

1/5/10 10 51 See table on p 97

for $n = 8$ mean diff between
sisters 1.57
stand dev $= \frac{1.57}{1.13} = \underline{\underline{1.39}}\ \sigma_x$

1
25
100
100
25
1
252

stand dev of poisson for $n = 4$ is $\underline{\underline{2\sigma_x}}$
Ratio $\frac{2\sigma_x}{1.39\sigma_x} = \underline{\underline{1.40}}$

Limont two

We must assume for our approximation
Var_x ~~[illegible]~~ = 11 years large compared to
mean age difference for
identical twins which represents non
genetic ~~[illegible]~~ scatter

for $n = 6$ $2n = 12$
sisters are $\frac{1.93}{1.13} = 1.73$ to comp with $\sqrt{6} = 2.45$
Ratio $\frac{\text{"sisters"}}{\text{prop.}} = \frac{2.45}{1.73} \simeq 1.4$

Life table mean diff after 60 10.2 years
uncorrected for id twins. → to comp is 6.2 years
corrected for id. twins
$(10.2)^2 - (2.6)^2 = (x)^2$
104
6.25
97.75
$x = \underline{9.9}$
Ratio uncorrected $\frac{10.2}{6.2} = 1.645$

$(6.2)^2 - (2.6)^2 = (y)^2$
38.5
6.25
32.25
$\underline{y = \sqrt{32.25}} = 5.68$
Ratio corrected $\frac{9.9}{5.68} = 1.75$

Lope curve see p. 46 for n = 4 + shifted n = 4 H 105

Remarks about "sisters"

sisters . parents 2 (n spec). = 1.4

distrib in parents

0	1	2	3	4	5
0.2466	0.3452	0.2417	.1128	.039	.011

Average Difference

P for n = 1.4		II	III
0	0.2466	0	
1	0.3452	0.5	0.17
2	0.2417	0.75	0.18
3	0.1128	0.94	0.106
4	0.0395	1.085	0.043
5	0.0111	1.28	0.014
			0.513 × 5.33 = 2.74 years

in reality it is less for it does not matter if difference is one or two. thus we have to revise column II and make numbers lower. write probab for 0 difference = q and [1−q] is value to put in column 2

1−q for

0 = 0 1 = 2 = 3 = 4 = 5 =

~~Bin~~ Binomials p. 47

			P for n = 1.4		
for 1	$q = \frac{1}{2}$	$1-q = \frac{1}{2} = 0.5$	1	.3452	0.172
for 2	$q = \frac{6}{2^4} = \frac{6}{16} = 0.36$	$1-q = .64$	2	.2417	0.154
for 3	$q = \frac{20}{2^6} = 0.31$	$1-q = .69$	3	.1128	0.088
for 4	$q = \frac{70}{2^8} = \frac{70}{4 \times 64} = 0.275$	$1-q = .725$	4	.0395	0.029
for 5	$q = \frac{252}{2^{10}} = \frac{252}{8 \times 8 \times 16} = \frac{8}{16}$ … $= 0.245$	$1-q = .755$	5	.0111	.009
					0.452

for sisters due to spec. limit

mean diff: = 2.4 years

0.452 × 5.33

$$\frac{\frac{7}{9}\ \frac{5}{9}\ \frac{3}{9}}{\frac{11}{9}\ \frac{13}{9}\ \frac{15}{9}}$$

$$\frac{7 \times 5 \times 3}{11 \times 13 \times 15} = \frac{105}{214} =$$

$$\frac{214}{105} = 2.04$$

$$\frac{16 \times 14 \times 12}{20 \times 22 \times 24} = \frac{8 \times 7 \times 6}{10 \times 11 \times 12} = \frac{335}{1320}$$

$$\frac{1320}{335} =$$

$$\frac{n!}{r!\,(n-r)!}$$

$$\frac{n!}{\frac{n}{2}!\ \frac{n}{2}!}$$

$n!$

$$\frac{6!\ 12!}{9!\ 9!} = \frac{\cancel{10}}{7 \times 8 \times 9} \cdot 10 \times 11 \times 12 \qquad \frac{1320}{500} =$$

$$\frac{1320}{500} = 2.64$$

~~8~~

16   32

$$\frac{12!\ \overset{n-r}{(32-12)}!}{16!\ 16!} = \frac{12!}{16!}\ \frac{20!}{16!}$$

$$= \frac{20 \times 19 \times 18 \times 17}{\cancel{12} \times 13 \times 14 \times 15 \times 16}$$

$\boxed{n = 16}$

$2n = 32$

$$\frac{17}{13}\ \frac{18}{14}\ \frac{19}{15}\ \frac{20}{16} \quad \text{OK.}$$

$$= \frac{17}{17-4}\ \frac{18}{18-4}\ \frac{19}{19-4}\ \frac{20}{20-4}$$

$$\frac{1}{1-\frac{4}{17}}\ \frac{1}{1-\frac{4}{18}}\ \frac{1}{1-\frac{4}{19}}\ \frac{1}{1-\frac{4}{20}}$$

10% diff in ~~mean~~ stand dev. gives ratio $\frac{0.4}{.2179} = 1.83$

$$\frac{\overset{306}{17 \times 18}\ \overset{380}{19\ 20}}{\underset{182}{13\ 14}\ \underset{240}{15\ 16}} = 1.68 \times 1.59$$

106

for $n = 4$ $\sim \frac{1.57}{1.13} \approx$ [illegible] $\sqrt{n} = 2$

~ 1.39

$$\frac{2}{1.39} = 1.44$$

---

for $n = 2.5$
$2n = 5$

weighted $\frac{\text{mean diff}}{\text{stand dev.}} = 1.19$ $\cong \frac{1.19}{1.13} \cong 1.05$

[illegible] $\sqrt{2.5} = 1.58$

$$\frac{1.58}{1.05} = 1.5$$

$n = 10$
$2n = 20$

Gaussian 1.65 1 st. d.
$\frac{1}{2.27}$ 2 st. d.

$$\frac{\text{stand dev of gauss}}{\text{stand dev of binom}} = \frac{3}{2.15} = 1.39$$

$$\frac{n!}{r!(n-r)!} = \frac{1\,2\,3\,4\,5 \times \left(\frac{n}{2}\right)! \left(\frac{n}{2}-1\right)\left(\frac{n}{2}-2\right)\left(\frac{n}{2}-\sqrt{n}\right)}{\left(\frac{n}{2}-1\right)\left(\frac{n}{2}-2\right) \cdot \left(\frac{n}{2}+1\right)\left(\frac{n}{2}+2\right)\left(\frac{n}{2}+\sqrt{n}\right)}$$

$$1 \quad \frac{\left(1-\frac{2}{n}\right)\left(1-\frac{2}{n}2\right)\left(1-\frac{2}{n}3\right)}{\left(1+\frac{2}{n}\right)\left(1+\frac{2}{n}2\right)\left(1+\frac{2}{n}3\right)}$$

$$\left(1-\frac{4}{n}\right)\left(1-\frac{4}{n}2\right)\left(1-\frac{4}{n}3\right)$$

$$\frac{2}{n}\sqrt{n} \ll 1$$

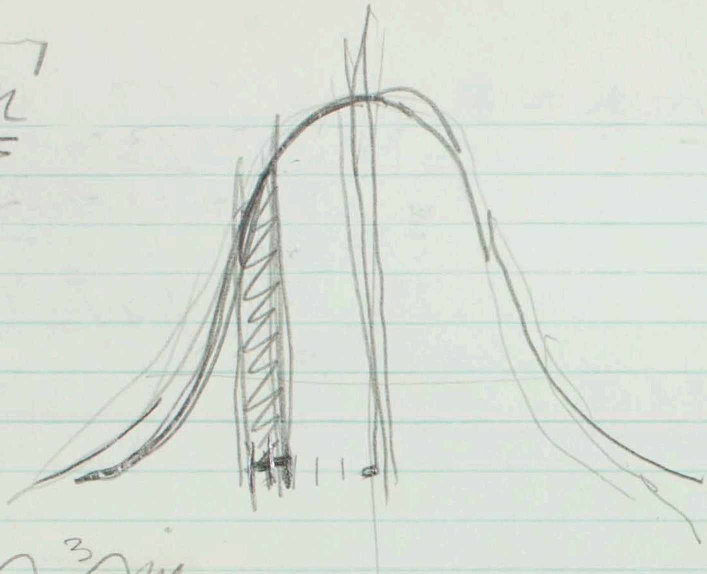
$$\frac{11}{\sqrt{n}} = 2$$

$$\left(\frac{11}{2}\right)^2 = n$$

$\boxed{n \leq 55}$

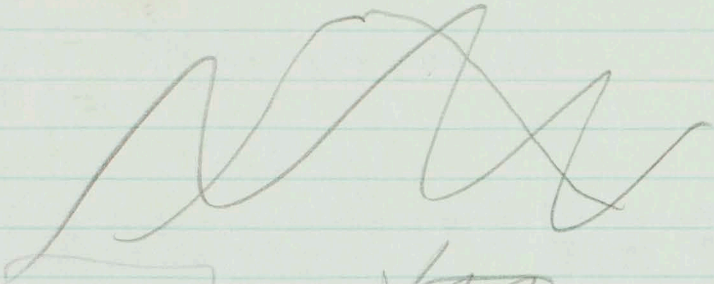
Gaussian at $\sqrt{2\pi}$

$\sqrt{2}\sqrt{n}$



$x\,n + \frac{n}{2} = \frac{3}{2}\,n$

$\frac{m}{\sqrt{m}}$



$\boxed{m \text{ and}}$ $\boxed{m+1}$

~~[illegible]~~ at $\sqrt{m}$

$\frac{0.4}{\sqrt{m}}$ is peak

$\frac{0.4}{\sqrt{2}\sqrt{m}}$

peak for m

peak for $\frac{1}{2}$ of m must be twice.

So that we have peak $= \frac{2}{\sqrt{2}} \frac{0.4}{\sqrt{n}}$ and stand dev of $\frac{m}{2}$ is $\frac{0.4}{\frac{\sqrt{2}\sqrt{n}}{2}} = \frac{0.4}{\frac{\sqrt{n}}{\sqrt{2}}}$

$n = 25$

$$\frac{26\ 27\ 28\ 29\ 30}{\cancel{20}\ 21\ 22\ 23\ 24\ 25}$$

$$\frac{26}{21}\cdot\frac{27}{22}\,\frac{28}{23}\,\frac{29}{24}\,\frac{30}{25} \approx \left(\frac{28}{23}\right)^5 = (1.23)^5$$

$(1.23)^2 = 1.48$

$(1.48)^2 = 2.19$

$2.19 \times 1.23 = 2.63$

$$\left(\frac{28}{28-\frac{25}{28}}\right)^5 = \left(\frac{1}{1-\frac{5}{28}}\right)^5$$

$$\left(\frac{1}{1-\frac{\sqrt{n}}{n}}\right)^{\sqrt{n}} \cong \left(1+\frac{\sqrt{n}}{n}\right)^{\sqrt{n}}$$

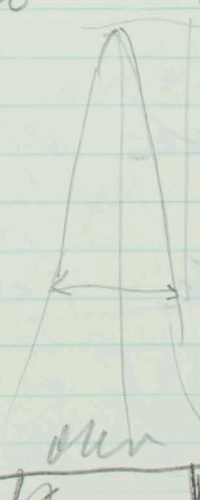
$$\boxed{\left(1+\frac{\sqrt{n}}{n}\right)^{\frac{n}{\sqrt{n}}} = e}$$

$\sqrt{\frac{1}{4n}}$

20 0.047

31

Poisson hohe ~~0.0795~~



$1/e$ at $\sqrt{n}$

$n = 25$

stand. dev. =

1.47 at Gaussian so at

at 1.41 stand dev.

Stand dev of binomial = $\frac{\sqrt{n}}{\sqrt{2}}$

Paper

$n = 3$ ~~$\tau_x = 7.4$ years~~

τ_x

~~$\frac{80}{7.4}$~~

$\tau_x = 6.1$

$13.2 + 3 = 16.2$

$(16.2)^2 = 12m$ or $10m$

256

$\boxed{m = 23}$

$\boxed{\text{for } 11.4m}$

$e^{-\frac{(16.2+1)^2}{4m}} = e^{-\frac{(16.2)^2}{4m}} \cdot e^{-\frac{32.4}{4 \times 23}} =$

or $e^{-\frac{32.4}{92}}$

or $e^{-\frac{1}{3}}$

Wallace ; fly

Russel both

~~200 r per~~ 300 r per gen

gives ~~10~~ $\frac{1}{100}$ lethals/gen

no X rays $\frac{0.4}{100}$ per gen.

both parents irradiated

200 r would double rate of "lethals"

~~same~~ in fly

In man lethal rate from Mueller

upper 4 mut.

$\simeq \frac{1}{6} \sim \frac{0.8}{6} = 0.133 \simeq 0.167$ or Sutland

for faults

2×2000 genes $\times \frac{1}{50}\, 10^{-3} \times \simeq \frac{4}{50} = 0.1$

page 74 Paper H

mean diff weighted for

$n = 3$ $n = 6$ [1.29]

mean for poisson for $n = 3$ (2.02) page 88

$$\frac{2.02}{1.29} = 1.565$$

poisson estimated $\sqrt{3} \cdot 1.13 = 1.957$

binomial unweighted $= 1.35$

$$\frac{1.957}{1.35} \simeq 1.45$$

$n = 46$

$$\left(\frac{80}{\tau} + n\right)^2 = 12\,m \quad \text{or} \quad 10\,m$$

$$\tau = \tau_x \quad \frac{80}{\tau} + n = \sqrt{560} = 23.6 \qquad n = 21.4$$

$n = 4$
$\sigma_x = 5.35$

$$\frac{80}{5.35} = 15$$

$$15 + 4 = 19$$

$n = 5$
$\tau_x = 4.92$

$$\frac{80}{4.92} = 16.4 \qquad 16.4 + 5 = 21.4$$

$n = 5$

1 fault added

$$e^{-\frac{(21.4+1)^2}{4m}}$$

$$e^{-\frac{21.4}{4m}} \quad e^{-\frac{42.8}{446}} \approx e^{-\frac{1}{4}}$$

Set permissible life shortening at 3 years — $\boxed{\text{This is correct}}$ permissible $\frac{100r}{l}$

$$\frac{n\,\text{"}100r\text{"}}{l}\,\tau_x = 3 \text{ years}$$

$$\frac{n\,\text{"}100r\text{"}}{l}\,\frac{\text{"}}{\sqrt{n}} = 3 \text{ years}$$

$$\cancel{l = \frac{3}{\text{"}100r\text{"}}} \qquad \sqrt{n}\,\frac{100}{3} = l$$

$$n = 5 \qquad l = \cancel{\ }$$

Better assume ~~...~~ 100r produces ~~...~~ chromosome breaks

$\frac{1}{2}$ deletion $\frac{1}{2}$ point mutation.

~~...~~ in somatic cell $1 \times \frac{1}{10}$ fault ~~...~~

In offspring of given to both parents 1 point mutation

i.e. $\frac{1}{10}$ fault.

We assume $\frac{1}{10}$ fault

109

If X-ray causes equal number of ~~faults~~ point mut and deletions.

~~and~~ ~~If X ray causes 10 faults in one deletion but ons~~ is likely to cause fault 10 times more often in deletion than point mut. then life-shortening of X-rays is due to deletions. There might be stronger selection ~~for~~ against faults induced by X-rays than faults carried by population. — or not if spontaneous mutations are similar to X-ray caused mutations. —

If in man 100 r to each parent causes 1 fault ~~one~~ chromosome break are fault then 100 r would increase mut rate in faults 10 fold If, 100 r to baby parents just gives ~~1~~ (point) ~~off~~ which we have $\frac{1}{6}$ $\frac{1}{1.67}$ faults or $\frac{1}{10}$ faults

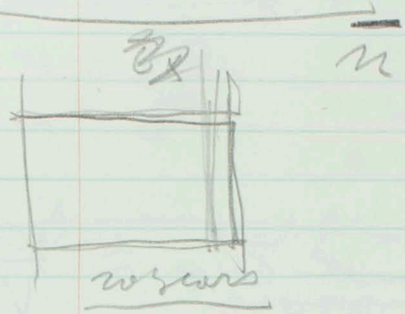
and $\frac{1}{10}$ faults are prod per gen then 100 r per gen ~~?~~ doubles mutation rate. —
(also producing one chrom break, means 1 fault, to somatic cells)

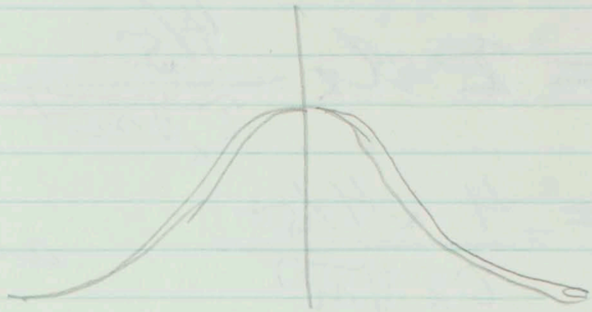
$n = 5$

0	1	2	3	4	5	6	7	8	9	
~~.00673~~ 0.00674	.03369	.08422	.14037	.17546	.17547 ~~.14622~~	.14622	.10444	.06528	.03627	
	.00674	.03369	.08422	.14037	.17547	.17547	.14622	.10444	.06528	
.00674	.04043	.11791	.22459	.31583	.35094	.32169	.25066	.16972	.10155	×1.042
.71	420	1260	2340	3290	3660	~~3080~~ 3360	2610	1770	1060	Σ 445
102½	98		89		80		71		62	Σx = 4.8
67	385	1190	2210	3100	3445	3170	2460	1670	1000	real × 0.945

10	11	12	13	14	15	
.01813	.00824	.00343	.00132	.00047	.00015	
.03627	.01813	.00824	.00343	.00132	.00047	
.05440	.02637	.01167	.00455	.00179	.00062	×1.042
566	275	123				
535	260	116				real × .945

Selection





$$\int n\,\phi(n)\,(n - n_0)\,\frac{\sigma_x}{20}\,dn = \text{loss}$$

$$\sigma_x = \frac{11}{\sqrt{n_0}}$$

$$\boxed{0.68\,\sqrt{n_0}}\quad \frac{\sigma_x}{20} = \text{rate}$$

$$\sigma_x = \frac{11}{\sqrt{n}}$$

0.8 ~~$\sqrt{n}$~~

$$2\times 0.68\,\sqrt{n_0}\,\frac{11}{20} = \frac{1}{10}$$

$$1.5\,\sqrt{n_0}\,\frac{\cancel{11}}{\cancel{20}} = \frac{20}{10\;11}$$

$$\cancel{11}\sqrt{n_0} = \frac{200}{10}$$

Offspring 30 to 40   95605
94080   ~~1 line~~

1000 to large

$$\frac{1}{2}\,10^{-2}\sqrt{n}\ \text{loss} = \frac{1}{10}$$

$\cancel{\sqrt{n}}\,\sqrt{n}\,\frac{\sigma_x}{20}$ is loss

$$\sqrt{n}\,\frac{11x}{11\;20} = \frac{40}{10}$$

Δ dead rube per unit time $\simeq d_x$ ~~Δ~~

~~$\frac{dy}{y}$~~ $= 2\, d_x \frac{4/5}{\tau_x \sqrt{n}}$

$\frac{\Delta}{d_x} = \frac{4 \times 4/5}{\tau_x \sqrt{n}}$ and $\tau_x = \frac{0.4}{\sqrt{n}} \frac{1}{d_x}$

0.5

$\left(\frac{dy}{y}\right) = \frac{4 \times 4/5\, d_x}{\sqrt{n}\, \frac{0.4}{\sqrt{n}}} = \frac{16\, d_x}{2}$

$= 8\, d_x$

$y = e^{\frac{t}{8}}$ $\frac{1}{8.5}$

$3.83/100$

8×3.83

Comparing mice and men

 treatment for men Δ $= M_1$ (man)

 M_2 (mouse)

$\left(\frac{M_1}{\tau_1} + n_1\right)^2 = 12\, m_1$

assuming equal number of faults for a given dose of X rays

$\left(\frac{M_2}{\tau_2} + n_2\right)^2 = 12\, m_2$

$\left(\frac{M_1}{\tau_1} + n_1\right)^2 = \frac{M_1}{\tau_1}\; 12\, m_1$

$\left(\frac{M_2}{\tau_2} + n_2\right)^2 = \frac{M_2}{\tau_2}\; 12\, m_2$

111

Height of binomial

$2n = \cancel{10}$
$n = \cancel{5}$

$\frac{252}{2^{10}} = \frac{252}{64 \times 64 \times 16}$

~~p_{10} 0.1251~~

~~0.2461~~

$\frac{252}{64 \times 16} = \frac{15.75}{64} = 0.244$

0.1725

$n = 4$ (16)

Proposition

$\frac{0.4}{\sqrt{n}}$ is change of area ~~per year~~ in τ_x years

~~deathrate~~ changes in $\sqrt{n}$ ~~years~~

$\frac{0.4}{\cancel{\tau_x \sqrt{n}}}$ is change of area per year

~~$\tau_x = \frac{11}{\sqrt{n}}$~~

~~ratio of deathrates~~

Height at maximum $= \frac{0.4}{\sqrt{n}} =$
$= P(m)$

$d_x^0(max)$ $\quad d_x \tau_x = \frac{0.4}{\sqrt{n}}$

$\frac{d \text{ Deathrate}}{dt}$ $= \frac{0.5 + \frac{0.4}{\sqrt{n}}}{0.5} = 1 + \frac{\frac{0.4}{0.5}}{\sqrt{n}}$

Δ deathrate per year $= \frac{d_x}{0.5} - \frac{d_x}{0.5 + \frac{0.4}{\tau_x \sqrt{n}}}$

$= \cancel{2}\left(d_x - \frac{d_x}{1 + \frac{4/5}{\tau_x \sqrt{n}}}\right)$

$$\frac{\cancel{2d_x}}{\dfrac{d_x}{0.5-\dfrac{d_x}{\tau\sqrt{n}}}} = \cancel{2}\left(0.5-\frac{d_x}{\tau\sqrt{n}}\right)$$

$$= 1-\frac{2d_x}{\tau\sqrt{n}}$$

$$\frac{2d_x}{\tau\sqrt{n}} = \frac{2d_x^2}{0.4} = 5d_x^2 = \frac{5\times 14.7}{10^4}$$

$$= \frac{73.5}{10^4} = \frac{0.73}{100}$$

$$\cancel{\frac{2\times 0.4}{\dfrac{0.4}{0.5-\dfrac{0.4}{\tau\sqrt{n}}}} = 2}$$

$$2\times\frac{\dfrac{0.4}{0.4}}{0.5-\dfrac{0.4}{\tau\sqrt{n}}} =$$

$$= 2\times\left(0.5-\frac{0.4}{\tau\sqrt{n}}\right) = \cancel{2\times 0}$$

$$= 1-2\times\frac{0.4}{\tau\sqrt{n}} = \boxed{1-\frac{2d_x}{n}}$$

$\cancel{7.69}/100$

7.66%

8.4% of base 0.83

160 years

$$e^{-\frac{t}{1.44\times 8.5}}$$

$$e^{-\frac{t}{12.25}}$$

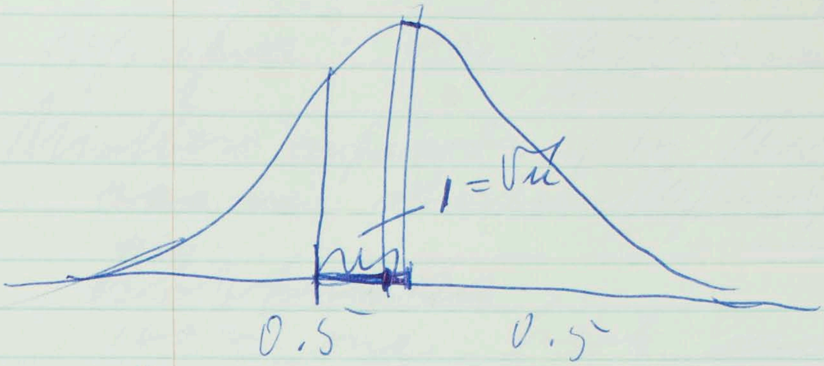
$$e^{-.08} = 1-\frac{7.7}{100} \quad e \quad \Vert$$

$$\left(8.15\%\right)$$

Should we raise d_x by saying $2d_x = 8\%$

$d_x =$

De Novo Jumpers $\vartheta_x = 3.83$



$\frac{d_x}{0.5}$

$\frac{d_x}{0.5} \quad \frac{d_x}{\tau_x} \quad \varepsilon_x$

$$\frac{e^{\frac{t}{\tau_{jump}}}}{e^{\frac{t-1}{\tau_{jump}}}} = e^{\frac{1}{\tau_{jump}}} \simeq 1 - \frac{1}{\tau_{jump}} \qquad \left(\frac{d_x}{0.5 - \frac{d_x}{\sqrt{n}} \cdot \frac{1}{\tau_x}} \right)$$

$$\boxed{\tau(x)\sqrt{n} = \frac{0.4}{d_x}} \qquad d_x \cdot \tau_x = \frac{0.4}{\sqrt{n}}$$

$\tau_x =$

$$\frac{d_x}{0.5 - \frac{(d_x)^2}{0.4}} \approx = 2\,\frac{d_x}{1 - \frac{5}{4}(d_x)^2}$$

$$= \left(\frac{1}{0.5}\right)^2 \frac{d_x}{1 - \frac{5}{4}(d_x)^2} \approx 4\, d_x$$

$$= 1 - \frac{5}{4}(d_x)^2 \qquad 1 - \frac{14.7}{100} \times \frac{5}{4} = 1 - \frac{18.5}{100}$$

$$2^{\frac{t}{8.5}} = e^{\ln 2 \frac{t}{8.5}} \quad e^{\frac{0.65\,t}{8.5}} = e$$

$$\varphi = e^{\frac{t}{12}}$$

if 100 r makes 1 mut
65 r makes 0.65 mutation

Life shortening
Müller 1 rep 0.1% of
life span $\frac{80 \times 365}{1000} \simeq$ ~~30000~~ 30 days! —
Muller reporting to Border James
~~200 r~~ shortens (4) ~~four~~ years

~~200~~
~~[illegible]~~
100 r one break ~~one~~ and if
probab of "fault" is 1/2 this
would give ~~8~~ years. —
$\frac{4 \text{ years}}{200}$ $\frac{1500 \text{ days}}{200}$ = 7.5 days
If ~~200 r makes~~ $\frac{1}{2}$. 4 (mutations — print)
those would not ~~make~~ give more
than say $\frac{4}{12} = \frac{1}{3}$ fault
Border James
1 r 5 days would give for three years =
= 1 "fault" ~~[illegible]~~. One fault takes 365 r
~~[illegible]~~ and if 50 r cause 1 mutation
this would be one/seventh of
mutations would be a fault

1 r 3 days would be about $\frac{1}{12}$ of
mutations a "fault"

1000 genes
333
1333 × 2 ≐ 2666 × 6 ≃ 16,000 genes
$\frac{1}{50000}$ – mut rate for Man 0.65/gen

Man

max at 80

$$= \frac{0.38026}{0.88045} =$$

lowering at 54th year
begin at 54th year

$\frac{d_x}{\beta}$ is independent

of cut off. —
Observed Comparison gives
us $\frac{d_x}{\beta}$

corrected max $d_x = 3670$ for age 40

β is corrected percentage of persons alive at 80.

	y	$100000 - y$
Alive at 40 –	94,080	5,920
45	92,725	7,275
at 50	90,685	9,315
at 55	87,699	12,301

Premature death concept.

β(40)

$$\begin{array}{r} 38.026 \\ 5.920 \\ \hline 43.946 = \beta \end{array}$$

β(45)

$$\begin{array}{r} 38.026 \\ 7.275 \\ \hline 45.301 = \beta \end{array}$$

β(50)

$$\begin{array}{r} 38.026 \\ 9.315 \\ \hline 45.341 = \beta \end{array}$$

β(55)

$$\begin{array}{r} 38.026 \\ 12.301 \\ \hline 50.327 \end{array}$$

Gompertzian again

β is Fraction surviving at age of maximal d_x

$$\frac{\frac{d_x}{\beta}}{\frac{d_x}{\beta - d_x}} = e^{\frac{1}{g}} = e^{\frac{\ln 2}{g^*}}$$

$$= 1 - \frac{1}{\beta} d_x$$

$n = 2.5$

$n = 3$

$n = 4$

$n = 5$

$$e^{-\frac{1}{g}} = e^{\frac{-1}{1.44 g^*}} = 1 - \frac{1}{\beta} d_x$$

$$e^{-\frac{1}{1.44 g^*}} \approx 1 - \frac{1}{1.44 g^*}$$

$$1.44 g^* \approx \frac{\beta}{d_x}$$

$n = 2.5$

.0821
2052
1282 $\frac{1}{2}$ 2565
.4155 = β

$n = 4.5$

.0111
.0500
.1125
.1687 $\frac{1}{2}$ .1898
.0949
.4372 = β

~~$n = 3$~~

~~.0498~~
~~1494~~
~~2240~~
~~4032 = β~~

$n = 3.5$

.0302
.1057
.1850
.1079 $\frac{1}{2}$ 2158
.4288 = β

$n = 16$

β = 1 − 5333 = .4667

natural point mut rate

$\frac{1}{50000}$	1000 genes 333 1333 genes (faults) 2666 " rec. lethals 16,000

$$\frac{2 \times 16000}{50000} = \boxed{0.64}$$ total point mut rate

$$= \frac{0.64}{12}$$ rate of faults"

50 r causes $\frac{1}{4}$ point ~~mut~~
or 128 r would double
mut rate
or 1 mutation for 200 r
given to both parents
life shortening

$\tau_x = \frac{11}{\sqrt{n}}$ $n = 5$ $\tau_x = 4.9$ y

$n = 25$ $\tau_x = 2.2$ years

$n = 16$ $\tau_0 = \frac{11}{4} = 2.75$ years

200 r one del.

$n = 5$ 5 years × 365 = 1800 days
1 r 9 days

$n = 25$ 2.2 years = 800 days = 1000 days
4 days 5 days/r

fewer deletions and
more substitutions give
fewer 11 days "/r

Upolar $\frac{1}{2}$

$\frac{1}{2}$

$\boxed{50\ r}$

Uniploidal

$\frac{1}{2}$ $\frac{1}{2}$

Uniploidal 50 r

$\frac{1}{4}$ point mut $\frac{1}{4}$ chrom

break

50 r to both parents

$\frac{1}{2}$ ~~dominance~~ ~~break~~ point mut

$\frac{1}{2}$ deletion

$4 \times 5 \times 10^{-3}$/r 100 r would cause $\frac{1}{2}$ point mut

T.D.)
(Puck. Proc. Nat. Acad. 1958

~~$\boxed{50\ r}$ another dominant break~~

$\frac{1}{2}$ cases no damage

$\boxed{\frac{1}{4} \text{ cases deletion}}$ – [illegible]

$\frac{1}{4}$ cases point mut – [illegible]

lethal $\frac{1}{4}$ $\frac{1}{6}$

faults $\frac{1}{4}$ $\frac{1}{6}$ $\frac{1}{2}$ of breaks

92 85.9 80

$n = 3.5$

0	1	2	3
.0302	.1057	.1850	.2158
		.0925	.1079
		1057	1850
		0302	1057
			0302
	0.05285	.2284	.4288
	0302		
	.08305	$\frac{18.5}{23}$	$\frac{0.5}{5.9} = 0.085$
	1.27	$\frac{0.81}{5.9} = \frac{13.7}{100}$	
	$\frac{21.5}{100}$		

$\tau_x = 5.9$ years

$\frac{2158}{4288} = 0.504 = \frac{0.504}{9.06} =$

89.5
6.5

8273
665
8948

82.73

$80 + \frac{3}{5.5}$ in conjunction with T.W. curve

(9.6) $n = 3$

89.5

0	1	2	3
.0498	.1494	.2240	.2240
.0249	.0747	.1120	1120
	0498	1494	2240
		0498	1494
			098
.0249	.1245	.3112	.5352
		2240	

$\tau_x = 5.5$

compute τ_x from q_x at 80

$\frac{.2240}{\tau_0 \times .3112} = \frac{\cancel{4.06}\ 10.83}{100}$

$\tau_0 = \frac{22.4}{\cancel{4.06}\ 10.83 \times .3112} = \cancel{7.7}\ \frac{.4}{2.92} =$ years

$\frac{.1494}{\cancel{7.7}\ 6.65 \times .1245} = \frac{18}{100}$

$\frac{498}{249} = \frac{2}{6.65}$ 6.65

$\frac{7.2}{6.65} = \frac{30\%}{}\ \frac{456}{400}$

$\tau = \frac{22.40}{53.52}\ \frac{1}{}\ \frac{2.06}{0.311} = \boxed{6.65}$

$\tau = \frac{0.42}{q} = \cancel{0.4}\ \frac{42}{7.53} = 5.6$ years

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New for τ_0 from ϕ_x above

for larger n

$$\frac{2}{\tau_0} \cdot \frac{0.4}{\sqrt{n}} = \frac{9.06}{100}$$

$$\tau_0 = \frac{0.4}{\sqrt{n}} \frac{100}{\frac{9.06}{2}} = \frac{0.4}{\sqrt{n}} \frac{100}{4.53}$$

~~$\frac{1}{\beta}\ \frac{1}{\%}\ P = \tau_0$~~

$$\frac{P(nn)}{\beta} \frac{100}{9.06} = \tau_0$$

for comp old
$\tau = \frac{.25.65}{3.67} = 7$

$n = 2.5$

$P_n = 0.2565$

$\beta = 0.4155 \qquad \frac{P_{nn}}{\beta} = 0.62$

$\tau_0 = \underline{6.82}$

$\boxed{21.88/3.67 = 5.9}$

$n = 3.5$

$P_{nn} = .2158 \qquad \frac{P_{nn}}{\beta} = 0.~~6175~~.5\ \frac{50.4}{9.06}$

$\beta = .42088$

$\tau_0 = \underline{5.55}$

$\boxed{\frac{18.98}{3.67} = 5.17}$

$n = 4.5$

$P_{nn} = 0.1898 \qquad \frac{P_{nn}}{\beta} = .4350$

$\beta = 0.4372$

$\tau_0 = \frac{43.50}{9.06} = \underline{4.8}$

$\boxed{\frac{13.00}{3.67} = 3.54}$

$n = 9.5$

$P_{nn} = 0.1300 \qquad \frac{P_{nn}}{\beta} = .2845$

$.4569 = \beta$

$\tau_0 = 3.14$

$\left(\begin{array}{l} n = 25 \\ n = \infty \end{array}\right) \tau_0 \frac{2 \times .4}{\sqrt{n}} \frac{\times 100}{9.06} = \frac{80}{5} \frac{1}{9.06} = 1.765$ years

$$e^{-\frac{\left(\frac{80}{\tau}+n\right)^2}{4m}}$$

$$\left(\frac{80}{\tau}+n\right)^2 = 10\,m$$

$n = 2.5 \quad \tau = 7$

~~$n = 25 \quad \tau = \frac{11}{5} = 2.2$~~

$$\frac{\left(\frac{80}{\tau}+n\right)^2}{4m}$$

$$\frac{\left(\frac{40}{\tau}+n\right)^2}{4m}$$

$$\frac{\left(\frac{80}{\tau}+n\right)^2 - n^2}{\left(\frac{40}{\tau}+n\right)^2 - n^2} = \frac{196-6}{60}$$

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$$e^{-\frac{2.5}{3}}$$

$$e^{-0.8}$$

11.4
2.5
14

5.7
2.5
8.2

$n = 25 \quad \tau = 2.2$

$\frac{80}{2.2} = 36.3$
25
61.3

(61.3

$\frac{40}{2.2} = 18.2$
25
43.2

3750
− 625
3125

1850
625
1.225

$$2.53 \quad \frac{\cancel{3760}}{\cancel{1225}} \left(\frac{3125}{1225}\right)$$

$$\frac{1}{e}$$

for 40 years

$$\boxed{\sqrt[3]{e} \sim 1.4}$$

of death at

$(\;)^2 = 4m$

multiple age
correction above 71.5%

τ_0 from ratio's of $\underline{\psi x}$;

$n = 3.5$	0	1	2	$\boxed{3}$	4	5
	.0302	.1057	.1850	.2158	.1888	.1322
			.0925	1079	.0944	0661
			1057	1850	2158	0944
			302	1057	1850	661
				0302	1057	
					.0302	
			.2284	.4288	.6311	.7915

.0661
1888
2158
1850
1057
.0302

5096
220

.7916

ratio

0.81 | 0.502 | 0.298 | .167

$\frac{81}{50} = 1.64$

$\frac{.502}{.356} = 1.68$

1,78

80 to 81

80 to 81

14.7

14.7

$\tau_0 = \underline{5.5}$ as Anklund II

13.96
15.14
29.10/2 = 14.5

$n = 2.5$

0	1	2	3	4
.0821	.2052	.2565	.2138	
	1026	1282	4155	
	0821	2052	1282	
		0821	1069	
	.1847	.4155	.6406	

$\tau_0 \psi x$	1.11	0.62	.334

1.8   1.85

$\frac{9.06}{1.4} = 6.5$

76.5 77.5

to comp 80 8

$\tau_0 = 3.5$

$f_1 = \frac{17.2}{100}$

87.5 to 88.5

1640
1775
3415/2 = 1707

~ 7.5 years $= \tau_0$

$e^{-\ln 2 \frac{t}{g^*}}$ $e^{+\ln 2 \frac{7.5}{g^*}} = 1.8$

g^*

$\ln 2 \frac{7.5}{g^*} = 0.58779$

$g^* = \frac{1}{1.44} \frac{7.5}{0.58779} = \frac{7.5}{0.85}$

$\boxed{g^* = 8.8 \text{ years}}$

~~Also~~ σ_x(max) has to be reduced

from ~~4~~ $\frac{3.67}{100}$ by factor $\frac{11.1}{9.8} = 1.13$

factor could be $\frac{11.1}{9.32} = 1.18$

$(11.1)^2 - (5)^2 = (\sqrt{96})^2 = (9.8)$

~~1.15~~

$\boxed{1.19}$ or take

$\begin{array}{r} 121 \\ -25 \\ \hline 96 \end{array}$ Is it 5 years?

~~By~~ Sisters mean abs. difference corrected for id twins is 5.65

to correct for ages below 60
$5.65 \times 1.32 = 7.45$

~~to get~~ to get st. dev divide $\frac{1}{1.13}$

$\frac{7.45}{1.13} = 6.6$ stand. dev for sister for genetic

reasons –
for whole pop.

~~st dev whole pop~~ ~~[illegible]~~ $6.6 \sqrt{2} = \boxed{9.32}$
(genetic)

$(11.1)^2 - (9.32)^2 = (5.8)^2$
$121 - 87 = 34$

5.8 ~~[illegible]~~ non genetic
scatter

or if we took 11.6 ~~.98~~
$(11.6)^2 - (9.32)^2$
$= (6.85)^2$
$\frac{11.6}{9.32} = 1.245$ ~~34~~

$e^{-\frac{2}{}} = \quad n = 2.5$

Middle age

$e^{-\frac{2}{3}} = \frac{1}{1.95} \cong \frac{1}{2}$ .51

$n = 25$ $\quad e^{-\frac{2}{2.5}} = \frac{1}{2.23}$ .45

$e^{-2} = \frac{1}{7.4} = 13\frac{1}{2}\%$ ✓

Chinese Hamsters $n:10$
J. Yerganian, Children's Hosp Boston.

Correction of $\bar{\varepsilon}$

If non genetic scatter is 5 years" and total scatter is 11.1 years (Cady

[mean diff corresp. to 11.1 is p.92]

11.1 × 1.13 = 12.45 years. comp with T.W. estimate abridged life tables 5 years intervals finds 13.33 for whole life 10.2 for deaths above 60.]

Ratio $\frac{13.33}{10.2} = 1.32$

Joe Hin Tjio
10th Int Congress at Montreal
Genetics 1958

X chromosome

$$\frac{6.3\%}{1.063} = 5.94\%$$

Y chromosome $$\frac{2\%}{1.02} - 1.96\%$$

$$\begin{array}{r} 5.94 \\ -\ 1.96 \\ \hline 3.98 \end{array}$$

4% of haploid uncovered by other chromosomes

$$\left(\frac{80}{\tau}+3\right)^2 - \cancel{x^2} = 2 \times 4 \times 23$$

or $3 \times 4 \times 23$

$$\tau = \sqrt{2 \times 4 \times 23} -$$

$$\tau_2 = \frac{\sqrt{2 \times 4 \times 23} - 2}{80} = \frac{80}{13.5 - 2}$$

$$\tau_3 = \frac{\sqrt{3 \times 4 \times 23} - 2}{80}$$

$$t_3 = \frac{80}{16.6 - 2}$$

$$\left(\frac{80}{\tau} + n\right)^2 = 8\,m_1$$

$n = 3.5$

$\boxed{\tau = 5}$

$$\left(\frac{80}{\tau} + n\right)^2 = 12\,m_2$$

$\boxed{\tau = 3}$

1) $\left(\frac{80}{\tau} + n\right)^2 = 8\,\frac{3 \times 14}{\tau}$

2) $\left(\frac{80}{\tau} + n\right)^2 = 12\,\frac{3 \times 14}{\tau}$

$n = 6$

$\approx \frac{(80+1 \cdot n)^2}{8 \times 3.14} = \tau$

$\approx \frac{(80 + 3)^2}{12 \times 3 \times 14} = \tau$

$n = 2.5 \quad \tau_1 = 6$

$(95)^2 = \frac{9000}{6 \times 14 \times 3} = \tau$

$$\left(\frac{80}{\tau} + n\right)^2 - n^2 = 24\,m$$

$13.3 + 2.5 = 15.8$

$250 = 24\,m$

$m = 23$

10.2

$z = 2.7$

$m = 25$

τ

$\frac{0.4}{\text{st. dev}} = \frac{0.4}{9.32} = 0.043$

How much corr. for workers?

2 x fraction dying between 40 and 60 of those dying after 40 multiplied with

20 =

~~at~~ above 60 dying 83,279

of those above at 40

$\left(\frac{0.83279}{0.94080}\right)^2 = (.885)^2$

$20 \quad 0.22 + 0.78 \times 6.2$

$4.4 + 4.84 = 9.24$

$\frac{9.24}{6.2} = 1.49$

father

$0.22 - [1 - .885]^2$

$\cancel{1.32} \quad .115$

0.22
$- 1.32$
$0.20\ 0.68$

$20 \times 0.20 + 4.84 =$
$= 8.84$

$\frac{8.84}{6.2} = 1.45$

T.W. 1.32

workers corr.

$\frac{5.65}{5.65 \times 1.32} = 7.45$

$7.45 \times \sqrt{2} = 10.5$

$\frac{10.5}{1.13} = 9.32$ st. dev whole pop. females origin.

H

set $n = 3$

$\tau = \frac{22.4}{3.675} \frac{1}{1.18} = 6.1 \frac{1}{1.18} = \underline{5.17}$

$\left(\frac{80}{\tau} + 3\right)^2 - 3^2 = A \times 4 \times 23$

$\frac{\left(\frac{80}{5.17} + 3\right)^2 - 3^2}{4 \times 23} = A = \frac{342 - 9}{4 \times 23} = \frac{333}{92} \cong 3.6$

15.5

$\left(\frac{80}{\tau} + n\right)^2 - n^2 = A \times 4 \times m$

$m = 3 \times 23$

$\tau = \frac{0.4}{\sqrt{n}} \frac{\times 100}{3.67 \times 1.18} = \frac{9.25}{\sqrt{n}}$

$\left(\frac{80}{9.25}\sqrt{n} + n\right)^2 - n^2 = A\,4m$

$\tau\,(\text{for } n = 6) = 3.77$

$\sqrt{6} = 2.45$

$75n + 17.3\, n\sqrt{n} = A\,4m$

$m = \underline{46}$

$\frac{75n + 17.3\, n\sqrt{n}}{184} = A$

$2.5 \times 4 \times 69 = 690$

$\boxed{n = 6}$

250

$\frac{700}{115} = 9$ 450 | 703

$3 \times 184 = 550$

$n = 6$

75×6 | $525 + 14.7 \times 17$

450

1 hit 1/2 chromosome

$\begin{array}{r} 250 \times \\ 700 \\ \hline 550 \end{array}$

$\tau = \frac{0.4}{\sqrt{n}} \frac{1}{4.3} = 9.3$

$\boxed{\text{or } A = 3.8}$

$n = 6$

$\boxed{3.8 \text{ years}}$

Trouble not the old people
no time because busy getting unlocked

Russia

old shoe 25 year old hole
new shoe - pinches.
we are attached rage

Sacher George
Radiology Vol 67 p. 250 - 258
1956
life shortening $10^{-4}/r$
80 year 20,000 years
3 days/r

Mole ; Harwell

female ~~identical~~ non twins $\frac{148.6}{2} = \frac{74.3}{12} = 6.2$

" " " $\frac{62.3}{2} = 31.1 = 2.6$ years

79.1
69.5

30.7
31.6

$(2.6)^2 + x^2 = (6.2)^2$

$6.75 + x^2 = 38.5$

$x^2 = \sqrt{31.75^2} = 5.65$

38.5
6.75
31.75

Poisson for $n = 2.5$

0	.0821
1	.2052
2	.2565
3	.2138
4	.1336
5	.0668
6	.0278
7	.0099
8	.0031
9	.0009
10	.0002

~~Muller in this book?~~

p. 106

p. 49

p. 60, 61, 62 63

Superimposed for $n = 4$ p. 46

College outline series.
Tables for Statisticians
Barnes & Noble Inc. N.Y.

Handbook of Probab & Statistics
Burlington & May
Handbook Publishers Inc., Sandusky, Ohio

Poisson!
4

r				
0	0.0183	4	0.073 × 0	0.000
1	0.0733	3	0.220 × 1	0.221
2	0.1465	2	0.293 × 2	0.586
3	0.1954	1	0.195 × 3	0.585
4	0.1954	0	0.000 × 4	
5	0.1563	1	0.156 5	
6	0.1042	2	0.208 × 6	
7	0.0595	3	0.180 × 7	
8	0.0298	4	0.120 × 8	
9	0.0132	5	0.066 × 9	
10	0.0053	6	0.032 × 10	
11	0.0019	7	0.014 × 11	
12	0.00064	8	0.005 × 12	
13	0.0002	9		
14	0.000056	10	—	
15				
16				
17				

4 $P(r+1) \times \left(1 - \frac{F}{20} \times 1\right)$

$$S' = \sum_r P(r)\left(1 - \frac{F}{20}(r-n)\right) = 1 + \sum_0^3 - \sum_5^\infty$$

$$S_1 = \sum_r P(r)\left[1 - \frac{F}{20}(r-n)\right] r = 4 + \sum_0^3 - \sum_5^\infty$$

The Gaussian

$$df = \frac{1}{\sigma\sqrt{2\pi}}\, e^{-\frac{1}{2}\frac{(x-x_0)^2}{\sigma^2}}\, dx$$

σ is the stand dev.