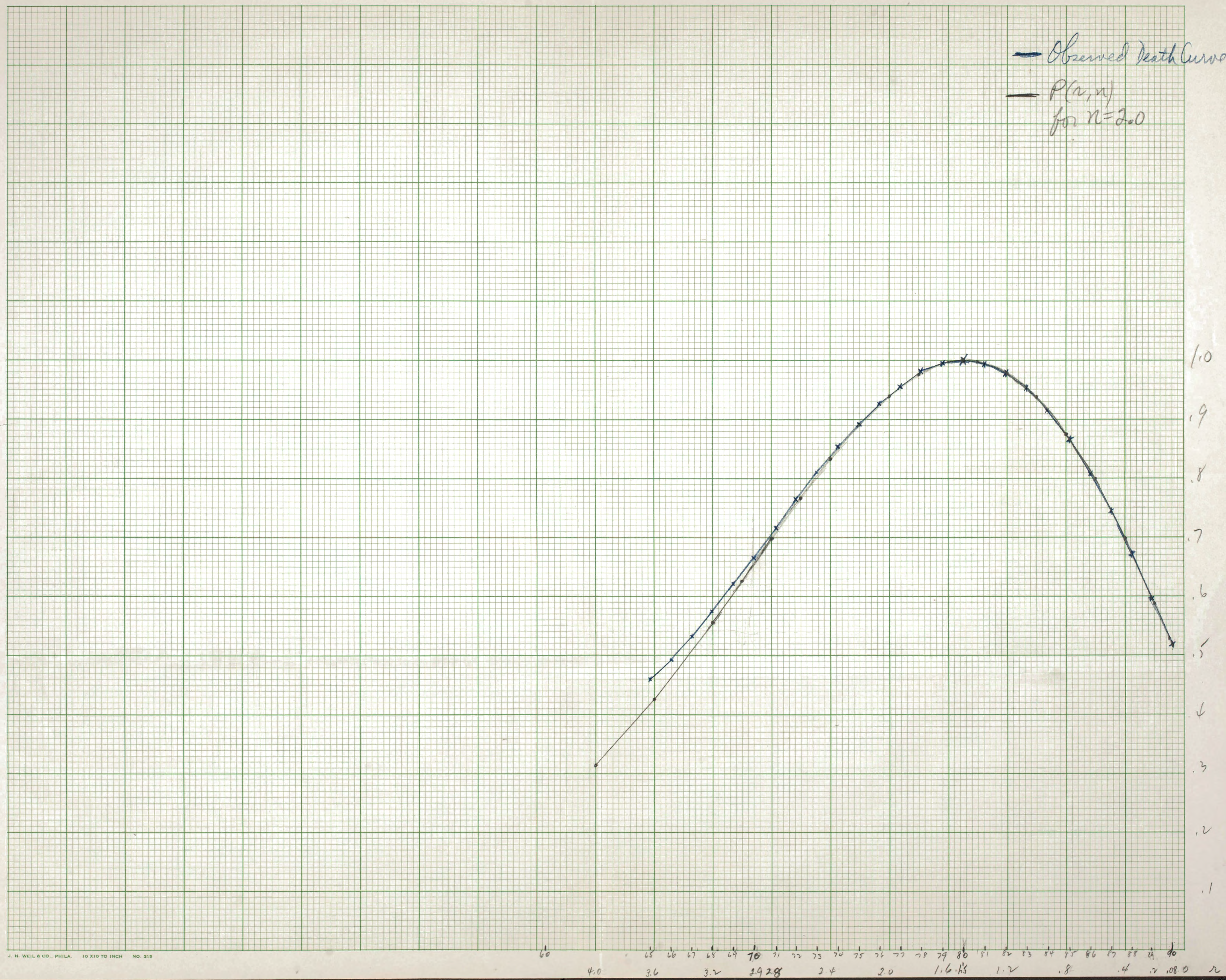
— 26

UNIVERSITY OF..
COLORADO
"Buffaloes"

UNIVERSITY OF COLORADO
ΛΑΜΨΑΤΩ ΤΟ ΦΩΣ ΥΜΩΝ
1876



Observed Death Curve
P(r, n) for n=2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
60
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
4.0
3.6
3.2
2.9 2.8
2.4
2.0
1.6 1.5
1.2
.8
.4
.2
.08 0
r
J. H. WEIL & CO., PHILA. 10 X10 TO INCH NO. 315

at constant f

H

$$\frac{-dr}{dx} = 1 - \frac{x+2r}{4m} + \frac{r}{x} - \left(\frac{1}{2} + \frac{r}{x}\right)\}^2$$

$$-dx = \frac{dr}{1 - \frac{x+2r}{4m} + \frac{r}{x} - \left(\frac{1}{2}+\frac{r}{x}\right)\left(\frac{x}{2m}\right)^2}$$

$x = 13.5$
$r = 2$

$$\frac{dr}{dx} = 1 - \frac{17.5}{92} + \frac{2}{13.5} - \left(\frac{1}{2}+\frac{2}{13.5}\right)\left(\frac{13.5}{46}\right)^2$$

$1 - 0.190$ $\quad 0.148$ $\quad 0.5 + 0.148$ $\quad 0.0862$

-0.056
190
$.246$
$-.148$
$.098$
902

$$\frac{dr}{dx} = 0.9$$

$x = 10.5$
$r = 5$

$$\frac{dr}{dx} = 1 - 0.223 + 0.475 - 0.051$$

051
-0.274
1.2

475
274

Correcting 8.12 years (obs

$$(8.12)^2 - (3.4)^2 = (7.35)^2$$

$$\begin{array}{r} 65.7 \\ -\cancel{11.5} \\ \hline \cancel{57.8} \quad 54.2 \end{array}$$

~~AAAA~~ $\boxed{\Delta_{40}(\text{gen}) = 7.35 \text{ years}}$

for $n = 2.5$. —

$7.35 = \tau$ Diff $(2n = 5)$ $= \tau \times 1.19$

$$\tau = \frac{7.35}{1.19} = 6.17 \text{ years}$$

or Approx. $\tau = \dfrac{7.35}{1.26} =$

Surviving fraction:

$$f = \left[1 - (1-e^{-\xi})^2\right]^m \cdot \left[1 - e^{-\xi} + e^{-2\xi}\right]^r$$

first factor can be written:

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

First term is probab that either chrom. A had a hit and B did not or vice versa. Second term is probability that neither A nor B had a hit.

Second factor
first term is prob. that the chromosome which contains a fault was hit before; Second term is probability that it was not hit before and that homologous chromosome was not hit either. —

approx

$$\ln \frac{1}{f} = m(\xi^2 - \xi^3) + r(\xi - \xi^2)$$

NORM

n, t_{max}, D_{max}

D(t) normal

2.5000000E 00	7.6469400E 01	~~2.4915493E-01~~
50	3.8422665E-02	
52	6.5205902E-02	
54	1.0413067E-01	
56	1.5740431E-01	
58	2.2631823E-01	
60	3.1077312E-01	
62	4.0891697E-01	
64	5.1698459E-01	
66	6.2939242E-01	
68	7.3911027E-01	
70	8.3828657E-01	death rate
72	9.1905258E-01	
74	9.7440957E-01	
76	9.9907550E-01	= 0.9990755
78	9.9016858E-01	
80	9.4762719E-01	
82	8.7430176E-01	
84	7.7568880E-01	
86	6.5934557E-01	
88	5.3405411E-01	
90	4.0884727E-01	

$\times 10^1$ age of max

3.0000000E 00	7.5252924E 01	~~2.2740823E-01~~
50	4.9894089E-02	
52	8.3223771E-02	
54	1.3051698E-01	
56	1.9360249E-01	
58	2.7298745E-01	
60	3.6741514E-01	
62	4.7363079E-01	
64	5.8642385E-01	
66	6.9897420E-01	
68	8.0347563E-01	
70	8.9195856E-01	
72	9.5719419E-01	
74	9.9355643E-01	
76	9.9770949E-01	
78	9.6902547E-01	
80	9.0966729E-01	
82	8.2433378E-01	
84	7.1970563E-01	
86	6.0367020E-01	
88	4.8444391E-01	
90	3.6970556E-01	

3.5000000E 00	7.3800515E 01	~~2.1089488E-01~~
50	6.8924233E-02	
52	1.1184736E-01	
54	1.7066629E-01	
56	2.4634720E-01	
58	3.3806100E-01	
60	4.4288911E-01	
62	5.5583405E-01	
64	6.7016535E-01	
66	7.7806416E-01	
68	8.7147838E-01	
70	9.4305706E-01	
72	9.8702029E-01	
74	9.9984082E-01	
76	9.8063117E-01	
78	9.3120077E-01	
80	8.5577925E-01	
82	7.6046561E-01	
84	6.5249124E-01	
86	5.3940922E-01	
88	4.2831911E-01	
90	3.2522613E-01	

TABLE 6. LIFE TABLE FOR WHITE FEMALES: UNITED STATES, 1949-51

YEAR OF AGE	PROPORTION DYING	OF 100,000 BORN ALIVE		STATIONARY POPULATION		AVERAGE REMAINING LIFETIME
Period of life between two exact ages stated	Proportion of persons alive at beginning of year of age dying during year	Number living at beginning of year of age	Number dying during year of age	In year of age	In this year of age and all subsequent years	Average number of years of life remaining at beginning of year of age
(1)	(2)	(3)	(4)	(5)	(6)	(7)
x to $x+1$	q_x	l_x	d_x	L_x	T_x	$\mathring{e}_x$
0-1	0.02355	100,000	2,355	97,965	7,203,179	72.03
1-2	.00189	97,645	185	97,552	7,105,214	72.77
2-3	.00112	97,460	109	97,406	7,007,662	71.90
3-4	.00087	97,351	85	97,308	6,910,256	70.98
4-5	.00069	97,266	67	97,233	6,812,948	70.04
5-6	.00060	97,199	59	97,169	6,715,715	69.09
6-7	.00053	97,140	52	97,114	6,618,546	68.13
7-8	.00048	97,088	46	97,065	6,521,432	67.17
8-9	.00044	97,042	43	97,020	6,424,367	66.20
9-10	.00041	96,999	39	96,980	6,327,347	65.23
10-11	.00040	96,960	39	96,940	6,230,367	64.26
11-12	.00039	96,921	38	96,903	6,133,427	63.28
12-13	.00041	96,883	39	96,863	6,036,524	62.31
13-14	.00043	96,844	42	96,823	5,939,661	61.33
14-15	.00048	96,802	46	96,779	5,842,838	60.36
15-16	.00053	96,756	52	96,730	5,746,059	59.39
16-17	.00059	96,704	57	96,676	5,649,329	58.42
17-18	.00063	96,647	61	96,617	5,552,653	57.45
18-19	.00067	96,586	65	96,553	5,456,036	56.49
19-20	.00070	96,521	67	96,488	5,359,483	55.53
20-21	.00073	96,454	71	96,418	5,262,995	54.56
21-22	.00076	96,383	73	96,347	5,166,577	53.60
22-23	.00079	96,310	77	96,271	5,070,230	52.65
23-24	.00082	96,233	79	96,193	4,973,959	51.69
24-25	.00085	96,154	82	96,113	4,877,766	50.73
25-26	.00088	96,072	85	96,029	4,781,653	49.77
26-27	.00092	95,987	88	95,943	4,685,624	48.82
27-28	.00096	95,899	93	95,853	4,589,681	47.86
28-29	.00102	95,806	97	95,757	4,493,828	46.91
29-30	.00108	95,709	104	95,657	4,398,071	45.95
30-31	.00115	95,605	109	95,551	4,302,414	45.00
31-32	.00122	95,496	117	95,437	4,206,863	44.05
32-33	.00131	95,379	125	95,316	4,111,426	43.11
33-34	.00140	95,254	134	95,187	4,016,110	42.16
34-35	.00150	95,120	143	95,049	3,920,923	41.22
35-36	.00161	94,977	153	94,901	3,825,874	40.28
36-37	.00173	94,824	164	94,742	3,730,973	39.35
37-38	.00188	94,660	178	94,571	3,636,231	38.41
38-39	.00204	94,482	193	94,386	3,541,660	37.48
39-40	.00222	94,289	209	94,184	3,447,274	36.56
40-41	.00242	94,080	227	93,967	3,353,090	35.64
41-42	.00263	93,853	248	93,729	3,259,123	34.73
42-43	.00287	93,605	269	93,471	3,165,394	33.82
43-44	.00314	93,336	292	93,190	3,071,923	32.91
44-45	.00342	93,044	319	92,884	2,978,733	32.01
45-46	.00373	92,725	345	92,553	2,885,849	31.12
46-47	.00406	92,380	376	92,192	2,793,296	30.24
47-48	.00442	92,004	406	91,801	2,701,104	29.36
48-49	.00480	91,598	440	91,378	2,609,303	28.49
49-50	.00519	91,158	473	90,922	2,517,925	27.62
50-51	.00561	90,685	509	90,430	2,427,003	26.76
51-52	.00609	90,176	548	89,902	2,336,573	25.91
52-53	.00662	89,628	594	89,331	2,246,671	25.07
53-54	.00721	89,034	642	88,713	2,157,340	24.23
54-55	.00784	88,392	693	88,045	2,068,627	23.40

start here

TABLE 6. LIFE TABLE FOR WHITE FEMALES: UNITED STATES, 1949-51—Continued

YEAR OF AGE	PROPORTION DYING	OF 100,000 BORN ALIVE		STATIONARY POPULATION		AVERAGE REMAINING LIFETIME
Period of life between two exact ages stated	Proportion of persons alive at beginning of year of age dying during year	Number living at beginning of year of age	Number dying during year of age	In year of age	In this year of age and all subsequent years	Average number of years of life remaining at beginning of year of age
(1)	(2)	(3)	(4)	(5)	(6)	(7)
x to $x+1$	q_x	l_x	d_x	L_x	T_x	$\mathring{e}_x$
55-56	0.00853	87,699	749	87,324	1,980,582	22.58
56-57	.00931	86,950	809	86,546	1,893,258	21.77
57-58	.01019	86,141	878	85,702	1,806,712	20.97
58-59	.01117	85,263	952	84,787	1,721,010	20.18
59-60	.01224	84,311	1,032	83,795	1,636,223	19.41
60-61	.01340	83,279	1,116	82,721	1,552,428	18.64
61-62	.01468	82,163	1,206	81,560	1,469,707	17.89
62-63	.01608	80,957	1,302	80,307	1,388,147	17.15
63-64	.01752	79,655	1,395	78,957	1,307,840	16.42
64-65	.01900	78,260	1,487	77,517	1,228,883	15.70
65-66	.02063	76,773	1,584	75,981	1,151,366	15.00
66-67	.02255	75,189	1,695	74,341	1,075,385	14.30
67-68	.02489	73,494	1,830	72,579	1,001,044	13.62
68-69	.02764	71,664	1,981	70,674	928,465	12.96
69-70	.03069	69,683	2,138	68,614	857,791	12.31
70-71	.03409	67,545	2,303	66,393	789,177	11.68
71-72	.03786	65,242	2,470	64,007	722,784	11.08
72-73	.04201	62,772	2,638	61,453	658,777	10.49
73-74	.04650	60,134	2,796	58,736	597,324	9.93
74-75	.05130	57,338	2,941	55,868	538,588	9.39
75-76	.05650	54,397	3,074	52,860	482,720	8.87
76-77	.06221	51,323	3,193	49,726	429,860	8.38
77-78	.06851	48,130	3,297	46,482	380,134	7.90
78-79	.07536	44,833	3,379	43,144	333,652	7.44
79-80	.08271	41,454	3,428	39,740	290,508	7.01
80-81	.09060	38,026	3,446	36,303	250,768	6.59
81-82	.09912	34,580	3,427	32,866	214,465	6.20
82-83	.10831	31,153	3,374	29,466	181,599	5.83
83-84	.11814	27,779	3,282	26,138	152,133	5.48
84-85	.12857	24,497	3,149	22,923	125,995	5.14
85-86	.13965	21,348	2,982	19,857	103,072	4.83
86-87	.15146	18,366	2,781	16,975	83,215	4.53
87-88	.16407	15,585	2,557	14,306	66,240	4.25
88-89	.17748	13,028	2,312	11,872	51,934	3.99
89-90	.19168	10,716	2,054	9,688	40,062	3.74
90-91	.20657	8,662	1,789	7,767	30,374	3.51
91-92	.22220	6,873	1,528	6,109	22,607	3.29
92-93	.23851	5,345	1,274	4,708	16,498	3.09
93-94	.25573	4,071	1,041	3,551	11,790	2.90
94-95	.27387	3,030	830	2,614	8,239	2.72
95-96	.29261	2,200	644	1,878	5,625	2.56
96-97	.31159	1,556	485	1,314	3,747	2.41
97-98	.33050	1,071	354	894	2,433	2.27
98-99	.34954	717	250	592	1,539	2.15
99-100	.36895	467	173	381	947	2.03
100-101	.38839	294	114	237	566	1.92
101-102	.40752	180	73	143	329	1.83
102-103	.42600	107	46	84	186	1.74
103-104	.44367	61	27	48	102	1.66
104-105	.46076	34	16	26	54	1.59
105-106	.47750	18	8	14	28	1.53
106-107	.49417	10	5	7	14	1.46
107-108	.51100	5	3	4	7	1.40
108-109	.52810	2	1	2	3	1.34
109-110	.54529	1	0	0	1	1.29
110-111	.56243	1	1	1	1	1.24

.0134
.0145
667
.0409
3.446
1.65
=2.09
.520
.0013

NOTE.—Proportions dying at ages above 92 are not based on actual statistics at these ages. Therefore, proportions dying and other life table functions based on them at these ages may not necessarily represent actual conditions.

Dr. Szilard Dupont Plaza

Against Leblond theory

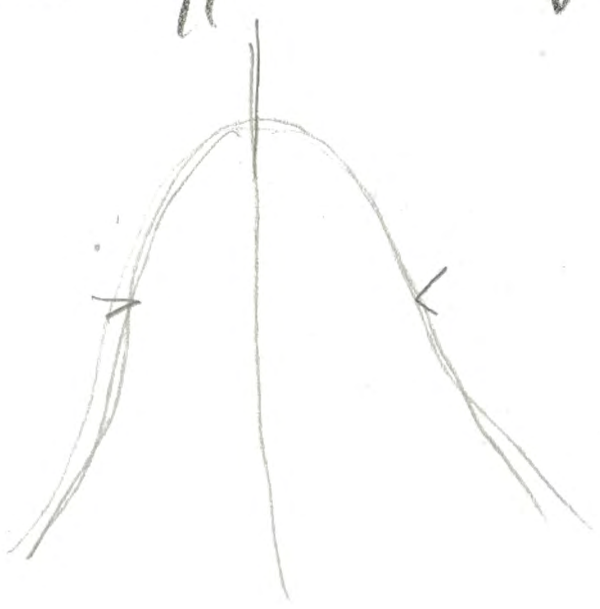
Lemma:

DNA

Fujikawa & Sibatani

Experientia Vol 10 p. 176 1954

Growing rats' DNA in liver is not "turning over"



J. Fabella Radiology Vol 69 1957
p. 22

NAS. 10 r to gonads in
whole pop. =
give a mutation ~~in~~ in 1 child out
of 20. —
doubling natl. mutation
rate would take 30 to 80 r per gen

Russel Proc. Nat. Acad. of Sc. Jan 57.
offspring — sensitive male Vol 43 p. 324/57
from mice 0.61 per r [mutations]
given to father
for man 20 days / per r

individual mice, mutations
percentage shortening 0.078% per r

Schubert & Lapp say 2.5 days / r

R F Kallman) Science Vol 128 / 58 p. 301
H. S Kahn
300 r in single dose 42 days / 100 r. Kaps

MacMillan & Co Ltd
St Martin's Street, London. W.C.2
Tel (Phusis Lesquare London)
Whitehall 8831

Spontaneous mut in Man

20,000 genes rate $\frac{1}{50\,000}$

$\frac{20\,000}{50\,000} = \frac{2}{5}$

total

$\cancel{\frac{2}{5} \times 2} \quad \frac{2}{5} \times 2 = \frac{4}{5} = 0.8$

of these $\frac{1}{6}$ ~~3333~~ 3333 are rec lethal, and say 1000 general faults

333 ~~for~~ organ specific faults

or ~~200~~ $\frac{1333}{20000} = \frac{1}{14.6}$ is fault

If ~~50~~ 75 ~~(illegible)~~ to both parent causes 1 mutation

If ratio causes 1 Somatic mut

5 years = $75 \times 14.6 = 1100$ r.

5 year = $5 \times 365 = 1800$ days

1100 r causes 1800 days

or $\frac{1800}{1100}$ per r = 1.6 days/r

~~If doubling of mut. rate is 50 r / gen and half of these are needed auto then doubling of point rate~~

Doubling dose of mut rate if given for both parents D_0.
D_0 would shorten life by $n\tau_x$

$$\frac{n\tau_x}{l} = 3 \text{ years permissible} \quad \frac{D_0}{l}$$

$$l = \frac{n\tau_x}{3} \qquad \tau_x = \frac{1}{\alpha_x}\frac{0.4}{\sqrt{n}}$$

$$l \simeq \cancel{\frac{\sqrt{n}}{3}\frac{0.4}{\alpha_x}} \quad \frac{n}{3}\frac{0.4}{\alpha_x}\frac{1}{\sqrt{n}} = \frac{0.4}{\alpha_x}\frac{\sqrt{n}}{3}$$

$$\alpha_x \approx \frac{3.83}{100}$$

$$l \approx \frac{40}{3.83}\frac{\sqrt{n}}{3} \approx \frac{10}{3}\sqrt{n}$$

$n = 4$ $l =$ 6.66

$n = 25$ $l = 16.6$

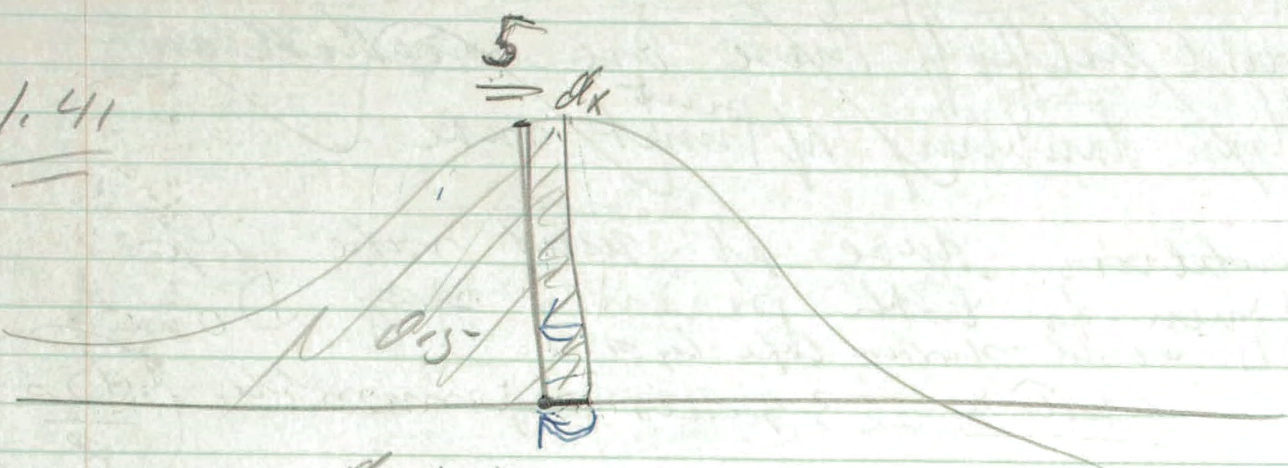
$D_0 = 50$

$D_0 = 7.6$ r

$D_0 = 3$ r

Assume 100 r 1 break; 1 point mut.

1.41



$$\frac{dx}{0.5}$$

$= 1 - {}^{8}$

$$\frac{0.4}{\tau\sqrt{n}} \quad dx$$

$$0.5 - \left(\frac{0.4}{\tau\sqrt{n-1}}\right) = dx_{\cdot 1}$$

$$\text{Ratio} = 2\left(0.5 - \frac{0.4}{\tau\sqrt{n}}\right)$$

$$2(0.5 - d_x)$$

$$1 - 2\,dx$$

$$q = e^{\frac{t}{g}}$$

$$\frac{q'}{q^2} = e^{\frac{1}{g}} \qquad e^{-\frac{1}{g}} = 1 - 2dx$$

$$\frac{q\,e^{\frac{t_1}{g}}}{q_2\,e^{\frac{t_2}{g}}}$$

$$\frac{2\,345}{90}$$

$$\frac{e^{\frac{t+1}{g}}}{e^{\frac{t}{g}}} = e^{\frac{1}{g}}$$

$366 = 382$

$.766$

$$2^{\frac{t}{g^*}}\,e^{\frac{t}{g}}$$

$$e^{\frac{+1}{g}} = 1 + \frac{7.66}{100}$$

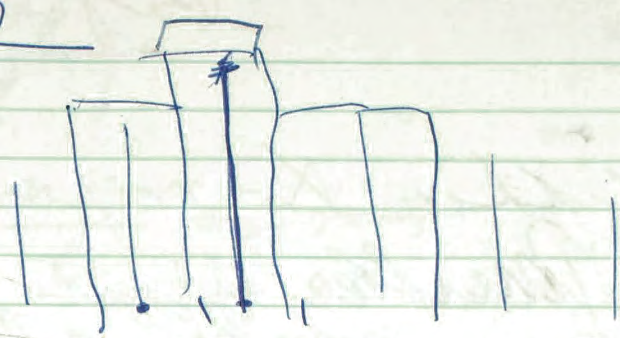
$$e^{\frac{1}{g}} = 1 + \frac{1}{g} + \frac{1}{2g^2} = \frac{7.66}{100}$$

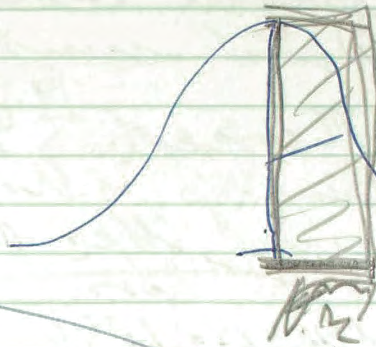
$$e^{\frac{\ln 2}{g^*}} = \frac{1}{g} \quad g^* = \frac{g}{\ln 2} \quad g = \frac{g}{1.44} \quad g = \frac{100}{7.66} = 13 \qquad g\,\frac{1}{1.44} = g^* = 9$$

Carly

τ_0*

4





$$P(n) = \frac{n^n}{n!} e^{-n}$$

$$\boxed{d_x = \frac{P(n)}{\tau_0}} \ll \frac{0.4}{\sqrt{n}} \quad (n \geq 5)$$

$$= P(n)$$

$$\tau_0 d_x = \frac{0.4}{\sqrt{n}}$$

$$\tau_0 \sqrt{n} = \frac{0.4}{d_x}$$

$$\frac{0.4\sqrt{n}}{1\sqrt{n}} = \frac{\cancel{0.4}\ \text{max ord of gaus}}{\sigma_{gaus}} \Rightarrow \frac{\text{max ord of pois}}{\sigma_{pois}} = \frac{\frac{n^n}{n!} e^{-n}}{\sqrt{n}}$$

$$n \longrightarrow \infty$$

$$0.4\sqrt{n} = P(n)_n = \frac{n^n}{n!} e^{-n}$$

$$\frac{n^n}{n!} e^{-n} \approx \frac{0.4}{\sqrt{n}}$$

Paper.

Paper

Mutation rate:

1.) Point mutations X-ray induced H.J. ~~Muller~~

Hearings of the Spec. Subcttee on Radiation of the Joint Cttee on At. En., Congress of the U.S. 85th Sess. June 4, 5, 6 and 7 1957.

Part 2. p. 1048

~~One point mutation (or more)~~

~~Point mutations~~

Spontaneous

Recessive lethals in fly (in germ cells $\frac{1}{6}$ of $1.4\ 10^{-}$

$\frac{.18}{100}$ recessive lethals in X-chromosome $\frac{0.18 \times 6}{100} = \frac{1.08}{100}$ lethals in genome

fly $\frac{2.16}{100}$ % lethals per gen.

Drosophila 1 : 200,000 per gene

$\frac{1.08}{100} \times 200{,}000 = 2160$ genes

~ 2000 genes

Man four times higher rate per gen $\frac{2.16}{100} \times 4 = \frac{8.65}{100}$ recif lethal point mut

per gen.

$\varepsilon\ \frac{8.65}{100}$ faults / gen

$$\frac{D_0}{\ell}$$

D_0/gen

$$\frac{n\tau_0}{\ell} = 3\text{ year}$$

$$\boxed{\tau_0 = \frac{1}{d_x}\frac{0.4}{\sqrt{m}}}$$

$$\frac{n}{d_x}\frac{0.4}{\sqrt{m}} = 3\,\ell$$

$$\ell = \frac{0.4\sqrt{m}}{3\,d_x} \approx \frac{10}{3}\sqrt{m} \approx$$

$$d_x \approx \frac{4}{100}$$

$$\frac{\cancel{4000}}{\cancel{100000}}$$

$n = 4$ $\ell = 6.666$

$n = 25$ $\ell \cong 16$

$D_0 = 50$

$$\frac{D_0}{\ell} \cong 7.\tfrac{1}{2}\,r$$

$$\frac{D_0}{\ell} \cong 3\,r$$

1000

$$\frac{1000}{333}$$

$1333 \times 2 = 2666 \times 6 = 16.000$

$$\frac{2}{5\cancel{0000}} \times 16\cancel{000} \text{ /gen} = \boxed{0.64}$$

How long does it take to double
mut rate?
63% of new rate is reached
~~years~~ generations $= \dfrac{n\,100}{\varepsilon \cdot 8.65}$

$\varepsilon \ll 1$

generations $= \dfrac{15\,n}{\varepsilon}$

Value of m for longer

$\left(\dfrac{80}{\tau_0} + n\right)^2 \pm \left[\cancel{2\overline{n}}\,(+25)\right]^2 = 10^m$

~~34.5~~
~~25~~
.5

$n = 25$ $\quad \tau_0 = \dfrac{11}{\sqrt{n}} = 2.2$ years

~~$n = 25 \quad \tau_0 =$~~

36.5
25
$(61.5)^2 = 3800$
$-\ 625$

$3,175$

~~$\sqrt{3,175}$~~ $\dfrac{3,175}{10} = 317,5$

$\dfrac{16,000 \text{ genes}}{317,5} = \dfrac{160}{3.17} = 50$ genes

~~"Visible" point mutations~~ 41

~~4x more~~

~~X-ray induced $\frac{8.65 \times 4}{100}$ per gen~~

X ray induced point mutation

in ~~fly~~ man $4.5\ 10^{-3}/r$

assume same number of divisions = same breaks.

life shortening of irradiated individual or short generation

$\begin{cases} 4.5\ 10^{-3}/r \times 1000 \text{ days} = 4.5 \text{ days}/r \\ n = 16 \quad \tau_0 = 2.75 \text{ years} = 1000 \text{ days} \end{cases}$

$n = 4 \quad \tau_0 = 5.35 \text{ years} = 1960 \text{ days or } 8.8 \text{ days}$

~~that~~ ~~base~~ assume mutation rate in Man for rec. lethals

$\frac{8.65}{100}$ / gen

and at X ray induced $4.5\ 10^{-3}/r$

$\frac{1}{6}$ rec. lethal × Doubling dose D_0

$\frac{8.65}{100} = \frac{D_0\ 4.5 \times 10^{-3}}{\cancel{4 \text{ or }} 6}$

$10^3\ \frac{8.65}{100}\ \frac{1}{4.5} \times 4 (\text{or } 6) = 86.\frac{4}{\cancel{4.5}}$ or $\left(\frac{6}{4.5}\right)$

$= \cancel{75\ r}$

or if we choose 6

$D = 75 \frac{6}{4} = 115\ r$

If there are r faults

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

(4) out of (1)

$$(1-e^{-y})^2 \approx y^2$$

if $y \ll 1$

because

(4)

$$f_1 \approx 1-y^2$$

$$f \approx (1-y^2)^m \qquad y = \frac{x}{2m}$$

(5) out of (2)

$$f \approx \; = e^{-\frac{x^2}{4m}}$$

and

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

out of (3)

6(a) Poisson summation | 6 b. approximation

Assumption: Turn but of f

is somewhere between 5 to $13\frac{1}{2}$%

(7) it at $$\frac{(x+r)^2 - r^2}{4m} = k$$

$(x+r)^2 \gg r^2$ $\qquad 2 < k < 3$

(8.) $$\frac{(x+r)^2}{4m} \approx k$$

Paper

(τ) $i\,\frac{1}{2m}$ — — — — — — — — H

1 fault 16000 gene

~~unusual kind~~ ~~fast~~ fault of general kind
fault of specific kind

$e^{-2} \ldots e^{-3}$

$e^{\frac{m}{-3}}$ ~~1~~ 5% to $12\frac{1}{2}\%$ $= e^{-2}$

r faults. $\frac{x}{\ } = \frac{t}{\tau}$ τ [2:2 → value]

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

~~(1)~~

~~probability of escape of 1 segment pair~~
"survival" of first segment pair —

$y = \frac{x}{2m}$ $\underline{\underline{e^{-2y}}} +$

$p_1 = 2e^{-y}(1-e^{-y}) + e^{-2y} =$ probab. of no lesions producing ... in first segment pair

~~$= \ldots$~~

~~$\ldots - 2e^{-2y} + e^{-2y}$~~

$= 2e^{-y} - e^{-2y} =$

(1) $= 1-(1-e^{-y})^2 =$ ~~$\ldots - e^{-2y}$~~

~~And if this~~ and prob of survival of cell

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

See page 70 book I

$m = 23$

$$\left(\frac{80}{\tau} + n\right)^2 - n^2 = A\,4m$$

$$= 276$$

$\left\{ m = 23 \right.$

$\underline{\tau = 5.9}$ for $n = 2.5$

$13\tfrac{1}{2} + 2.5 = \underline{16}$

$256 - 6.25 \approx \underline{250}$

$$A_f = \frac{250}{92} = 2.72$$

$n = 3.5$ $\quad$ $\underline{m = 23}$; $n = 3$; $\tau = 5$

$\frac{80}{5} + 3.5$

$16 + 3.5 = 19.5$

$$(19.5)^2 = \frac{370}{92} = 4.01 = A_f$$

$n = 3$ $\quad$ $\underline{m = 23}$

$\tau = 5.16$

$\frac{80}{5.17} + 3 = 18.5$

$$(18.5)^2 \quad \frac{343}{92} = A_f = 3.73$$

Choose $\underline{n = 2\tfrac{1}{2}}$ $\quad$ $A_f = 2.72$

Male has one more but
lives 3 years shorter

$$\frac{1}{92}\left(\frac{80-3}{5.9} + 2.5 + 1\right)^2 = A_m$$

$$(13 + 2.5 + 1)^2 = (16.5)^2 = 272 \qquad \frac{272}{92} = A_m = 2.96$$

$$\frac{A_m}{A_f} = \frac{2.96}{2.72} \qquad \frac{A_m}{A_f} \approx 1.09$$

$m = 10$ ~~100 genes~~

~~1000 genes~~

Burgers 28

$$f = e^{-\frac{x^2}{4 \times 10}}$$

$$\frac{(100x)^2}{4 \times 1000} \qquad \frac{x^2}{4\,10} \qquad (100x)$$

$$\frac{t_d}{\tau}$$

$$\frac{t_d}{\tau} \approx \sqrt{k\,4m} - r$$

two people differing in number of faults r by one would differ in lifetime by τ. —
This would give discontinuous curve, for non genetic scatter identical twins. —

$$\left[\frac{80}{9.3}\sqrt{n} + n\right]^2 - n^2 = A_f \, 4 \times p \times 23$$

$$\frac{\left(\frac{80}{9.3}\right)^2 n + 2 \times \frac{80}{9.3} n\sqrt{n}}{92 \, A_f} = p$$

$$\sqrt{\frac{(8.65)^2 \times 9 + 17.1 \times 9 \times 3}{92 \times 3.5}}$$

675
462
1137

$675 + 462 = 1137$

$\frac{1137}{3.5} = 322$

$$\left[\frac{80}{9.3}\sqrt{n} - \frac{3}{9.3}\sqrt{n} + n + p\right]^2 - n^2 = A_m 4 p 23$$

$n = 9 \quad A_f = 3$

665 465

$$p = \frac{74 \times 9 + 17.2 \times 9 \times 3}{92 \times 3} = 4.1$$

665
465
1130 / 276 $= 4.1$

A_f $\quad (25.8 + 9)^2 = (34.8)^2 = 1200$

1200
− 81
1119 = $A_f \, p \, 92$

A_m

25.5
9
4.1
38.6

$(37.6)^2 = 1400$
− 81
1319

$\frac{A_m}{A_f} = 1.18$

Try $\frac{A_m}{A_f}$ if $m = 3 \times 23$ W

$A_f = 2.72$ ~~$n = 6$~~ ~~$\sqrt{6} = 2.45$~~

$\delta = \frac{0.4}{\sqrt{n}\ 3.67 \cdot 1.18} = \frac{.40}{\sqrt{n}\ 4.3} = \frac{9.3}{\sqrt{n}} = \frac{9.3}{2.45} = 3.8$

$\left(\frac{80}{9.3}\sqrt{n}\right)^2 + 2 \times \frac{80}{9.3}\, n\sqrt{n} = A_f \overset{4}{3}\ 23$

$= \underline{245}$

p for 1 chromosome $p = \frac{m}{23}$

$\left(\frac{80-3}{9.3}\sqrt{n}\right)^2 + 2 \times \left(\frac{80-3}{9.3}\right)(n)\sqrt{n} = A_m\, p \times 23\ 4$

$n\left(74 + 17.2\sqrt{n}\right) = A_f\ 3 \times 23 \times 4$

$A_f = 2.72$

$n = 6$; $6 \times (74 + 39.5) = 106 \times 6 = \cancel{630}\ 700$

A_f

445 | 74.0
255 | 42.0
700 | 113.5
 | 116.0

$A_f \times 12 \times 23 = \cancel{630}\ 700$

or $A_f = \cancel{2.72}\ \underline{\underline{2.54}}$

~~$\sqrt{n} = \ldots$~~

$\left(\frac{77}{9.3}\right)^2 = 68.5$

$68.5 \times 6 = 374$

$+ \underbrace{2 \times 8.3 \times 9 \times 2.45}_{2 \times 182} = \underline{364}$

738

$\left(\frac{80-3}{9.3}\sqrt{n} + n + p\right)^2 - \cancel{n^2} =$

$p = \frac{\left(\frac{80}{9.3}\sqrt{n}\right)^2 + 2\frac{80}{9.3}\, n\sqrt{n}}{A_f \times 23 \times 4}$

$$\left[4 \times 8.6 + 16 + 8 - \frac{12}{9.3}\right]^2 - 256$$

~~4×8.6~~

$$\begin{array}{r} 50.4 \\ 8 \\ \hline 58.4 \\ -\ 1.4 \\ \hline \end{array}$$

$$(57.0)^2 = 3250$$

$$\begin{array}{r} 3250 \\ -\ 256 \\ \hline 3000 \end{array}$$

$$\frac{A_m}{A_4} = \frac{3000}{2256} = 1.36$$

$$\boxed{3 \times 1.36 = 4.07}$$

$n = 25$ H

$$\cancel{R_0}\ p = \frac{[5\times 8.6 + 25]^2 - 625}{92 \times A_f}$$

$$\begin{array}{l} 43 \\ 25 \\ \hline (68)^2 = 4620 \\ \quad -625 \\ \hline \quad 4000 \end{array}$$

$$p = \frac{4000}{275} = 14.5$$

A_m |

$$\cancel{5\times 8.6 + 25}$$

$$\frac{A_m}{A_f} = \frac{\left[68 + 14.5 - \frac{5}{3}\right]^2 - 625}{4000} = \frac{5,875}{4000}$$

$$\frac{A_m}{A_f} = \underline{\underline{1.46}}$$

$$\begin{array}{l} 68 \\ 14.5 \\ \cancel{} \\ \hline 82.5 \\ -2.0 \\ \hline (80.5)^2 = 6500 \\ \quad -625 \\ \hline \quad 5875 \end{array}$$

If $A_f = 3$ $A_m = 4.36$

Try $n = 16$

$$p = \frac{[4\times 8.6 + 16]^2 - 256}{92 \times A_f} = \frac{2250}{3\times 92}$$

$$\underline{p \approx 8}$$

$$\begin{array}{l} 34.4 \\ 16 \\ \hline (50.4) = 2504 \\ \quad -256 \\ \hline \quad 2250 \end{array}$$

Dose rate to avoid killing

5 r per 5 days 1 r/day

$n = 0.1$

$P(0) + P(1) = \begin{array}{r} 0.9048 \\ 0905 \\ \hline 0.9953 \end{array}$

$1 - [P(0) + P(1)] = \cancel{1.0047}$ 0.0047

$\frac{1}{2}$% killing per 5 days

$\left(1 - \frac{1}{200}\right)^{200}$ e^{-1} in ~~[illegible]~~ 1000 r ~~[illegible]~~

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

$1 - \frac{1}{2} n^2$

" death $= \frac{1}{2} n^2$

for $n = \frac{0.1}{2}$ " death $= \frac{1}{2} \frac{1}{4} \frac{1}{100} = \frac{1}{800}$

corresponds to $\frac{1}{2}$ r/day and 5 day accumulation time.

$\frac{365}{2}$ r/year $= 182$ r/year

550 r in 3 years

life shortening $3 \times 550 = 1650$ days $= 4.5$ years

Mutational load

~~$0.2461 = \sqrt{2} \times .1755$~~

assume $n = 9$

$$\tau = \frac{0.4 \times 100}{\sqrt{9}\ 3.67 \times 1.18} = \frac{9.3}{3} = 3.1 \text{ years or } 1130 \text{ days}$$

$$\frac{1130}{220} = 5.3 \text{ days}/r$$

If 220 r causes 1 mut
and mut rate 0.64
then doubling dose $220 \times .64 = 140\,r$

if $n = 9$ $\frac{140\,r}{9} = 15.5\,r$ would ~~lengthen~~ shorten life by 3 years.

assume deletion $\frac{1}{2}$ of point mut.

~~[illegible]~~ or 0.32 deleterious persistence 3 gen. would give mut load $\frac{1}{2}$ —

If total mut load is say $n = 3$ come from point mut.

Assume $n = 3$ $\tau = \frac{6.1}{1.18} = 5.15$ years

to add $\frac{3}{5.15} = 0.583$

$$\frac{.583}{3} = 0.194 = \frac{1}{5.15}$$

$$D^* = \frac{D_1}{5.15} = \frac{140}{5.15} = 27.2\,r$$

Müller

Fly

Doubling dose
400 to 500 r

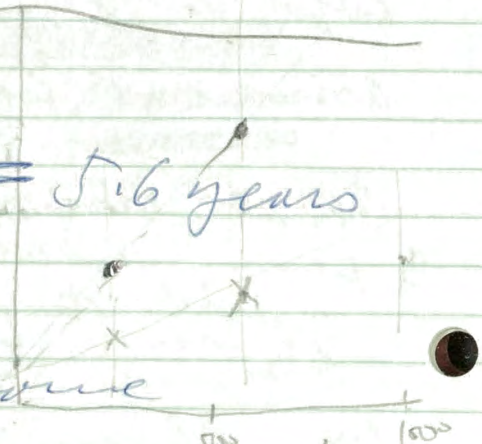
Rotblatt

50 r shorten $3\frac{1}{2}\%$ of
life span
100 r $\frac{7}{100}$

Mutation Research

Discussion
If 100 r shortens $\frac{7}{100} \times 80 = 5.6$ years

100 r about $\frac{1}{4}$, but 4



This could be 3 chromosome
break giving loss with
probability $\frac{1}{3}$

Russel finds 30 r doubles
mutation rate in mouse if
given to both parents.

Mutation rate in fruit fly 1 : 300,000
" " in mouse 1 : 100,000

assuming 2000 genes which can mutate
to recessive lethals
$2000 \times 10^{-5} / 30 = \frac{2}{3} 10^{-3}$ rec. leth/r
or 1500 r to make 1 rec. lethal
or $\frac{1500}{5}$ r = 300 r to make one mutation

200
~~mouse~~ ~~[illegible]~~ r for 5 years
~~[illegible]~~ ~~[illegible]~~
4 traits
12

~~[illegible]~~ ~~0.2 nat. mut.~~ matter
50 r

220 parents
~~to both~~ ~~[illegible] one parent~~
30 r / for mouse ~~doubling~~
~~dose~~ Russel

1 : 300,000 fly
1 : 100,000 mouse

2000 | 10^{-5} | 30 r

$\frac{2000 \cdot 10^{-5}}{30}$ / r

$\frac{2}{3}$ 10^{-3} rec. lethals mutations / r

1,500 r to make 1 rec. lethal.
1 to 50,000 in man
would give 750 r one rec. lethal

Muller says:—
deletions with X rays between 1% and 10%
of point mutations in fly in single
process.—

Hug [Inst. für Strahlenbiologie
Bavariaring 15
Regensburg]

G.W. Grahn & J. Stadler with 20 to 950 r X-rays
find in mice

Lifespan of mouse 575 days
0.15 days/r
factor $\frac{1}{3430}$ per r $= 2.9\,10^{-4}$

J. Exp. Zool. **132**, 133 (1956)

$\boxed{\approx 8 \text{ days}/r}$

$$\frac{P(1)}{P(0)+P(1)} = \frac{\frac{n^r}{r!}e^{-n}}{e^{-n} + n^r e^{-n}} = \frac{n}{1+n}$$

Stadler 200 r gives 1 hit $= \frac{80}{35}\,2 = 4.6$ years
either because it gives 1 fault or else
because it destroys a whole chromosome

Rotblat 7% for 100 r
$7\,10^{-4}/r$

Selection via mortality

$n = 3$

$r = 2 \quad r = 3 \quad r = 4$

$$\frac{\cancel{1\times}1\times 2 + 1\times 3 + 0.9\times 4}{3} =$$

2.2
3
3.6

8.8

$$\frac{8.8}{3} = 3 - \frac{0.2}{3}$$

1×	1.2	× .149	.179	.179
2×	1.1	× .224	.246	.492
3×	1	× .224	.224	.672
4×	.9	× .168	.151	.604
5×	.8	× .101	.089	.445
6×	.7	× .05	.035	.210
7×	.6	× .02	.012	.084
8×	.5	× .008	.004	.032
			.940	2.718

$$\frac{2.718}{0.940} = 2.92$$

or loss per generation

$$\frac{1}{2}\cdot\frac{8}{100} = \frac{1}{25}$$

Paper Work

Assumptions: 23 chromosome pairs
~~of a certain finite fraction~~
chromosome destroyed with a
certain probability per generation in a random
process

essential genes

2 kinds of faults   point faults
deletions involving
an essential
gene. —

essential genes of a general kind
" " of a special kind

~~[illegible]~~

~~deviation of the curve for~~
non symmetrical shape could be
due to two causes. —

Designations A_W; A_M

~~Correction~~; Change

We may say that $r = 1$ and $r = 2$ add little because fertility is low at high ages. ~~Therefore we may take proportions of ... the ...~~

Correction of what went before

		P(r)		
1	1.5	.149	.224	.224
2	1.25	.224	.280	.560
3	1.00	.224	.224	.672
4	0.75	.168	.126	.504
5	0.50	.101	.050	.250
6	0.25	.050	.012	.072
		~~.916~~	.916	2.282

$$\frac{2.282}{.916} = 2.5$$

loss:

$$\frac{1}{2}\ 0.5 = 0.25/\text{gen}$$

If we assume ~~1.228~~ only ages 20 to 30 ~~matter~~

		P(r)		
1	1	.149	.149	.149
2	1	.224	.224	.448
3	1	.224	.224	.672
4	0.75	.168	.126	.504
5	0.50	.101	.050	.250
6	0.25	.050	.012	.072
			.785	2.095

$$\frac{2.095}{.785} = 2.67$$

loss

$$\frac{1}{2}\ \frac{23}{100} = \frac{11.5}{100}$$

Is reason assumption of of using $\frac{\bar{t}}{2}$ ~~correct~~ = 2.5 years correct?

$$e^{-\frac{(x+r)^2}{4m}} \approx \frac{1}{20}$$

$(x+r)^2$

No! should be $\bar{t}$

Half!

1	1.5	.149	0.224	.224
2	1.025	.224	0.280	.560
3	0.75	.224	0.168	.504
4	0.50	.168	0.084	.336
5	0.25	.101	0.025	.125
			$.781_2$	1.749_1

$$\frac{1.749}{0.781} = 2.24$$

loss per gen $= \frac{1}{2} \times 0.76 = 0.38$/gen

for uncompensate

2×2000 genes $\times \frac{1}{50,000} \cong \frac{1}{10}$

Ask Nathan Shock about decrease of cells in Brain. —

Herman Chase Brown Univ.
Producing gray hair in mice or rats is it aging

Natali Bach - Moscow | Bach Inst.

Harold Smith ~~Plant~~ Plant gen.

Nor Free Austin Texas
Potassium iodide nervous ~~Sch~~ Science

Firth at Oak Ridge used fast neutrons. —

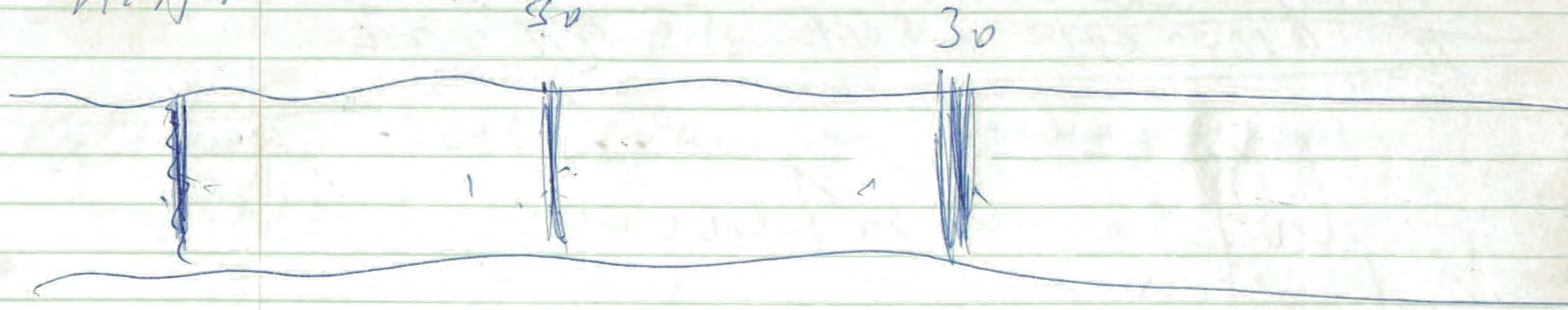
fast neutrons
Mole (England) Nature 1957
Mice - low dose safe —

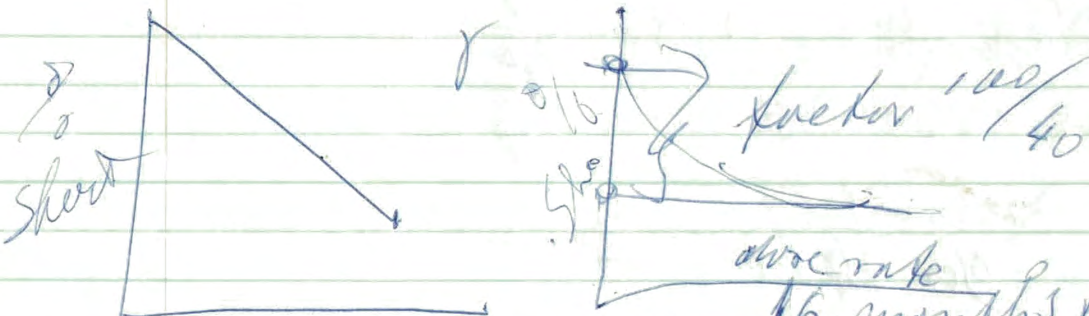
Chester Beatty Peter Alexander
Lambertson

Curtis (H)

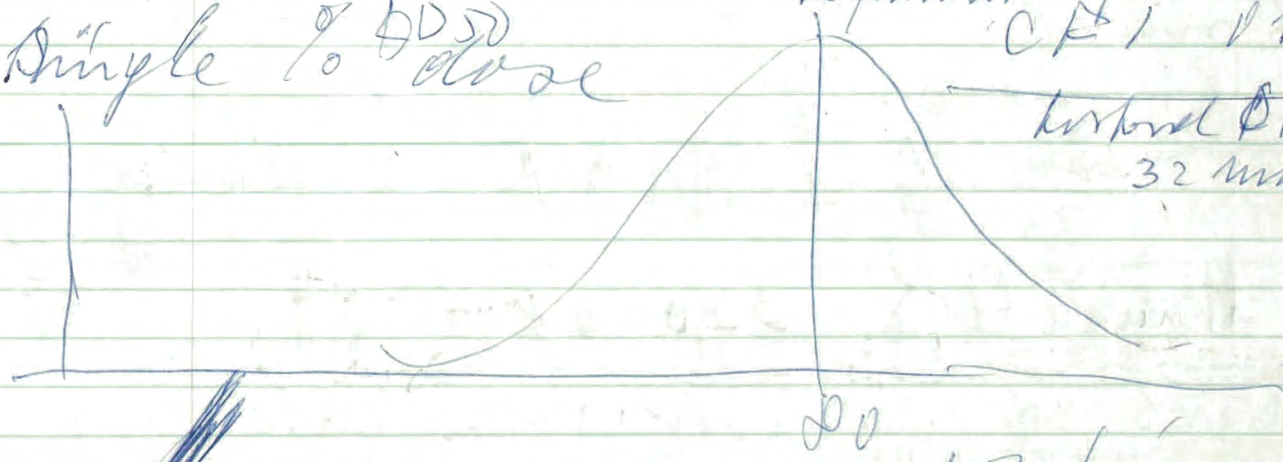
12 day ~~[illegible]~~ x rays. mice

L.A.





16 months for mice
CF1 hybrid
[illegible] BA
32 months



neutrons per rep 1.7 times more effective in acute effect and life shortening in single doses

Starr plutonium at L.A.
neutron radiation longevity in mice
Starr now at Bar Harbor

Samuel Greenhouse
Section of Applied Math & Statistics
Harold Dorn Chief of Biometrics Section
~~Lathrop~~
~~Th 1030 AM 9th floor 9N226~~

Life shortening
by X-rays

Assume 30r causing 1 break
and at low dose rate $\frac{1}{3}$ point mut.

~~$\frac{1}{10}$ ... days for 40 r~~

$\frac{2000}{30} \frac{1}{24} / r = 2.80$ days

at single 48×3 dose X ray
30 r causes $\frac{2.5}{3}$ point mutations

$\frac{2000}{30} \frac{1}{8} = 7$ days | Stadler 8.7 days

Human life 30,000 days

neutrons 30 causing say 1 point mut $\frac{1}{8}$
$\frac{1}{8}$ or 1/2 deletion and 1 fault

Life shortening would be 2 times } for equal mut. prod.

and if 1.5 times more effective
30 r would give $\frac{2.5}{3} \times 1.5 = 1.25$ point mut | 30 r
and 2×1.25 or $\frac{2.5}{8}$ faults | 30 r

Life Shortening by X-rays

avg $4^{\circ}/_{0}$ per 100 r single dose

$\frac{5}{10^{-4}}$ Survey (Shalker

0.15 days/r

Kalckar selection in homozygous condition:

If mut rate of 1 gene is μ / gen

2μ / ~~[illegible]~~ / gen is frequency ~~in~~ of gene

equilibrium is p. [probab that 1 given gene is a mutant is p.]

Then p^2 is prob of loss of 2 genes

~~[illegible]~~ $2\mu = 2p^2$

$p = \sqrt{\mu}$

If $\mu = 10^{-5}$ ~~[illegible]~~ 1 in 10^5 children born is homozygous.— or if $\mu = \frac{1}{50000}$

If persistence were 10 generations

$p \approx 10^{-4}$

$p^2 = 10^{-8}$ or only 1 in 100 million children would be homozygous.—

4×1650

Selection ~~of~~ against mutant genes,

Assume all mutant genes are ~~[illegible]~~ equally selected against through foetal mortality. —

Say ~~[illegible]~~ 40 mutant genes (of which 2.5 are faults) in equilibrium

1.1 mutation rate 0.8

~~[illegible]~~ selection $\frac{1}{50}$ per gen per mutant gene (persistence 50 generations. —

of these 2.5 are faults ~~or [illegible]~~ (of ~~an~~ ~~the mutation load~~

$$\frac{2.5}{25} + \frac{37.5}{x} = 0.8$$

$$\frac{37.5}{x} = 0.7$$

$$x = 53 \qquad \frac{37.5}{53} = 0.7$$

~~If 10% of fetuses die ~~and~~ this means~~

~~5%~~

~~(+0.05%) 0.95 – ~~8~~ (0.90%)~~

~~[illegible] loss 34 40 46~~

~~$\frac{0.6}{2} + \frac{1.2}{2} = 0.9$ is loss of mutants per gen ~~in father and~~ in child. —~~

10% loss ~~[illegible]~~ means (if an side of two many mutations that these lost are beyond 1.65 Stand dev. i.e. they represent $1.65 \times \sqrt{40}$

$\simeq 10$ mutations lost with 10%, proba

H

~~Paper~~;

Ins. Page 1, — Number of segments that can be hit 2m ~~cell~~ Immortal cell remains viable if one of two is hit only. —

$x = \bar{s} = \alpha t$

prob that a given xy $\frac{x}{2m}$

hit rate, characteristic of ~~species~~ species, same for both sexes. —

Probab of a given segment ~~be~~ ~~hit~~ ~~hit~~ is knocked out $\frac{x}{2m}$

Prob. that a given cell is knocked out after s hits

Life shortening per $\sqrt{r}$ fast neutrons

$\frac{2000}{30} \cdot \frac{2.5}{8} = 21$ days. —

Infant mortality in Human
3 % female, reduces life exp. 2.4 year
4 % male (X chromosome carries detrimentals, amounting in hemizygous condition to 1 % infant mortality)

2.4 year loss might be due to mut load of these genes. — Is small compared to $3 \times 5.36 = 15$ year loss of adult

If this represents 7 mutations produced by X-rays.
1 point mut limit unit to infant loss 0.3 years compared to $\frac{1}{8}$ 5.88 years adult loss. — = 0.725 years

rather assume $\frac{1}{3}$ of rec. lethal

detrimental. $\frac{1}{6}$ of all genes

~~organisms~~ adult essentials.—

~~Late~~ Load of faults 2.5
Load of $m + l$ = 25

5. 1.6 =

$\mu = 0.6$ loss due to heterozygous
fetal selection

Faults ~~Homozygous selection~~

mutation rate per gene 10^{-5}

~~production per gen~~

gain/gen $= 2\,10^{-5}$

loss per gen if ξ is probab that 1 gene is mutant

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

Number of faults in reproduction

$$X = 2 \times 1000 \times \xi$$

$$\left(\frac{\xi}{2}\right)^2 = 10^{-5} \qquad V^2 = 10^{-5}$$

$$\frac{\xi}{2} = 0.3\ 10^{-2}$$

$$\xi = .6\ 10^{-2}$$

$X = 12$

lethality or loss / gen ≃ vit / gen

$\frac{40}{16000} = \frac{1}{400}$ Homozygous probab

$\frac{40}{(400)^2} = \frac{4}{16} 10^{-3} = 2.5\ 10^{-4}$

for a visible mutant

3% dies as children 7%
would dye as embryo – 8

De novo assume (stationary) genes in faults
(2000) genes

l non fetalls
14000 genes

a ~~cut~~ certain fraction of these

both recessive lethals and detrimentals are not selected against through — fetal death in heterozygous condition but only ~~[illegible]~~ when homozygous*.
What fraction of 16000 genes are these.

Number of these* genes = ~~k~~ Z frequency in population stationary state ~~[illegible]~~ f

$\frac{Z}{50000} = 2f^2 \quad f^2 = 10^{-5} \quad f = 10^{-\frac{5}{2}} = 3.16\ 10^{-3}$

fraction of children afflicted

$Z \times f^2 = Z\ 10^{-5}$

Z could be 1000 genes, — perhaps 3000

Selection the Nano

Heterozygous

Deaths $= \lambda \bar{n} =$

$2\mu = 2\lambda V$

$\mu = 10^{?} N V$

V is prob that one given gene is [illegible]

$\mu = \frac{1}{100{,}000}$

related to ~~one out~~ hundred [illegible]

$\boxed{\mu = \lambda V}$

$N\mu = \lambda n =$ Deaths

$N =$ number of genes $= \frac{\text{Deaths}}{\mu}$

$\mu = 10^{-5}$

Deaths $= 0.2$

$N = \frac{2}{10} 10^{5} = \underline{\underline{20{,}000}}$

Homozygous selection

$2\mu = 2(V)^2$

~~Death~~ Deaths $= N V^2$

$0.2 = N V^2 = N\mu$

$\mu = 10^{-5}, \quad N = \frac{0.2}{10^{-5}}$

$N = 20{,}000$

$N = 10{,}000 \qquad$ Deaths $= 0.1$

~~How many~~ what value $\bar{n}$?

$2\mu = 2(V)^2$

$\mu = 10^{-5} \qquad V = \sqrt{10^{-5}} = 0.31 \times 10^{-2}$

$\bar{n} = 10^4 V \simeq \frac{10^4}{300} = \underline{31}$

300 ~ 1 [illegible]

$\frac{31}{10} = 3$

Heterozygous selection

10,000 genes

mutation proliferation

$\frac{2}{10^5}$ 10000

Genes ~~......~~ 25

[illegible] rates [illegible] negative tolerance

[illegible] of loss (hump to $\underline{\underline{r}}$)

selection $\quad \frac{x\,10}{10} = \frac{2}{10^5}\,10^4$

$x = \frac{2}{10}$

5% $\frac{1}{5}$ 2 × 5 $\qquad$ $\frac{1}{10}$

$r \cdot 25 = \frac{5}{100}$ $\qquad \frac{1}{4} \quad \frac{1}{2} \quad 4$

$r = \frac{5}{25 \times 100}$

$\frac{1}{2}\; 5 \times \frac{5}{2500} = \frac{1}{2}\,\frac{1}{100}$

$r \times 16 = \frac{5}{100} \qquad r = \frac{5}{16 \times 100}$

$3 \times \frac{5}{9 \times 100}$

$\frac{2}{10^5}\,\underline{5000} = \frac{1}{10}$

Mut rate $\frac{1}{200,000}$

Assume 10% aborting

$\frac{2}{2 \times 10^5} \times 10^4 = \underline{\underline{0.1}}$

$\frac{3}{9} \times \frac{1}{10}$

K in Mol   Molekular weight ~~1~~70,000

$10^{-4.7}$ $10^{-8.8}$

4

4 Peaks, 4.7   6.2   6.8   8.8

10%   35%   40%   10 to 25%

All 80% of globulin

New Born Rabbit

can not elicit precip. AB

of new born to rays B.S.A.

New Born Rabbit | Influenza virus (killed)

Rat up to 14 days | strong binding only

while produced | no

precipitation. — ~~Start~~ Cardee

Rabbit

mice

Polysaccharide

~~Dec 13 to~~

Dec 20 —

— intravenous

~~BSA — Ra~~

Rabbit

Selection through mothers only

If gene present reduction by 6 years ~~say three~~ 2 fertile years

or reduction by ~~25~~ 15 percent

should be present on average ~~six at two~~ one of five surviving children, or less

$$2\mu = V_1 \frac{15}{100}$$

$$\frac{100 \times 2\, 10^{-5}}{15} = V_1 \qquad 1000 V_1 = \frac{2}{15} = n_1$$

would have to assume $N_1 = 15000$ to get $n_1 = 2$.—

homozygous births

$$V_1 = \frac{2}{15}\, 10^{-3}$$

$$V_1^2 = \frac{4}{(15)^2}\, 10^{-6}$$

$N_1 V_1^2$ small

but if we also have another $N_2 = 15000$ selected only homozygously, O.K.

Upper limit for rec. lethals No of homozygous selection and mut mut rate $\mu = 10^{-5}$

$$\text{Births} \times \frac{1}{5} = N_0 \mu \qquad N_0 < 20{,}000$$

of selection homozygous.—

De Novo

~~1000 gen~~ N genes (recessives) μ

mut rate per gen per gene μ

Assumptions

1.) death of ~~heterozygote~~ homozygote

2.) death of ~~homozygote~~ heterozygote

1.) gain of mut gene = loss

$2\mu = 2(\nu)^2$ N haploid number of genes

$\mu = \nu^2 = 1$

$\nu = \sqrt{\mu}$

$n = 2N\nu$

$\mu = 10^{-5}$ $\nu = \sqrt{10^{-5}} = 0.317 \times 10^{-2}$ | $\nu^2 = 10^{-5}$

~~$N = N_1 + N_2 + N_3 = 1333 + 8,667 = 10^4$~~ ~~$n = 63.5$~~

~~Duds $= N\mu = 0.1$~~ ~~$n_1, n_2 = 6.35$~~

$N_0 = N_1 + N_2 + N_3$ Duds $= N\mu = \frac{5}{100}$

$1000 + 333 + 3667$

$N = 1000 + 300 + 3,700 = 5000$

$n_1 = 6.24$

$n_2 = 2.0$

$n_0 = 31.7$

2.) Heterozyg gains selection

For same mutation rate duds twice as numerous

and n would be lower

What would heterozygous selection give for n_1 if $p = 50$

$2\,10^{-5} = \frac{v}{50}$

$10^{-3} = v \qquad N = 10^4$

$N 10^{-3} = Nv = 10$

Bacteria 5000R / 1 break

~~Drosophila~~

$\mu_t = 5\% \qquad 2\mu_t = \frac{1}{10}$

1 break

500 R should produce 1 mutation (or $\frac{1}{5}$ rec. lethal); 50 r should produce $\frac{1}{10}$ as Müller says it does. → (50 r to 1 immature germ cell doubles its nat. mut rate.)

~~rec. lethals in haploid set~~

$\mu_t = \frac{10}{1000}$ rec. lethals in fly haploid set spontaneous

$\mu_t = \frac{50}{1000}$ ($\frac{1}{5}$ is rec. lethal)

In ~~diploid~~ haploid

$\frac{2}{100}$ rec. lethal prod by 50 r [in haploid]

or 2 rec. lethals prod by 2500 r

X-ray effect | assume 35 r make one break / one mutation

assume 6 day/r life shortening

in man $\frac{2150^{\text{day}}}{6} = 350\,r$ per fault

1 break in 10 makes a "fault"

Mut rate 10^{-5}, if this is doubled by 35 r!; means 10^5 genes

10000 genes are adult genes. —

another 10000 rec. lethals (devlp.) and 80000 either no genes or unimportant genes. —

100,000

Maternal selection!

$2\mu = V_1 X$ ~~$\frac{4}{4}$~~

$N_1 \frac{2\mu}{X} = V_1 N_1 = 2$

$N_1 \mu = X$

$\mu = 10^{-5}$

$10^{-5} = \frac{1}{4}\frac{X}{10^4}$ or $X = \frac{1}{10}$

$N_1 = 10^4$

but what about organ specific faults? — these are selected in homozygote. —

assume

$2 \mu = 2\left(\frac{0.7}{N_2}\right)^2$ | $N_2 = \sqrt{5}\,100$

$N_2^2 = \frac{1}{2}\,10^5$

or 300 r produces 1 fault
in offspring

If 30 r produces a break
then $\frac{1}{10}$ of the breaks would
be a fault.

30 r should produce $\frac{1}{2}$ break
in offspring; assume ~~10~~ 5000 genes
mutation probab. from 30 r is 10^{-5}

Reasoning

In drosophila we know
how many rec. lethals are
produced /r and we know
doubling dose, we also know
spont. mut rate

Probab. of producing a
mutation per locus with X-
rays should also be known.

in diploid

or 1 fault produced by 25000 r

M

On mice. observe by ??
2 rec. lethals ~ 300 r
1 fault ~ 300 r ~ 0.6 ?

How many genes are rec. lethals?

Spont. rate 10^{-5} in haploid
$2\mu = 2(10^{-5})$

$N^{*}\mu = 0.1$ Postulate
$N^{*} = 10^{4}$

$N_1^{*} = 5000$
faults gain $= .1$/gen;
faults loss/per fault carried could be $\frac{1}{20}$

1 break is 1/2 as mutation in haploid/2 sex

Muller 50 r makes
$\frac{5}{100}$ mutation in haploid or
$\frac{1}{100}$ rec. lethal in haploid
or $\frac{2}{100}$ rec. lethal in diploid
$\frac{1}{100}$ fault in diploid

rec. lethals $\mu_{tot}^{*} = .1$ means between ~~one~~ 10% and 20% die
~~between~~ If doubling dose 30 r this produces in diploid chance 0.1

Housekeeping genes [illegible] of [illegible] specific genes

$2\mu_2 = 2V^2$

$N_2 V = 0.3\ 10^{-2}$ $N_2 =$

$= 0.7$

$N_2 = \frac{0.7}{0.3}\ 100$

If these are selected heterozygously

$2\mu = \frac{V^2}{40}$

$V_2 = 80\ 10^{-5}$

$N_2 V_2 = N_2\ 8 \times 10^{-4} = 0.7$

$N_2 \cong \frac{7}{8}\ 10^3$

> 6 days / τ

$\mu^*_t < 0.1$ Do is doubling time

~~[illegible]~~ must produce / τ $< 0.1 D_0$

if all ~~[illegible] lethals are~~ essential genes

or are vegetative essentials.

must / τ $\leq$ $\tau \leq$ ~~[illegible]~~ 6 years 2,200 days

shortening / τ = $\frac{D}{10}$ 2.200 > 6

~~[illegible] 2200 < 10 D~~

$\frac{2200}{10 D} > 6$

[illegible]

Mean   Js

μ = .5 Mutation in Haploid set

~~set~~ probability. set these 30 ~~x~~

~~[illegible]~~ would make 0.5

~~unit in Haploid set~~

$\frac{1}{10}$ are ~~[illegible]~~

~~fat~~ recessives may be worse

Spont rate $\mu = 10^{-5}$/gene. 0.1

~~let recess~~ genes 10^4 rec. lethals

5000 vegetative genes. —

selection in heterozygous cond.

$$2 \times 5000 \times 10^{-5} = \frac{V}{40}$$

$$= 4$$

~~Homozygous selection~~

~~W~~ $V = 3$

$\mu^* = 0.1$

assume $\mu_1 = \mu^*$

Total faults prod. for doubling

dose D_0 **0.2**

life short. for ~~D_0~~ $< \dfrac{2200}{10} = 220$ days

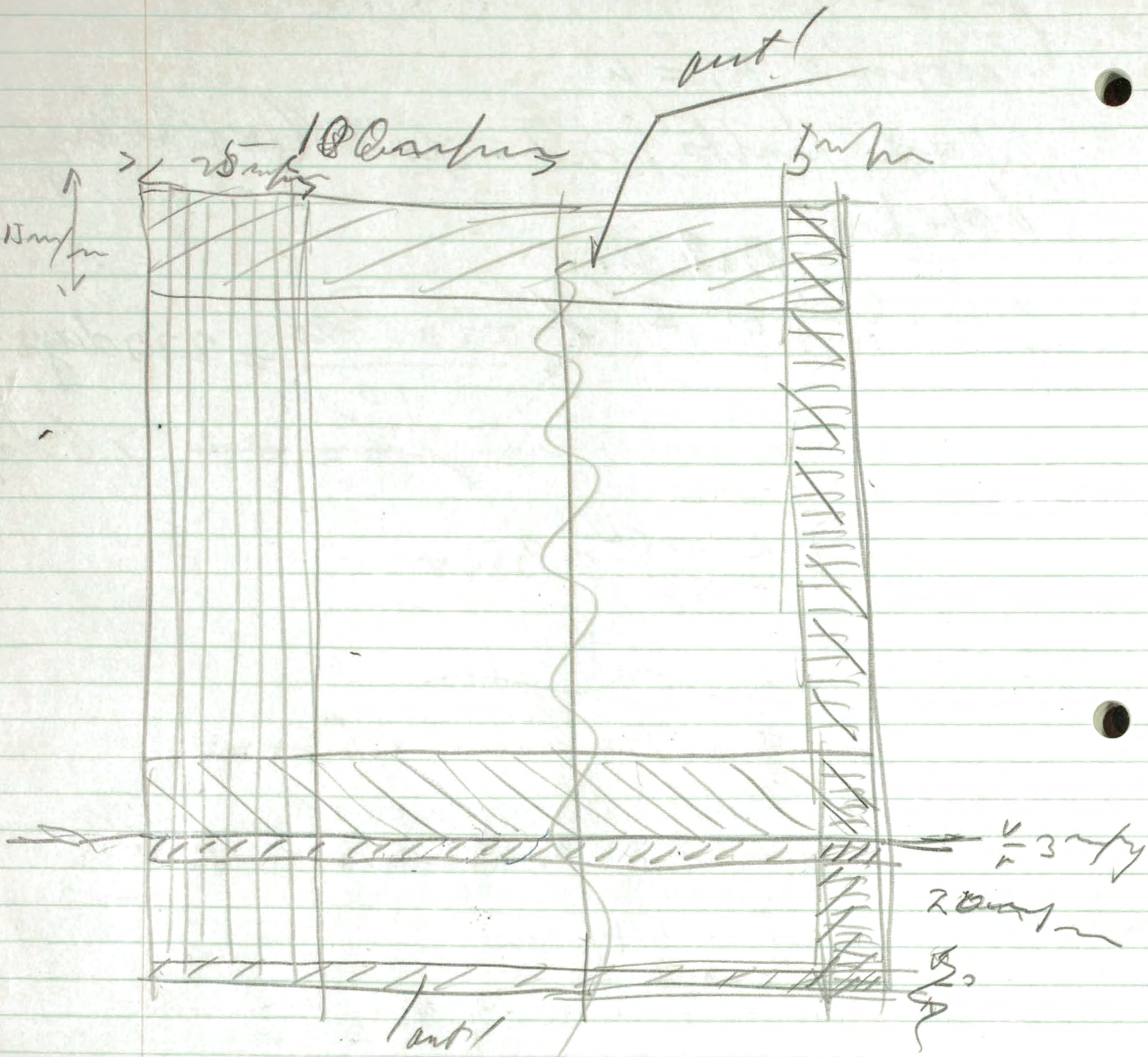
Life shortening ~~per r~~ > 6 days

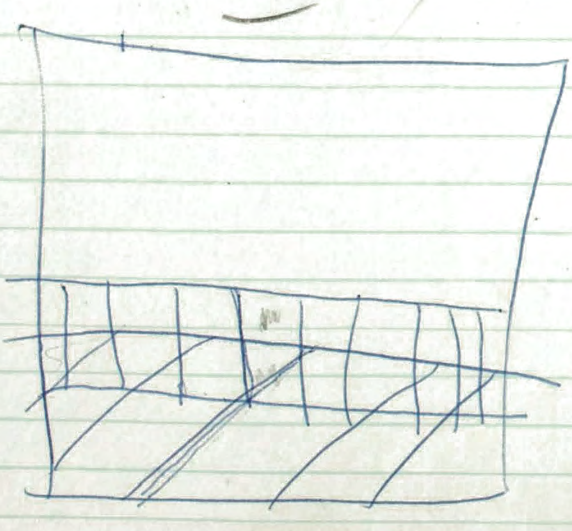
$$D \leq \frac{2200}{>6} \sim 356\,r$$

~~If they are all~~

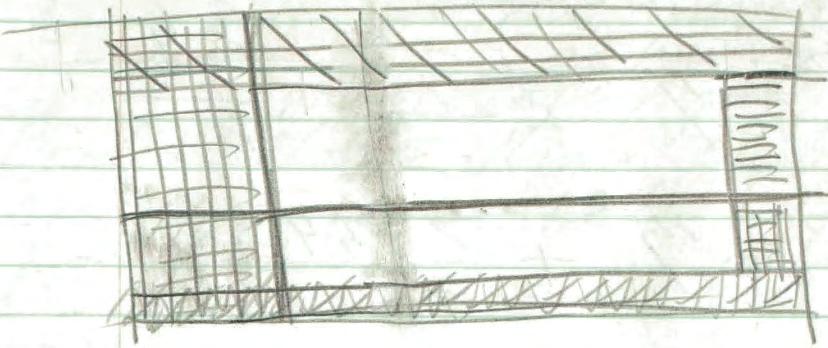
we even get 70 r if we assume that all essential genes are vegetative.

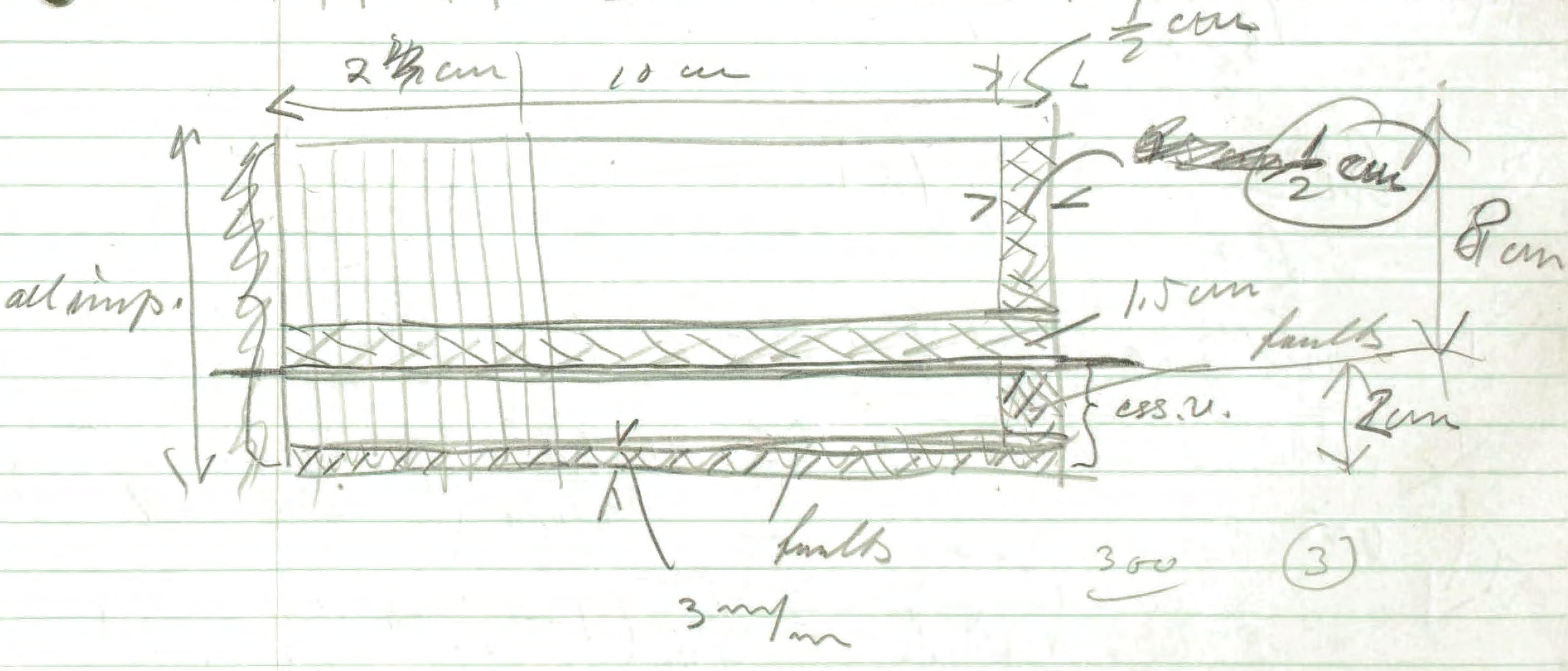
or if $\mu^* > 0.1$/gen


out!
out!



For paper de Novo





300

(3)

$$\cancel{\ln \frac{1}{f(z)} = m\left(1 - 2e^{-z} + e^{-2z}\right)}$$

$$\ln \frac{1}{f(z)} \cong m\left(z^2 - z^3 + \frac{z^4}{3} + \frac{z^4}{4}\right)$$

8 $$\cong z^2 - z^3 + \frac{7}{12} z^4 = mz^2\left(1 - z + \frac{7}{12} z^2\right)$$

9 At the critical age number of bits x

$$z = \frac{x}{2m} \qquad f(z) = f^*$$

$$\cancel{\ln \frac{1}{f^*}} \qquad \cancel{\ln f^*} =$$

14 $$f^* = \left[1 - \left(1 - e^{-\frac{x}{2m}}\right)^2\right]^m$$

15 $$\ln \frac{1}{f^*} = \varphi(x)$$

16 where $$\varphi(x) = m\left(1 - e^{-\frac{x}{2m}}\right)^2$$

$$\cong m \frac{x^2}{4m^2}\left(1 - \frac{x}{2m} + \frac{7}{12}\frac{x^2}{4m^2}\right)$$

17 or

$$\varphi(x) \cong \frac{x^2}{4m}\left(1 - \frac{x}{2m} + \frac{7}{12m}\frac{x^2}{4m}\right)$$

If ~~x~~ r faults present

18 $$f^* = \frac{\left(1 - \left(1 - e^{-(x+r)}\right)^2\right)^m}{\left(1 - \left(1 - e^{-r}\right)^2\right)^m}$$

The paper

14

(7) $\eta = \frac{x}{2m}$ x number of hits; m number of segments in haploid set

For functionally perfect female: Probability that first segment pair does not (due to hits) ~~[illegible]~~ cause loss of function

(6) $f_1(\eta) = \underbrace{2e^{-\eta}(1-e^{-\eta})}_{\text{prob that segment "a" is hit and "b" escapes + prob that "b" is hit and "a" escapes}} + \underbrace{e^{-2\eta}}_{\text{prob. that both escape}}$

(8) $f_1(\eta) = 1-(1-e^{-\eta})^2$

That all segment pairs escape has probab.

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

we may write this also in the form

or if $\eta << 1$

(10) $\left[1-(1-e^{-\eta})^2\right]^{\frac{1}{(1-e^{-\eta})^2}} = e^{-1}$

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

(11) $\ln\frac{1}{f(\eta)} = m(1-e^{-\eta})^2 = \cancel{m\eta}$

(12) $\cong m\left(\eta - \frac{\eta^2}{2} + \frac{\eta^3}{6}\right)^2$

H

~~15 where $z = x + r$~~

19 $\ln\left(\frac{1}{f^*}\right) \simeq \varphi(x+r) - \varphi(r)$ ~~$\ln\frac{1}{f^*} = A^*$ | $A^* = \varphi(x+r) - \varphi(r)$~~

20 $A^* \simeq \frac{(x+r)^2}{4m}\left(1 - \frac{x+r}{2m} + \frac{7}{12m}\frac{(x+r)^2}{4m}\right) - \frac{r^2}{4m}\left(1 - \frac{r}{2m} + \frac{7}{12m}\frac{r^2}{4m}\right)$

~~writing t for chron age ... years of ... x = chron age~~ ~~x_0 for $x(r=0)$~~ $x = \frac{t}{\tau}$

~~if for $r = 0$ $t = t_0$ then for perfect birth. $A^* = \left(\frac{t_0}{\tau}\right)^2$~~

~~and~~

(21) $A^* \approx \varphi(x + r)$

writing for chron age at death "$t = t_0$" than for faultless ~~birth t_0~~ = we have

(22) $A^* = \varphi\left(\frac{t_0}{\tau}\right)$

and with r faults who dies at $t = t_r$

23 ~~$A^* = \varphi\left(\frac{t_r}{\tau} + r\right)$ $\frac{t_0}{\tau} = \frac{t_r}{\tau} + r$~~

24 or $A^* = \varphi\left(\frac{t_0}{\tau}\right) = \varphi\left(\frac{t_r}{\tau} + r\right)$

25 or $\frac{t_0}{\tau} = \frac{t_r}{\tau} + r$ or $t_r = t_0 - \tau r$

25

$$\ln \frac{1}{1-\sqrt{\frac{1}{m}\ln\frac{1}{f^*}}}$$

$$\boxed{\frac{X_r+r}{2m} \cong \sqrt{\frac{1}{m}\ln\frac{1}{f^*}} - \frac{1}{2}\frac{1}{m}\ln\frac{1}{f^*}}$$

$$X_r + r \cong \sqrt{4m\ln\frac{1}{f^*}} - \ln\frac{1}{f^*}$$

$$\frac{1}{m}\ln\frac{1}{p^*} = (1-e^{-z})^2$$

$$1-\sqrt{\frac{1}{m}\ln\frac{1}{p^*}} = e^{-z}$$

$$\ln\left(1-\sqrt{}\right) = -z$$

$$\boxed{\ln\frac{1}{1-\sqrt{\frac{1}{m}\ln\frac{1}{f^*}}} = \frac{X_r+r}{2m}}$$

$$\approx 2m\ln\left(1+\sqrt{\frac{1}{m}\ln\frac{1}{f^*}}\right) = X_r + r$$

$$\ln\frac{1}{f^*} = \frac{(x_r+r)^2}{4m}$$

$$4m\ln\frac{1}{f^*} = (X_r+r)^2$$

$$\log(1+X) = X - \frac{1}{2}X^2 + \frac{1}{3}X^3 - \frac{1}{4}X^4$$

$$\frac{1}{1-y} = 1 + y + y^2 + y^3$$

$$\boxed{\ln(1+y+y^2)} = \cancel{y}\, y + y^2 - \frac{1}{2}(\cancel{y}\, y+y^2)^2$$

$$= \cancel{1} + y + y^2 - \frac{1}{2}y^2 = \boxed{\cancel{1} + y + \frac{1}{2}y^2}$$

$$\boxed{y = \sqrt{\frac{1}{m}\ln\frac{1}{f^*}}}$$

$\frac{1}{m} \ln f^* = \ln\left(1-(1-e^{-y})^2\right)$

(19) $\frac{1}{m} \ln \frac{1}{f^*} = \ln \frac{1}{1-\underbrace{(1-e^{-y})^2}_{z}} \cong z + \frac{1}{2} z^2$

(20) $\frac{1}{m} \ln \frac{1}{f^*} = y^2 - y^3$

or with $y = \frac{x+r}{2m}$ we obtain

(21) $\ln \frac{1}{f^*} = \frac{(x+r)^2}{4m}\left(1 - \frac{x+r}{2m}\right)$

$$e^{\frac{1}{m} \ln f^*} = \frac{1}{1-(1-e^{-y})^2}$$

$$e^{-\frac{1}{m} \ln \frac{1}{f^*}} = 1-(1-e^{-y})^2$$

$$1-e^{-\frac{1}{m} \ln \frac{1}{f^*}} = (1-e^{-y})^2$$

$$\sqrt{1-e^{-\frac{1}{m} \ln \frac{1}{f^*}}} = 1-e^{-y}$$

$$e^{-y} = 1-\sqrt{1-e^{-\frac{1}{m} \ln \frac{1}{f^*}}}$$

$$-y = \ln\left(1-\sqrt{1-e^{-\frac{1}{m} \ln \frac{1}{f^*}}}\right)$$

(22) $y = \ln \frac{1}{1-\sqrt{1-e^{-\frac{1}{m} \ln \frac{1}{f^*}}}}$

$$y \cong \sqrt{1-e^{-\frac{1}{m} \ln \frac{1}{f^*}}} + \frac{1}{2}\left(1-e^{-\frac{1}{m} \ln \frac{1}{f^*}}\right)$$

$\ln \frac{1}{1-z} = z + \frac{1}{2} z^2$

For proper De Novo

$$\cancel{\frac{1}{m}\ln\frac{1}{f^*} = (1-e^{-y})^2 - 1 = -2e^{-y}+e^{-2y}}$$

$$f^* = \left(1-(1-e^{-y})^2\right)^m$$

$$\frac{1}{m}\ln f^* = \ln\left(1-(1-e^{-y})^2\right)$$

$$\frac{1}{2}(1-e^{-y})(1-e^{-y})^2$$

$$(1-e^{-y})^2 =$$

$$= 1-2e^{-y}+e^{-2y} = 2y - 2y - y^2 + \frac{2}{6}y^3 + 4y^2 - \frac{8y^3}{6}$$

$$\boxed{\frac{1}{m}\ln\frac{1}{f^*} = y^2 - y^3}$$

$$y = \frac{x+r}{2m}$$

$$\ln\frac{1}{f^*} = \frac{(x+r)^2}{4m} - \frac{(x+r)^3}{8m^2} = \frac{(x+r)^2}{4m}\left(1-\frac{x+r}{2m}\right)$$

$$\ln\frac{1}{1-z} = z + \frac{1}{2}z^2$$

$\cancel{\ln 1/\varphi^* = 1}$ $\ln \frac{1}{\varphi^*} = 1$

A) $\tau = \frac{80.5}{9} = 8.9$ years. $\varphi = 0.82$

B) $\tau = \frac{6.15}{0.82} = 7.5$

$\ln \frac{1}{\varphi^*} = 2$ $\varphi = 0.726$

A $\tau = 5.75$

B) $\tau = 8.5$ years

$\ln \frac{1}{\varphi^*} = 1.5$ $\varphi = e^{-\frac{11.8}{46}} = e^{-0.257}$ 0.773

$\frac{80.5}{11.8 + 1.5 - 1.6} = \cancel{6.8 \text{ years}}$

A) $\tau = 6.8$ years

B.) $\tau = \frac{6.15}{.773} = 7.95$

$\ln \frac{1}{\varphi^*} = 1.2$ $e^{-1.2} = 0.3$ 0.16

A) $\tau = \frac{80.5}{10.5 + 1.2 - 1.6} = 8$ $e^{-0.225} = 0.78$ ≈ 0.78

B) $\frac{6.15}{0.78} = \tau = 7.9$ 2.48

$\ln \frac{1}{\varphi^*} = 1.3$ $\frac{10.7}{46} = 0.233$

A) $t = \frac{80.5}{11.0 + 1.3 - 1.6} = \frac{80.5}{10.7} = 7.5$

B.) $\tau = \frac{6.15}{}$

23

$$y \approx \sqrt{\frac{1}{m}\ln\frac{1}{f^*}} + \frac{1}{2}\frac{1}{m}\ln\frac{1}{f^*}$$

$$y = \frac{X+r}{2m}$$

(24) $$\boxed{x_r + r = \sqrt{4m\ln\frac{1}{f^*}} + \ln\frac{1}{f^*}}$$

~~Or including ...~~

Higher order terms

$$y = \sqrt{\frac{1}{m}\ln\frac{1}{f^*} - \frac{1}{2}\frac{1}{m^2}\left(\ln\frac{1}{f^*}\right)^2} + \frac{1}{2}\left(\frac{1}{m}\ln\frac{1}{f^*} - \frac{1}{2}\frac{1}{m^2}\ln^2\frac{1}{f^*}\right)$$

$$\sqrt{\frac{1}{m}\ln\frac{1}{f^*}}\sqrt{1-\frac{1}{2}\frac{1}{m}\ln\frac{1}{f^*}} + \frac{1}{2}\frac{1}{m}\ln\frac{1}{f^*}\left(1-\frac{1}{2m}\ln\frac{1}{f^*}\right)$$

$$X+r = \sqrt{4m\ln\frac{1}{f^*}}\left(1-\frac{1}{4m}\ln\frac{1}{f^*}\right) + \ln\frac{1}{f^*}\left(1-\frac{1}{2m}\ln\frac{1}{f^*}\right)$$

O.K.

$$\tau = \frac{80.5}{\sqrt{4m\ln\frac{1}{f^*}} + \ln\frac{1}{f^*} - (n-\frac{1}{2})}$$

$$\ln\frac{1}{f^*} = 2.5$$ ~~... 19.65 = 1.6 = 18~~

15.2
2.5
17.7
1.6
16

$$\frac{80.5}{16} =$$

$$\left(\frac{t_0}{\tau_{2m}}\right) = \sqrt{\frac{1}{m}\ln\frac{1}{p^*}} + \frac{1}{2m}\ln\frac{1}{p^*}$$

$$\tau = \tau^* \times e^{\sqrt{\frac{1}{m}\ln\frac{1}{p^*}} + \frac{1}{2m}\ln\frac{1}{p^*}}$$

$\tau^* = 6$ years for $n = 2.5$, –

$$\frac{\delta 0.5}{\tau} + \left(n - \tfrac{1}{2}\right) = \left(\sqrt{4m\ln\frac{1}{p^*}} + \ln\frac{1}{p^*}\right)$$

$$\frac{\delta 0.5}{\tau^* e^{\frac{1}{2m}\left(\sqrt{4m\ln\frac{1}{p^*}} + \ln\frac{1}{p^*}\right)}} = (\sqrt{\ } + \ln) -$$

$$\tau^* = \frac{\delta 0.5}{e^{\frac{1}{2m}(\ )}\left[(\ ) - \left(n - \frac{1}{2}\right)\right]}$$

$$\tau^* = \frac{\delta 0.5}{(\ ) + \frac{1}{2m}(\ )^2 + \frac{1}{4m^2}(\ )}$$

$$\frac{\beta\left(\sqrt{4m\ln\frac{1}{p^*}} + \ln\frac{1}{p^*}\right) - \left(n - \frac{1}{2}\right)}{\beta}$$

$$\tau^* = \frac{\delta 0.5}{\left(\sqrt{4m\ln\frac{1}{p^*}} + \ln\frac{1}{p^*}\right) + \frac{1}{2m}(\ ) - \left(n - \frac{1}{2}\right)e^{\frac{1}{2m}(\ )}}$$

$$\beta = e^{-\frac{1}{2m}(\ )}$$

Nrohe $f = 2$

$M/f^* = 1.2$

$k_F + r = \sqrt{k_B 2m \; 1.2} + 1.2$

0.5

τ^* versus τ

$t = t_0 - \beta r \tau \qquad \beta = e^{-\frac{t}{2m}} = e^{-\frac{t}{\tau 2m}}$

$(n - 1/2)$

$r = \frac{t_0 - t}{\beta \tau}$

$-\frac{dr}{dt} = \left(\frac{1}{\beta} - \frac{t_0 - t}{\beta^2} \frac{d\beta}{dt} \right) \frac{1}{\tau}$

$P(r) \frac{dr}{dt} dt$

$-\frac{dr}{dt} = \underbrace{\frac{1}{\beta \tau}}_{\tau^*} \left(1 - \frac{d\beta}{dt} \frac{t_0 - t}{\beta} \right)$

$\frac{1}{\beta\tau}\left(1 - \frac{d\beta}{dt} \frac{t_0 - t}{\beta}\right) =$

$= \frac{1}{\beta \tau} \left(1 + \frac{t_0 - t}{\tau 2m} \right) = \frac{1}{\tau} e^{+\frac{t}{\tau 2m}} \; e^{+\frac{t_0 - t}{\tau 2m}}$

$-P(r) \frac{dr}{dt} = \frac{1}{\tau} \times e^{\frac{t_0}{\tau 2m}} \; e^{\frac{t_0 - t}{\tau 2m}}$

for small $\frac{t_0 - t}{\tau 2m}$

$\tau^* = e^{-\frac{t_0}{\tau 2m}} \tau$

where we may write

$e^{+\frac{t_0 - t}{\tau 2m}} = 1 + \frac{t_0 - t}{\tau 2m}$

contd from prec-page

$$\tau^* = \frac{80.5}{\frac{t_0}{\tau} + \frac{1}{2m}\left(\frac{t_0}{\tau}\right)^2 - \left(n - \frac{1}{2}\right)\left(1 + \frac{1}{2m}\frac{t_0}{\tau}\right)}$$

$$\frac{t_0}{\tau} = \sqrt{4m \ln \frac{1}{4\nu}} + \ln \frac{1}{4\nu}$$

for what $\frac{t_0}{\tau}$ gives $\tau^* = 6$ years?

Fitting the curves to life tables at 70–71   H   90–91

$\frac{1}{1.15}$ $\frac{1}{1.925}$

$n = 2.5$

max at $\underline{n=2}$ / factor 1.5 at

factor of 1.65 drop from max gives σ (for abs = 10.1 years)

$\sigma_{40}(\text{twins}) = \frac{2.6 \times 1.31}{1.13} = 3 \text{ years}$

$(10.1)^2 - (3)^2 = (9.65)^2$

$\begin{array}{r} 102 \\ -9 \\ \hline 93 \end{array}$ $\begin{array}{r} 101 \\ 96.5 \\ \hline 4.5 \end{array}$ or 4.5%

$$\frac{80.5}{\tau^*} + n - \frac{1}{2} = \sqrt{4m \ln \frac{1}{p^*}} + \ln \frac{1}{p^*}$$

$$\frac{1}{1 + \frac{n}{2m}}$$

$$\times$$

$$+ \sqrt{4 \ln \frac{1}{p^*}} + \sqrt{\frac{1}{m}} \ln \frac{1}{p^*} \sqrt{\ln \frac{1}{p^*}}$$

$$\frac{80.5}{\tau^*} + n - \frac{1}{2} = \left(\sqrt{4m \ln \frac{1}{p^*}} + \ln \frac{1}{p^*} + 2\sqrt{\ln \frac{1}{p^*}} + \cancel{\sqrt{\left(\ln \frac{1}{p^*}\right)^3} \times \sqrt{\frac{1}{m}}} \right)$$

15.4

error

$$\frac{1}{1 + \frac{n - \frac{1}{2}}{2m}}$$

$$= 10.5 + 1.2 + 2.2 + \sqrt{\frac{1.7}{m}} \cong 1$$

$$\cancel{\ln \frac{1}{p^*} = \left(\frac{80.5}{\tau} + n - \frac{1}{2}\right)^2}$$

Unnecessary, useless, odd

$$\frac{80.5}{\tau} + \left(n - \frac{1}{2}\right)\beta^* = \frac{t_0}{\tau} = \left(\sqrt{4m \ln \frac{1}{p^*}} + \ln \frac{1}{p^*} \right)$$

$$\beta^* \tau = \tau^*$$

$$\tau = \frac{80.5}{\sqrt{4m \ln \frac{1}{p^*}} + \ln \frac{1}{p^*} - \left(n - \frac{1}{2}\right)\beta^*}$$

$$\tau^* = \frac{80.5}{\sqrt{} + \ln \frac{1}{p^*} - \left(n - \frac{1}{2}\right)\beta^*} \beta^*$$

$$\sqrt{4m \ln \frac{1}{p^*}} + \ln \frac{1}{p^*} = \frac{80}{\tau^*}\beta^* + \left(n - \frac{1}{2}\right)\beta^* = \left[\frac{80}{\tau^*} + \left(n - \frac{1}{2}\right)\right]\beta^*$$

$\ln\frac{1}{p^*}$ for $n = 2.5$

M

$\cancel{80.5 + \tau^*(n-\frac{1}{2})} = t_0$

$\frac{80.5}{\beta^*\tau} + \frac{\tau^*}{\beta^*\tau}(n-\frac{1}{2}) \frac{1}{\beta^*}\frac{t_0}{\tau} =$

$\tau^*_{max} = \beta_{max}\tau$

$$\ln\frac{1}{p^*} = \frac{\left[\frac{t_m}{\tau} + \beta_{(max)}(n-\frac{1}{2})\right]^2}{4m} \left[1 - \frac{c}{2m}\right]$$

$\beta_{max}\tau = \underline{6 \text{ years}}$

$\beta^* = e^{-\frac{t}{2m\tau}}$ $\frac{80.5}{\tau^*} + n - \frac{1}{2} = \frac{1}{\beta^*}\left(\frac{t_0}{\tau}\right)$

$$\boxed{\beta^*_t = \beta_0 e^{\frac{2.5}{2m}} = \beta_0(1 + \frac{2.5}{2m})}$$

$$\boxed{\beta_0 = \left(1 - \sqrt{\frac{1}{m}\ln\frac{1}{p^*}}\right)}$$

$\frac{80.5}{\tau^*} + n - \frac{1}{2} = \frac{t_0}{\tau} \times \frac{1}{1 - \sqrt{\frac{1}{m}\ln\frac{1}{p^*}}} \frac{1}{(1 + \frac{2.5}{2m})}$

$\frac{80.5}{\tau^*} + n - \frac{1}{2} = \left(\sqrt{4m\ln\frac{1}{p^*}} + \ln\frac{1}{p^*}\right) \times$

$$\cancel{\ldots}\sqrt{4m \ln \frac{1}{p*}} + \ln \frac{1}{p*}$$

$$= \frac{80.5}{\tau*} + \left(n - \frac{1}{2}\right)\left[1 + \frac{n-1}{2m}\right]$$

$$1 - \cancel{\ldots} \frac{1}{2m}\sqrt{4m \ln \frac{1}{p*}}$$

$$\sqrt{4m \ln \frac{1}{p*}} + \frac{1}{\cancel{2m}} \cancel{4m} 2 \ln \frac{1}{p*} + \ln \frac{1}{p*}$$

$$\boxed{\sqrt{4m \ln \frac{1}{p*}} + 3 \ln \frac{1}{p*} = \left(\frac{80.5}{\tau*} + n - \frac{1}{2}\right)\left[1 + \frac{n-1}{2m}\frac{\tau}{\tau*}\right]}$$

$$\tau* = \frac{9.3}{\sqrt{n}}$$

Check $\qquad$ M

$$\beta_0 = e^{-\frac{t_0}{\tau}\frac{1}{2m}}$$

$$\sqrt{4m \ln\frac{1}{p^*}} + \ln\frac{1}{p^*} = \left[\frac{80.5}{\tau^*} + (n - 1/2)\right]\left[1 - \sqrt{\frac{1}{m}\ln\frac{1}{p^*}}\right] \times \left[1 + \frac{n-\frac{1}{2}}{2m}\right]$$

$$\beta_0 = 1 - \sqrt{\frac{1}{m}\ln\frac{1}{p^*}}$$

$$\underbrace{10.5 + 1.2}_{11.7} = [13.4 + 2]\overbrace{\underbrace{[1 - 2.28]}_{0.772}}^{\beta^0}[1.0435]$$

$\underbrace{0.772 \times 1.04}_{0.805}$

$\cancel{18.2}$ 15.4 $\times$ 0.805

$$\beta_0^2 = \cancel{1 - 2\sqrt{\frac{1}{m}\ln\frac{1}{p^*}}} = 1 - 2\sqrt{\frac{1}{m}\ln\frac{1}{p^*}}\ 2.24 + \frac{1}{m}\ln\frac{1}{p^*}$$

$$(\beta^*)^2 = \beta_0^2\left[1 + \frac{n - 1/2}{m}\right] = 1 - .456 + 0.052 = 0.6$$

$\cancel{(\beta^*)^2 = 0.6 \times 1.09 = .65}$

De Nunno different

$$\ln\frac{1}{p^*} = \frac{\left[\frac{80.5}{\tau^*}\beta^* + (n - \frac{1}{2})\beta^*\right]^2}{4m}\left(1 - \frac{\quad}{2m}\right)$$

$(1 - 0.267) = 0.733$

$$\ln\frac{1}{p^*} = \frac{(\beta^*)^2\left[\frac{80.5}{\tau^*} + n - \frac{1}{2}\right]^2}{4m}\left(1 - \frac{\beta^*\left[\frac{80.5}{\tau^*} + (n - \frac{1}{2})\right]}{2m}\right)$$

$\frac{0.8}{46} \times 15.4$

1.3

$$\ln\frac{1}{p^*} = 0.65 \times \frac{240}{92} \times 0.733$$

If we assume $n \geq 3$ the Poisson P distribution(?) comes very close to a Gaussian. We may then write for the ~~standard~~ square root of the variance i.e. the standard deviation σ

$$\sigma = \frac{\tau^*}{\sqrt{n}}$$

The observed value at 70.5 ~~of years of age~~ of 0.67 corresponds to a distance of 0.9σ from ~~the~~ t^* and thus we would obtain $\sigma =$. The observed value ~~of~~ at 90.5 years of age corresponds to 1.14σ and thus we would obtain $\sigma =$. On this basis we may estimate

$$(\quad) \qquad \sigma = 9.8 \text{ years}$$

And thus we may write

$$(\quad) \qquad \tau^* = \frac{9.8}{\sqrt{n}} \text{ years}$$

Correction of τ^*

The value of t^*, —

maximum of deaths/year close to ~~t^*~~ $n - \frac{1}{2}$ $\quad r =$

$$\frac{t^*}{\tau} \cancel{+ r^*} \beta^* = \frac{t_0}{\tau} \qquad r^* \approx n - \frac{1}{2}$$

$t^* = 80.5 \qquad n = 2.5$

or

$$\left(\frac{t^*}{\tau^*} + r^*\right) = \frac{t_0}{\tau}\frac{1}{\beta^*} \qquad \beta_0 = e^{-\frac{1}{2m}\frac{t_0}{\tau}} =$$

$$\text{and } \beta^* = e^{-\frac{1}{2m}t^*} = \beta_0 e^{\frac{1}{2m}\frac{t_0 - t^*}{\tau}} \qquad = 1 - \sqrt{1 - e^{\dots}}$$

$$\beta^* \approx \beta_0 \left(1 + \frac{1}{2m} r^* \frac{\tau}{t^*}\right) \qquad = 1 - \sqrt{\frac{1}{m}\ln \frac{\dots}{f^*}}$$

Paper H

our crude theory ~~may be expected~~ might well
~~to~~ give too low values for the number
of deaths per year ~~at~~ at lower ages ~~than we should~~
~~expect I than to find in reality~~. This
is due to the assumption of the crude theory
that there is no appreciable death prior to
the critical year for a group of genetically
identical individuals.* In these circumstances
we shall ~~turn further below the~~ ~~[illegible]~~
~~of a differ~~ adopt a different kind of
reasoning for obtaining an upper bound
for the value of n. As we shall
see later ~~$n = 2.5$ will appear~~

( ) $n = 2.5$

may be regarded as a reasonable
estimate for the value of n.

For $n = 2.5$ we obtain ~~[illegible]~~ from ( ) $r^* = 2$

Further ~~$r^* = 2$~~ ~~for $r_1 = 2$~~ we obtain $R(r_1) =$ ... which corresp. to the ratio for 70.5 years
~~and for r_2 ... $R(r_2) =$ for $r_1 =$~~
~~and this gives ... would give us from~~
~~we would therefore write from~~ by setting
~~$\Delta t = 10$ in ( ) we thus and $\Delta r =$ in~~
by substituting into ( ) $\Delta r =$ and
$\Delta t = 10$ we would thus obtain
$\tau^* =$

On the other hand we obtain $R(r_2) =$ which
corresponds to the ... ratio for 90.5 years
and by substituting $\Delta r =$ and $\Delta t = 10$
into ( ) we obtain We may
therefore set the estimated value of
τ^* ~~for $n = 2.5$~~

( ) $\tau^* =$ for $n = 2.5$

Greenhouse

$$\frac{80.5}{\tau^*} + \left(n - \frac{1}{2}\right) = H\left(1 - \frac{t_0 - t}{\tau}\frac{1}{2m}\right)^{\frac{1}{2}}$$

$$H = \sqrt{4m \ln\frac{1}{f^*}} + 3\ln\frac{1}{f^*} + \frac{1}{m}\sqrt{4m\ln\frac{1}{f^*}}\ \ln\frac{1}{f^*} +$$

$$H = \left(1 + \frac{1}{2m}A\right)A$$

$$A = \sqrt{4m\ln\frac{1}{f^*}} + \ln\frac{1}{f^*}$$

for $\ln\frac{1}{f^*} = 1$: $H = 13.01$

2 $H = 20.74$

$\ell\ \ln = 3$. $H = 27.78$

Rechen

$\boxed{n = 4 \quad \text{[illegible] } 20.82}$ neglecting

$7.15 - 5\% = 6.$

n=2 $\frac{80.5}{6.8} + 1.5 =$

$\frac{12.5}{1.5}$ $= H = 14$

$$\frac{80.5}{4.6} + 3.5 = 17.5$$

3.5

$H = 21.0$

$4 = \frac{9.8}{\sqrt{4}} = 4.85$

$4.85 \times 95\% =$

$\tau^*_{corr} = 4.6$

M

Exacta: $\Psi(r) = \frac{(\beta r)^2}{4m}\left(1-\frac{\beta r}{2m}\right)$

~~$\ln\frac{1}{f_*} + \Psi(r) = m \ln$~~

$\ln\frac{1}{f_*} + \frac{(\beta r)^2}{4m}\left(1-\frac{\beta r}{2m}\right) = m \ln \frac{1}{1-(1-e^{-t})^2}$

$= K$

~~$\ln f_*(\beta r)$~~ $= K$

$$\boxed{\frac{t r}{\tau} = \sqrt{4m K_*} + K_* - (\beta r)}$$

O.K. $\boxed{\beta = 1}$

$$q(y+z) = q(y) - 2e^{-y}(1-e^{-z}) + e^{-2y}(1-e^{-2z})$$

$$A)\ q = q(y) - 2e^{-y}(1-e^{-y})\left(z - \frac{z^2}{2} + \frac{z^3}{6}\right)$$

$$B)\ q(y+z) = q(y) - 2e^{-y}\left(z - \frac{z^2}{2} + \frac{z^3}{6}\right) + e^{-2y}\left(2z - \frac{(2z)^2}{2} + \right.$$

$$A)\ q = q(y) - 2e^{-y}\left(z - \frac{z^2}{2} + \frac{z^3}{6}\right) + 2e^{-2y}\left(z - \frac{z^2}{2} + \frac{z^3}{6}\right)$$

B.)

$$e^{-2y}\left(2z - \frac{2z^2}{2} + \frac{2z^3}{6}\right)$$

If we neglect terms of z^2

$$q(y) = 2e^{-y}(1-e^{-y}) + e^{-2y}$$

$$= \cancel{}$$

$$q = 2\,e^{-y}(1-e^{-y})\cancel{(1-e^{-\frac{x}{2m}})}e^{-\frac{x^2}{2m}} + e^{-2y}$$

$$q = \cancel{2e^{-y}(1-e^{-y}) + e^{-2y}} \cancel{2e^{-y}(1-e^{-y})e^{-\frac{x^2}{2m}}}$$

$$q = 2e^{-y}(1-e^{-y})\,e^{-\frac{x}{2m}} + e^{-2y}$$

$$+2e^{-y}(1-e^{-y}) - 2e^{-y}(1-e^{-y})$$

A) $q = q(y) + \cancel{e^{-2y}}$ $\underline{2e^{-y}(1-e^{-y})\left(1-e^{-\frac{x^2}{2m}}\right)}$

writing $\frac{x^2}{2m} = z$

$$q(y) = 1-(1-e^{-y})^2 = \underline{2e^{-y}+e^{-2y}}$$

$$q(y+z) = 1-(1-e^{-y}e^{-z})^2 =$$

$$1-\left[1-2e^{-y}e^{-z}+e^{-2y}e^{-2z}\right]$$

$$q(y+z) = 2e^{-y}e^{-z} - e^{-2y}e^{-2z}$$

$$+2e^{-y} - 2e^{-y}$$

$$\boxed{q(y) = 2e^{-y} - e^{-2y}}$$

B) $q(y+z) = 2e^{-y}e^{-z} - e^{-2y}e^{-2z}$

$$+2e^{-y} - 2e^{-y} - e^{-2y} + e^{-2y}$$

$$8 \quad \frac{1}{m} \ln \frac{1}{f} = m \ln \frac{1}{1-(1-e^{-\eta})^2}$$

or inversely

$$(9) \quad \eta = \ln \frac{1}{1-\sqrt{1-e^{-\frac{1}{m}\ln\frac{1}{f}}}}$$

~~developed in second approx~~

10 for $\eta \ll 1$ ~~we~~ and $\frac{1}{m} \ln \frac{1}{f} \ll 1$

we obtain in second approx

$$11 \quad \ln \frac{1}{f} = \eta^2 - \eta^3$$

and from 1)

$$12 \quad \eta = \sqrt{\frac{1}{m} \ln \frac{1}{f}} + \frac{1}{2m} \ln \frac{1}{f}$$

~~for the total number~~ ~~At~~ the ~~time~~ age at death t / ~~we have~~ ~~we may~~ $f = f^*$

( ) ~~we we write~~ ~~$f_X = f^* 2m\xi$~~ / and ~~for~~ the average total number of aging hits ~~for the tot~~ ~~in~~

~~for the~~ ~~haploid~~ ~~set~~ ~~of~~ ~~chromo~~ two ~~homologous~~ set of homologous chromo of the somatic cell is given by

$$(\ ) \quad X_* = 2m\xi = 2m\frac{t}{\tau}$$

Paper

$\cancel{q = 2e^{-\frac{\xi}{2m}} e^{-\frac{r}{2m}}}$ (1) $\xi = \frac{\text{chrom age}}{2m\tau}$

ξ ~~prob that a chromosome has~~

ξ average number of breaks per chromosome

ρ average number of faults per chromosome

(2) $q = 2e^{-\xi}e^{-\rho}(1-e^{-\xi}) + e^{-2\xi}$

and ~~to~~ ~~so~~ neglecting terms higher than ρ (3) $\rho =$

ξ this is the approx

$\cancel{q \approx 2e^{-(\xi+\rho)} \quad + e^{-2(\xi+\rho)}}$

~~(3) or writing $\xi+\rho = \eta$~~

$\cancel{q = 2e^{-\eta} + e^{-2(\eta)}}$

(4) $q = 2e^{-(\xi+\rho)}(1-e^{-(\xi+\rho)}) + e^{-2(\xi+\rho)}$

(5) $\xi+\rho = \eta$

(6) $q = 1-(1-e^{-\eta})^2$

(7) $\hat{f} = q^m = [1-(1-e^{-\eta})^2]^m$

$\ln\frac{1}{f^*}$	t/τ	
		$92 \cdot 1.2 = 10.48$ $\quad$ 1.2 $\quad$ 11.7
1	10.59	
1.2	11.7	
1.3	13.3	~~close to n = 2~~
1.4	14.3	
1.35	13.75	$(n=2)$ $\boxed{f^* = 0.26}$ close to $\frac{1}{4}$
2	15.7	$(n = 2.5)$ $f^* = 0.135$ $\boxed{1/f^* = \frac{1}{7.4}}$
2.5	17.66	$(n = 3)$ $f^* = 0.082$ $\frac{1}{f^*} = \frac{1}{12.4}$
3	19.6	

12.9, 1.4, 3

12.3, 12.4

12.4, 1.35

276, $\frac{13.75}{2}$, 15.466, 15.36, 2.5, 16.613, 3

for $n = 2.5$ $\quad \frac{t_0}{\tau} = 15.56$ affect at last hit is ~~factor~~ what?

$$\ln\frac{1}{f^*} = \left(\frac{\frac{t}{\tau}+r}{4m}\right)^2\left(1-\frac{\frac{t}{\tau}+r}{2m}\right)$$

$$\ln\frac{f}{f^*} = \cancel{\left[\left(\frac{t_0}{\tau}-1\right)+r\right]^2}$$

$$\frac{d}{dx}\left[\frac{x+r}{4m}\right]^2\left[1-\frac{x+r}{2m}\right]$$

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

and ~~[illegible]~~ working

14 $\cancel{A}\ \frac{x_r + r}{2m} = y$

~~we obtain from ( )~~ we ~~obtain at the age of start~~

(15) ~~[illegible]~~ $+ z = y$

Thus at the age of death

one may write from ( )

(16) $\ln \frac{1}{p^*} =$

and from ( )

(17) $x_r + r =$

$\frac{80.5}{9.3}\sqrt{n} + n - 0.5 = \frac{t_0}{\tau}$

$8.65\sqrt{n} + n - 0.5 = \frac{t_0}{\tau}$

2	~~2.8~~	$8.65 \times 1.41 + 1.5 =$	13.7
~~2.5~~ 2.5	~~8~~ 4	$8.65 \times 1.58 + 2 =$	15.7
3		$8.65 \times 1.73 + 2.5$	17.5
4		$8.65 \times 2 + 3.5$	20.8

$n = 2.5\ \sqrt{2.5} = 1.58$

$n = 2\ \sqrt{2} = 1.41$

$n = 3\ \sqrt{3} = 1.73$

$n = 4\ \sqrt{4} = 2$

$\cancel{}\; e^{-\cancel{}(f)^{\cancel{}}}$ = Proba of degeneracy per year

$\ln \frac{1}{p} = \cancel{}\, F(x_0)$

$\ln p = -F(x_0)$ $\left(p = e^{-F(x_0)} \right.$

$\ln C \; \cancel{}\; (p)^{b}$ = log prob

log 1

$$\frac{15.5}{46}\left(1-\frac{15.5}{46}\right)-\frac{(15.5)^2}{8\times(23)^2}\ \mathcal{H}$$

$$= 0.337(0.663) = \underline{0.223}$$

$$\frac{1}{f\alpha} = e^{-0.223} \approx .800 \text{ or } \frac{1}{1.25}$$

much bigger effect is factor $\underline{2}$

middle age $n = 2.5$

~~Check 80.5 years also.~~

$$\ln\frac{1}{f\alpha} = \frac{(8.65\sqrt{n}+n-0.5)^2}{4m}\left(1-\frac{(\ \ )}{2m}\right)$$

$$= \frac{242}{92}\left(1-\frac{15.56}{46}\right) = \underline{1.74}$$

.662

~~.338~~

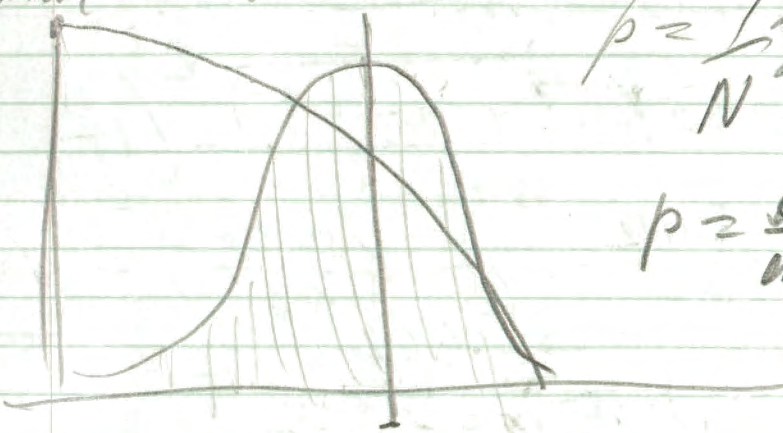
$$e^{-1.74} = \boxed{0.175}$$

$$\cancel{f^{\frac{j}{m}} = e^{+\frac{\ln f}{m}}}$$

$$p = e^{-x[f(t)]^y}$$

$$\boxed{\cancel{f = \tfrac{1}{6}} \quad \cancel{p = 0.9}}$$

and middle



$f = 6$

$$p = \frac{1}{N}\frac{dN}{dt}$$

$$p = \frac{d}{dt}\log N$$

$$\ln\frac{1}{f_*} = \frac{\left(\frac{t}{\tau}\right)^2}{4m}$$

$$f = e^{-\left(\frac{t}{\tau}\right)^2 \frac{1}{4m}}$$

New Approx: keeping x^2 but neglecting $\rho^2 r$;

$$q = q^* + e^{-2\xi}\rho^2$$

$$q = 1-(1-e^{-\xi})^2 + e^{-2\xi}\rho^2$$

$$\underline{e^{-2\xi} \approx 1 - 2\xi}$$

$$q^m = \left(1-(1-e^{-\xi})^2 + \rho^2\right)^m$$

$$\frac{1}{m}\ln f^* = 1-(1-e^{-\xi})^2 + \rho^2$$

$$\underline{A = 1}$$

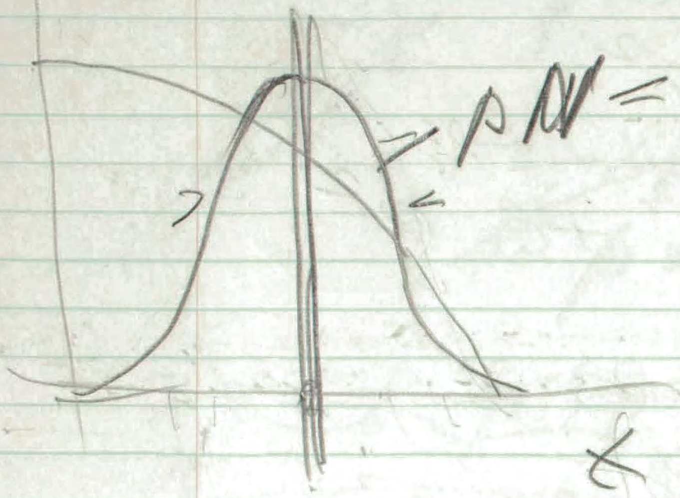
$$\xi = \ln \frac{1}{1-\sqrt{1-f^{\frac{1}{m}}+\rho^2}} \qquad \rho = \frac{r}{2m}$$

$$x + r = 2m \ln \frac{1}{1-\sqrt{1-f^{\frac{1}{m}}+\frac{r^2}{4m^2}}}$$

$$\ln \frac{1}{1-\sqrt{(1-f^{\frac{1}{m}})}\sqrt{1+\frac{\rho^2}{1-f^{\frac{1}{m}}}}}$$

$$\ln \frac{1}{1-\sqrt{\underbrace{\frac{1}{m}\ln\frac{1}{f} + \rho^2 - \frac{1}{2m^2}\left(\ln\frac{1}{f}\right)^2}_{z}}} = \ln(1+z+z^2)$$

$p = e^{-x(t)^{y}}$ $\qquad f(t)$



$pN = f(t) \qquad p = \frac{1}{N}\frac{dN}{dt}$

3.4 years

$\int (t_1 - t_2)\, f(t)$ ~~f(t) dt, dt years~~

3.4 years

M

~~N~~ old

$$x + r = \sqrt{4m^2 \frac{1}{m} \ln \frac{t}{f^*}} + m \frac{1}{m} \ln \frac{t}{f^*}$$

new

$$x + r = \sqrt{4m^2\left(\frac{1}{m} \ln \frac{t}{f^*} + \rho^2\right)} + m\left(\frac{1}{m} \ln \frac{t}{f^*} + \rho^2\right)$$

$$x + r = \left[\sqrt{4m \ln \frac{1}{f^*} + r^2} + \ln \frac{1}{f^*} + \frac{r^2}{4m}\right]$$

$$\rho^2 = \frac{r^2}{4m^2}$$

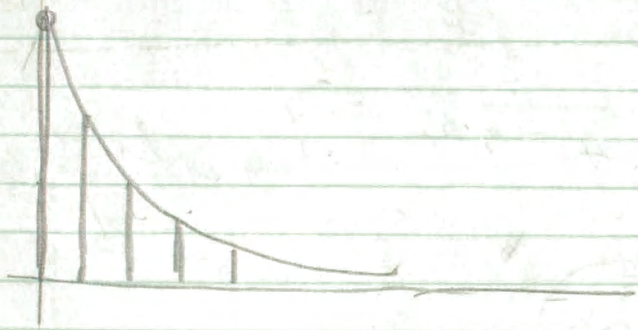
$$\frac{t}{\tau} = \left[\quad\right]^2 - r$$

Check Gaussian

$$\begin{array}{r} .2665 \\ \underline{0.95} \\ 0.208 \end{array} \qquad \begin{array}{r} 1.145 \\ 2.045 = \end{array}$$

O.K.

Semi-lattice!



0 1 2 3

(01) ok. $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}$ | $\frac{1}{16}$ $\frac{1}{32}$ $\frac{1}{64}$

$\xi = \frac{1}{8}$

$A_1 + A_2 + A_3 + A_4 + A_8$ | probab of succ. for a full unit.

Number of segments

Prom(42) $\quad 4m = 184 \quad m = 2\times 23$

$2m = 92$

$$(92) = \ln\frac{1}{f^*} = \frac{1}{4m}\left(\frac{80.5}{9.3}\sqrt{n} + n - 0.5\right)\left[1 - \frac{1}{2m}\left(\frac{80.5}{9.3}\sqrt{n} + n - 0.5\right)\right]$$

$n = 2.5$

$$= \ln\frac{1}{f^*} = \frac{1}{184}\underbrace{(8.65 \times 1.58 + 2)}^{2}\left[1 - \frac{1}{92}(\quad)\right]$$

$m = 2\times 23 \quad \frac{(15.7)^2}{184} = 1.34\,(\underbrace{1 - 0.17}_{.83}) = 1.1$

try $n = \cancel{10}$

$$\ln\frac{1}{f^*} = \frac{1}{184}\left(\frac{\cancel{\ }\ 27.4}{9.5}\right. = 4.17$$

$$(36.9)^2 = \frac{1360}{184}\left(\underbrace{\underbrace{1 - \frac{40}{92}}_{1-0.435}}_{.565}\right) =$$

$n = 4 \quad m = 23$

$$\ln\frac{1}{f^*} = \frac{1}{92}\underbrace{(8.65\times 2 + 3.5)}_{}{}^{2}\left(1 - \frac{1}{46}\right.$$

17.3
3.5

$$(20.8)^2 = \frac{430}{92}\left(\underbrace{1 - \frac{20.8}{46}}_{\substack{1-.45\\ .55}}\right) = 2.57$$

Check on $\frac{t_0}{\tau}$ for fixed n, changing

$~~\text{ee.}~~ \; 8.65 \sqrt{n} + n - \frac{1}{2}$

$n = 2.5 =$

13.6 $\qquad$ 2^{45} $\qquad$ 0.34

$\boxed{f = 1}$

$$\ln \frac{1}{f^*} = \frac{\boxed{15.0}}{92} \left(1 - \frac{15.7}{46}\right) =$$

2 $\;$ = 11

$\times$ 0.66 $\qquad$ = 1.76

0.085 $\qquad$ $f^* = 0.172 = \frac{1}{5.8}$

$f = 2$

$$\ln \frac{1}{f^*} = \frac{246}{184} \left(1 - \frac{15.7}{184}\right)$$

1.34 $\quad$ .915 $\qquad$ $= 1.23$

$f^* = 0.325$

$= \frac{1}{3}$

$$\ln f\varphi = \xi^2 - \xi^3 + p$$

$$\ln \varphi = -\xi + \frac{1}{2}\xi^2 + \frac{1}{2}\left(-\xi + \frac{1}{2}\xi^2\right)^2$$

De Novo

1 fault

1 point of survival φ

$$\varphi = \cancel{2m}\ (\cancel{1}-e^{-\xi}) + e^{-2\xi}$$

$$\varphi = +\xi - \frac{\xi^2}{2} + 1 - 2\xi + \frac{4\xi^2}{2}$$

$$= 1 - \xi + \frac{3}{2}\xi^2$$

$$\ln \varphi = -\xi + \frac{3}{2}\xi^2 - \frac{1}{2}[-\xi]^2$$

$$\cancel{p}\ \ln \varphi = p[-\xi + \xi^2]$$

$$\ln f\varphi = m(\eta^3 - \eta^2) + p[-\xi + \xi^2]$$

$$\ln \frac{1}{f\varphi} = m(\eta^2 - \eta^3) + p[\xi^2 - \xi]$$

$$\frac{x^2}{4m}\left(1 - \frac{x}{2m}\right) + p[\xi - \xi^2]$$

$$+ \frac{p}{2m}x - \frac{p}{2m}\frac{x^2}{2m}$$

$p = 1$ camp

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

$$\frac{x^2}{4m} + \frac{2x}{4m} + \frac{1}{4m} \Bigg\| - \frac{x^3}{4m}\frac{1}{2m} - \frac{x^2}{4m}\frac{1}{2m} - \frac{2x^2}{4m}\frac{1}{2m}$$

Basic formula:

$f(\xi)\,\varphi(\xi,\rho)$

~~small ρ~~ 1 faults added

$\cancel{(1-e^{-\xi})}$

$\left[\cancel{(1-e^{-\xi})+e^{-2\xi}}\right]$

$\left(\cancel{\xi^2-\xi^3}\right)\left[\xi-\frac{\xi^2}{2}+\frac{\xi^3}{3!}+1-2\xi+\frac{4\xi^2}{2}\right]$

$\left[1-\xi+\frac{3}{2}\xi^2\right]$

$\cancel{\left(\xi+\frac{1}{2m}\right)^2-\left(\xi+\frac{1}{2m}\right)^3=\xi^2\varphi}$

$\cancel{f=f(\xi)\left[1-\xi+\frac{3}{2}\xi^2\right]}$

$= \ln$

$\cancel{\ln f\varphi = \ln f}$

p faults

$\cancel{f(\xi)=\left[\quad\right]^m}$

$\varphi(\xi,r)=\left[1-\xi+\frac{3}{2}\xi^2\right]^p$

$\ln f\varphi = \frac{1}{m}\ln[\xi]+p\ln\left[1-\xi+\frac{3}{2}\xi^2+\right]$

De Novo

Planck [p = 1]

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

$$\ln f\varphi = m\ln[\quad] + p\ln(\quad)$$

$$p\ln(\quad) = p\ln\left[+\xi-\frac{\xi^2}{2}+1-2\xi+\frac{4}{2}\xi^2\right]$$

$$p\ln\left[1-\xi+\frac{3}{2}\xi^2\right]$$

$$= p\left[-\xi+\frac{3}{2}\xi^2-\frac{1}{2}\xi^2\right] = p\left[-\xi+\xi^2\right]$$

$$\ln f\varphi = m\ln[\quad] + p[-\xi+\xi^2]$$

$$\ln\frac{1}{f\varphi} = m[\xi^2-\xi^3] + p(\xi-\xi^2)$$

$$\boxed{p\xi^2 < m\xi^2}$$

To comp with $m\left[\left(\xi+\frac{p}{2m}\right)^2-\left(\xi+\frac{p}{2m}\right)^3\right]$

$$= m\xi^2 - m\xi^3 + m\,2\xi\frac{p}{2m} + \frac{mp^2}{4m^2} -$$

$$- m\left[\xi^2\frac{p}{2m} + \xi\frac{p^2}{4m^2} + \frac{p^3}{8m^3}\right]$$

$m\left(\frac{p}{2m}\right)^3$ fr comps with $m\left(\frac{p}{2m}\right)^2$

$\frac{1}{27}$

$\frac{1}{100}$

[illegible]

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

$$= \cancel{x^2}\frac{1}{4m}\left(x^2+2x+1\right) - \frac{1}{4m}\frac{1}{2m}\left(x^3+2x^2+x\right)$$

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

$$= \frac{x^2}{4m}\left(1-\right.$$

$$m\left[\frac{x^2}{(2m)^2} - \cancel{\left(\frac{x}{2m}\right)^3}\frac{x^3}{(2m)^3}\right.$$

$$\frac{d}{dx} = m\left[\frac{2x}{(2m)^2} - \frac{3x^2}{(2m)^3}\right]$$

$$f(x) + \frac{2x}{4m} - \cancel{\frac{3x^2}{8m^2}}$$

$$= \frac{x^2}{4m}\left[1-\frac{x}{2m}\right]$$

$$e^{-2\mu t}$$

$$e^{-0.5}$$

if we can neglect $r\xi^2 << m\xi^2$

$$r\xi^2 << m\xi^3$$

$$\frac{r}{25} < \frac{23}{125} = \frac{1}{5}$$

$$\frac{r^2}{4m} = \frac{1}{4}$$

$$f = \left(2e^{-\eta} - e^{-2\eta}\right)^m$$

$$\ln f = m \ln\Big(2 - 2\eta + 2\frac{\eta^2}{2} - 2\frac{\eta^3}{6} - 1 + 2\eta - \frac{4\eta^2}{2} + \frac{8\eta^3}{6}\Big)$$

$$\ln\left(1 - \cancel{2}\frac{\eta^2}{\cancel{2}} + \eta^3\right)$$

$$\ln f = r\ln\left(1 - e^{-\xi} + e^{-2\xi}\right)$$

$$r\ln\left(+\xi - \frac{\xi^2}{2} + 1 - 2\xi + 4\frac{\xi^2}{2}\right)$$

$$r\ln\left(1 - \xi + \frac{3}{2}\xi^2\right)$$

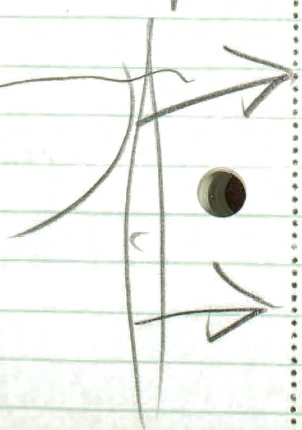
$$= r\,\cancel{\ln}\left(-\xi + \frac{3}{2}\xi^2 - \frac{\xi^2}{2}\right)$$

$$r\left(-\xi + \xi^2\right)$$

Correct [illegible]

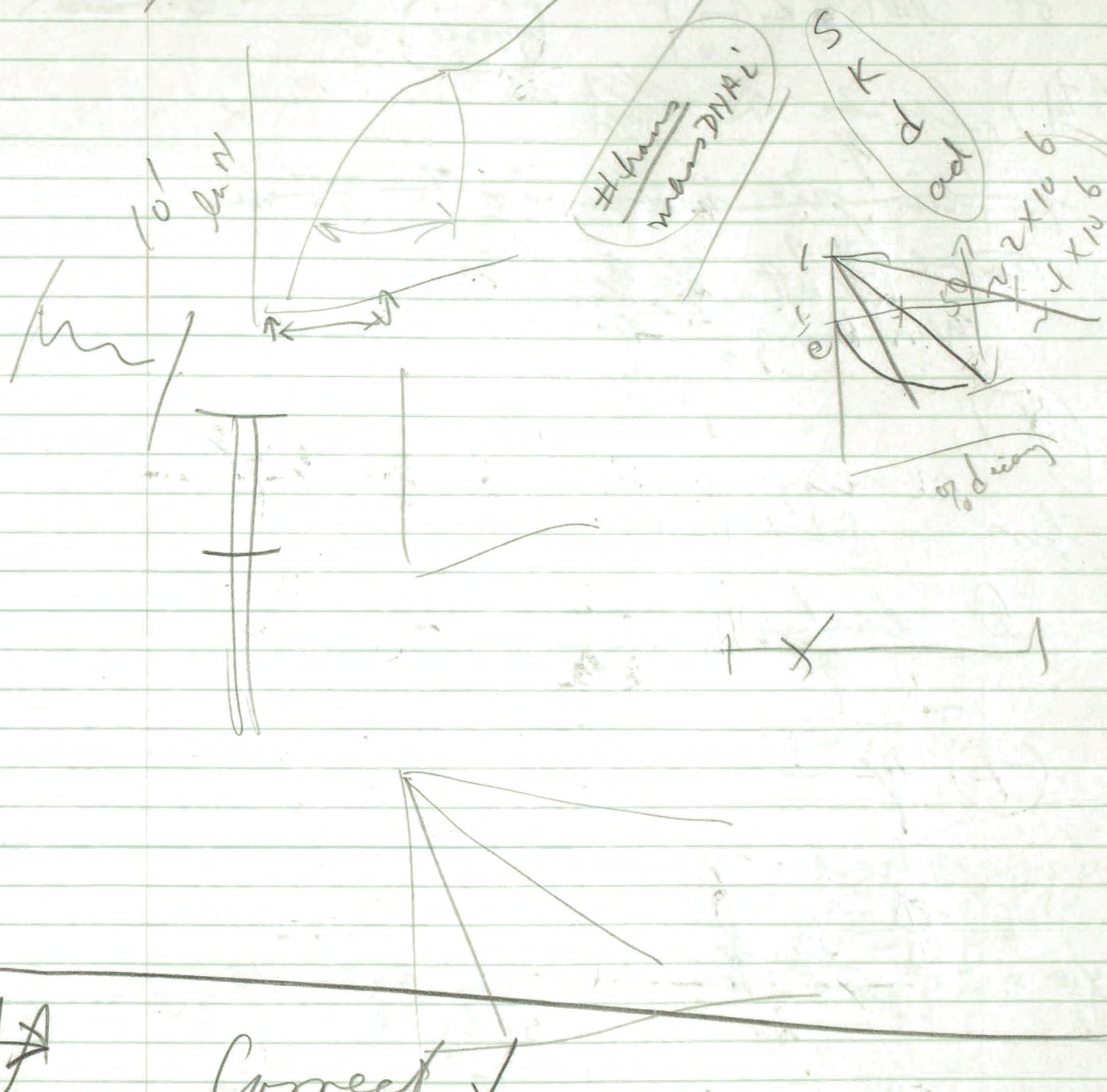
$$\ln\frac{1}{f^*} = m(\xi^2 - \xi^3) + r(\xi - \xi^2)$$

$$= m\xi^2(1-\xi) + r\xi(1-\xi) =$$



B20

$2\,\mu t = 0.2$



Correct ↓

$$\ln\frac{1}{f^*} = m(1-\xi)(\xi^2 + 2\rho\xi) \quad m(1+\xi)\rho^2 - m(1-\xi)\rho^2$$

$$\ln\frac{1}{f^*} = m(1-\xi)(\xi+\rho)^2 - m(1-\xi)\rho^2$$

$\boxed{\rho \ll 1}$ $\qquad$ $\boxed{\rho^2 \ll (\xi+\rho)^2}$

2 $\quad x =$

(3) (~~[illegible]~~ $\ln q = 2\Big[$ $\quad\Big] + x\Big[$ $\Big]$

or ~~[illegible]~~ $\xi < 1$ $\quad$ approx

(31) $\ln \frac{1}{q} \approx$ ~~[illegible]~~ $\quad x$

~~for this we may write if we~~

~~have~~ ~~[illegible]~~ ~~[illegible]~~

working $\quad$ ~~$\rho =$~~

(5) $\quad \rho = \dfrac{\gamma}{2m}$

we may write for $\xi, \rho^2 < (\xi + \rho)^2$

for $\quad \rho << 1$ and

6 $\quad \ln \frac{1}{q} = 4\left(\xi + \rho\right)^2 \left(1 - (\xi + \rho)\right)$

or

(7) $\quad q =$

where $\eta = \xi + \rho$

8 $\quad$ ~~[illegible]~~ $f = (\quad\quad ?)$

or inversely

9 $\quad \eta = \ln \dfrac{1}{1 -}$

From paper sent in [illegible] models for x-ray induced faults in rat [illegible].

~~[illegible]~~

~~From our approximation:~~ 8

$$\ln\frac{1}{f} = m\left[(\xi+\rho)^2 - (\xi+\rho)^3\right]$$

$$= \cancel{m\xi^2} + 2m\xi\rho + m\rho^2 - \cancel{m\xi^3} - 3m\xi^2\rho - 3m\xi\rho^2 - m\rho^3$$

$$\ln\frac{1}{f_x} = m\xi^2 - m\xi^3 + r\xi \quad + m\rho^2 - 3m\xi^2\rho - 3m\xi\rho^2 - \cancel{m\rho^3}$$

$$23\frac{1}{100} - \frac{23}{30} + \frac{5}{3} \quad \frac{23}{100} - 3\times 23\times\frac{1}{10}\frac{1}{10}$$

$\rho = \frac{r}{2m}$

$\ln \frac{1}{f} = m[\xi + \rho]^2 [1 - (\xi + \rho)]$

$(m\xi^2 + 2m\xi\rho + m\rho^2)[1 - (\xi + \rho)]$

$m\xi^2 [1 - (\xi + \rho)] + \underbrace{2m\xi\rho}_{r\xi} [1 - (\xi + \rho)]$

$m\xi^2 (1 - \xi) + r\xi(1 - \xi)$ Correct

$\ln \frac{1}{f} = m(\eta)^2 [1 - \eta]$

$\ln \frac{1}{f} = m(\eta^2 - \eta^3)$

$\frac{\ln \frac{1}{p}}{\xi(1-\xi)} - m\xi = r$

$\ln f = m \ln$ | $\frac{2 m \frac{1}{f}}{\frac{x}{2}} = \frac{1}{2}\frac{1}{f}$

thrown away

$m\xi^2\rho$ $\quad$ $r\xi\rho$ $\quad$ $\frac{m\rho^2}{m\rho\,\rho}$

$m\xi^3$ kept $\quad$ $m\left(\frac{x}{2m}\right)^3 = \frac{x^2}{8m^2}x$

$\frac{13}{8}$ 0.32 $\quad$ $\frac{1}{4}\frac{1}{8}$ 13 $= \frac{1}{2}$

$\frac{10}{6}$

$\frac{13}{23}$

$\frac{r}{2} \frac{1}{16} = \frac{3}{16}$ | $\frac{6}{2}\frac{1}{4}\frac{6}{46} =$

$\frac{6}{2}\frac{13}{23}$

$\frac{23}{4}\left(\frac{13}{23}\right)^2$

1.8

~~36 · rep 0.5~~

~~$\boxed{70 \text{ rep}}$ 1 mint ...~~

~~$^1/_{10}$~~

~~$\boxed{25 \text{ rep}}$~~

~~7 rep duplicated~~

3 8,0000

Fox

$$f = \left[1-(1-e^{-\xi})^2\right]^m \left(1-e^{-\xi}+e^{-2\xi}\right)^r$$

$$\ln f = m\ln[\quad] + r\ln[\quad]$$

$$m\ln\left[2e^{-\xi}-e^{-2\xi}\right] = \ln\left[1-\cancel{2\xi}+2\frac{\xi^2}{2}-2\frac{\xi^3}{6}+\cancel{2\xi}-4\frac{\xi^2}{2}+\frac{8\xi^3}{6}\right]$$

$$= m\ln(1-\xi^2+\xi^3) = -\xi^2+\xi^3$$

$$\ln(1+x) = x-\frac{1}{2}x^2$$

checks

$$r\ln\left[1+\xi-\frac{\xi^2}{2}-2\xi+\frac{4\xi^2}{2}\right)$$

$$\left[1-\xi+\frac{3}{2}\xi^2\right]$$

$$= -\xi+\frac{3}{2}\xi^2-\frac{\xi^2}{2}$$

$$= -\xi+\xi^2$$

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

$$= \left[1-(1-e^{-(\xi+1)})^{2}\right]^{m}$$

$$2e^{-(\xi+1)}$$

For

$$\eta = \ln \frac{e^{\frac{1}{m}\ln f}}{1-\sqrt{1-e^{\frac{1}{m}\ln f}}}$$

$$\eta = \ln\left(1+\sqrt{} + \underbrace{1-e^{\frac{1}{m}\ln f}}_{x}\right)$$

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

$$\eta =$$

$$\frac{x+r}{2m} = \sqrt{1-e^{-\frac{1}{m}\ln f}} + \left(1-e^{-\frac{1}{m}\ln f}\right)$$

$$-\frac{1}{2}\left(1-e^{\frac{1}{m}\ln f}\right)$$

$$\frac{x+r}{2m} = \sqrt{\frac{1}{m}\ln\frac{1}{f}}$$

$$x+r = \sqrt{4m\ln\frac{1}{f}}$$

$x = 14$, $r = 2.44$

$$\frac{46 \times 2}{x\left(1 - \frac{14}{46}\right)} - 7 = r$$

$$\frac{92}{14\left(1 - \frac{14}{46}\right)} - 7 =$$

$$\underbrace{\frac{14}{46}}_{0.304}$$

$$\frac{92}{15\left(1 - \frac{15}{46}\right)} - 7.5$$

$$\begin{array}{r} 1.00 \\ .326 \\ \hline .674 \end{array}$$

$$\begin{array}{r} 9.1 \\ 7.5 \\ \hline 1.6 \end{array}$$

$$\begin{array}{r} 2.44 \\ 1.60 \\ \hline .84 \end{array}$$

$$\ln\frac{1}{f} = m\,\xi\,\xi(1-\xi) + r\,\xi(1-\xi)$$

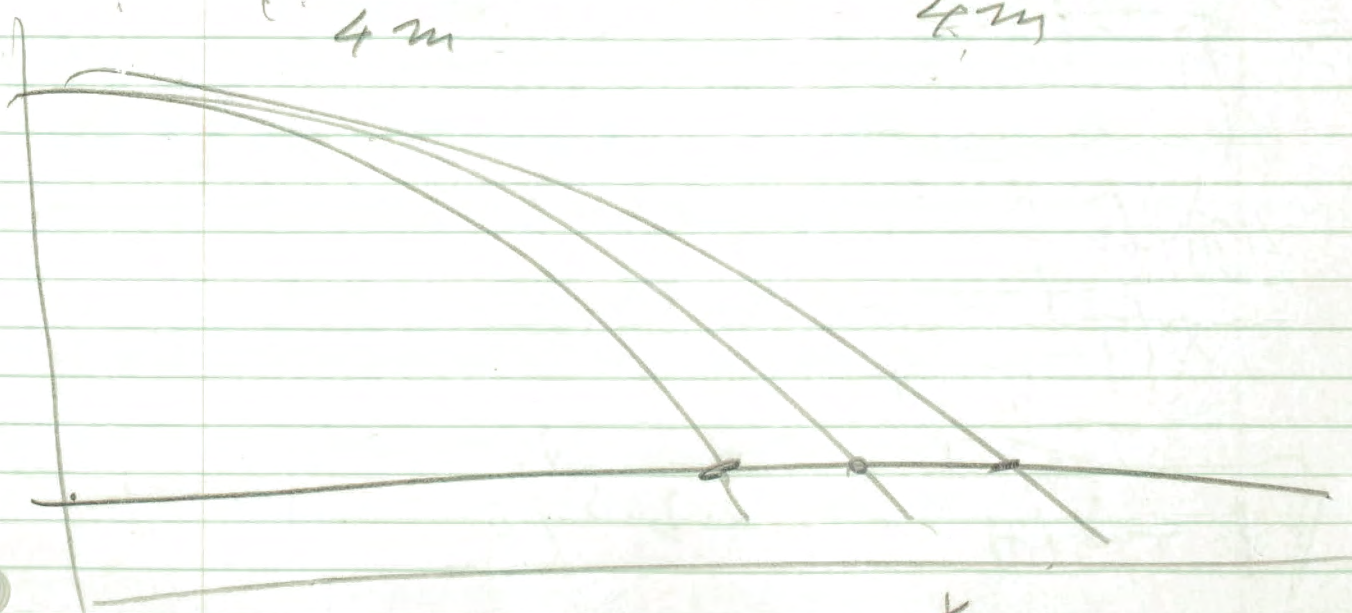
$$\frac{\ln\frac{1}{f}}{\xi(1-\xi)} - m\xi = r$$

$$\frac{x}{2m}$$

$$\boxed{\frac{2m\ln\frac{1}{f}}{x(1-\xi)} - \frac{x}{2} = r}$$

$$\ln\frac{1}{f} = \frac{x^2}{4m}\cancel{(1-\xi)} + \frac{rx}{2m}\cancel{(1-\xi)}$$

$$\frac{(x+r)^2}{4m} = \frac{x^2 + 2xr + r^2}{4m}$$



x

$$\ln \cancel{f} = \ln\left(1-\left(1-e^{-\frac{3}{5}}\right)^2\right)$$

$$\ln \cancel{f} = 3\ln\left(1-\left(1-e^{-\frac{3}{?}}\right)^2\right) = \boxed{m\ln\left(1-\left(1-e^{-\frac{3}{?}}\right)^2\right)}$$

$$m\ln = \frac{r^2}{4m}\left(1-\rho\right) \qquad \frac{4}{46}$$

$$\frac{16}{92}$$

16%

$$\ln\frac{1}{f} = \frac{(x+r)^2}{4m}\left(1-\frac{x+r}{2m}\right) - \frac{r^2}{4m}\left(1-\frac{x+r}{2m}\right)$$

$$\frac{\ln\frac{1}{f}}{\left(1-\frac{x}{2m}\right)} = \frac{x^2}{4m} + \frac{2xr}{4m} \qquad \frac{r^2}{4m}$$

$$\frac{4m\ln\frac{1}{f}}{x\left(1-\frac{x}{2m}\right)} = x = 2r$$

$$\sqrt{1+5\%} = 1+2.5\%$$

A

$$\ln \frac{1}{\varphi^*} = m\xi(1-\xi) + r\xi(1-\xi)$$

$$\ln \frac{1}{\rho^*} = (m\xi + r)\xi(1-\xi)$$

$$= \left(\frac{13.7}{2} + 2\right)\frac{13.7}{46}\left(1 - \frac{13.7}{46}\right)$$

$$\frac{8.85 \times 13.7}{46} \cdot 0.7 = 1.82$$

$$\frac{1}{\rho^*} = 1$$

$r = 2$

$\frac{4}{2}$

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

$\frac{0}{90}$

$$\left(1 - (1 - e^{-\beta})^2\right)^m$$

$$\eta = \xi + \rho$$

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

$$\ln \frac{1}{\rho^*} = \frac{\beta^2}{4m}(1-\beta)$$

Semi lattices

(x, z) involves

(x, x) involves

(y, z) does not

(y, y) does

$$x\lambda_y = yz$$

$$(y+x)\lambda_z = yz + z^2$$

$$\frac{y}{x} = \frac{\lambda_y}{z}$$

$$\cancel{\frac{y}{x} = \frac{\lambda_z}{z}}$$

$$(y+x)\lambda_z = x\lambda_y$$

$$\frac{\lambda_y}{\lambda_z} = \frac{x+y}{x}$$

$$* \quad z^2 = (x+y)\lambda_z - x\lambda_y$$

$$z \simeq \sqrt{(x+y)\lambda_z}$$

$$\lambda_y = \frac{y}{x}\sqrt{(x+y)}\,\sqrt{\lambda_z}$$

Faults

$$\frac{1}{N}\frac{dN}{dt} \qquad e^{+\beta t} \Big/ C_{ms}\, e^{-\beta t} = \cancel{A} \cdot \cancel{f}$$

$$\frac{1}{10}$$

Accurate formula

R = ~~[illegible]~~ i faults induced

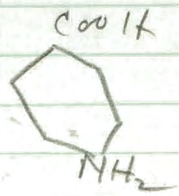
$$\frac{i}{2m} =$$

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

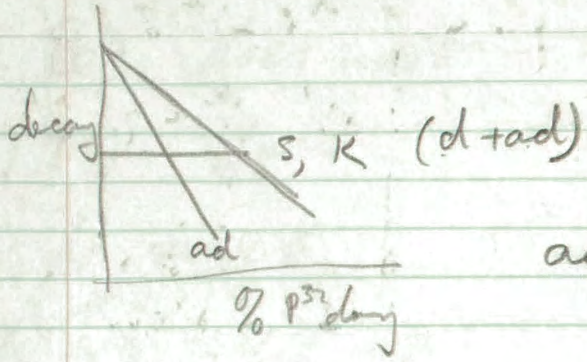
$$\eta = \left[\xi + \frac{i}{2m} + \frac{r}{2m}\right]$$

~~a b d~~

a 20 x SA
d ~~60~~ 80 x SA
ad ~ 400 x SA

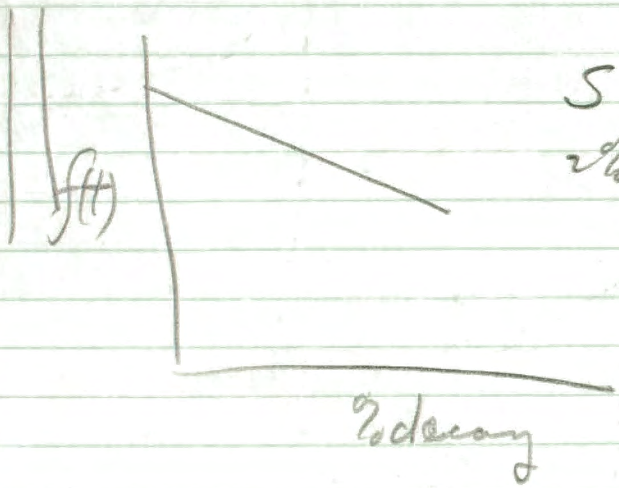


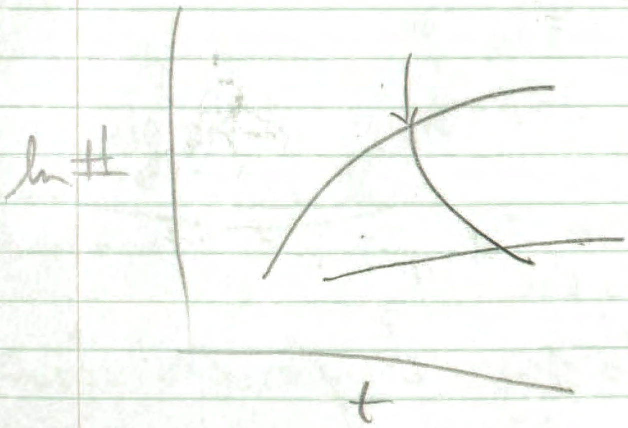
a ~ d ~ ad. S K

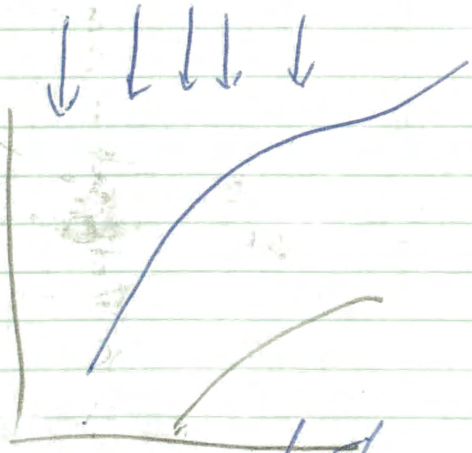


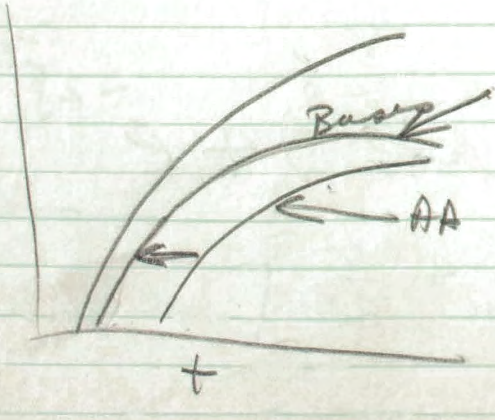
ad $\frac{1 \text{ decay}}{4 \times 10^6}$ $\frac{1 \text{ decay}}{2 \times 10^6}$

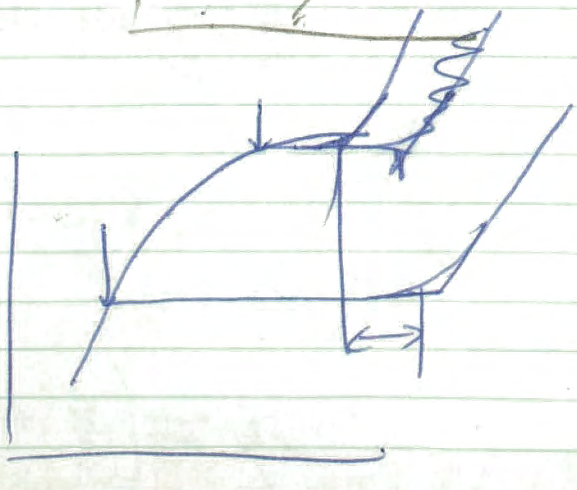
S	3'	80'	120
2%	30%	30%	100%











$x \mid y \mid z$

1.) $x\lambda_y = yz + y\lambda_z$

2. $(x+y)\lambda_z = yz + z^2$

$x\lambda_y = (x+y)\lambda_z + y\lambda_z$

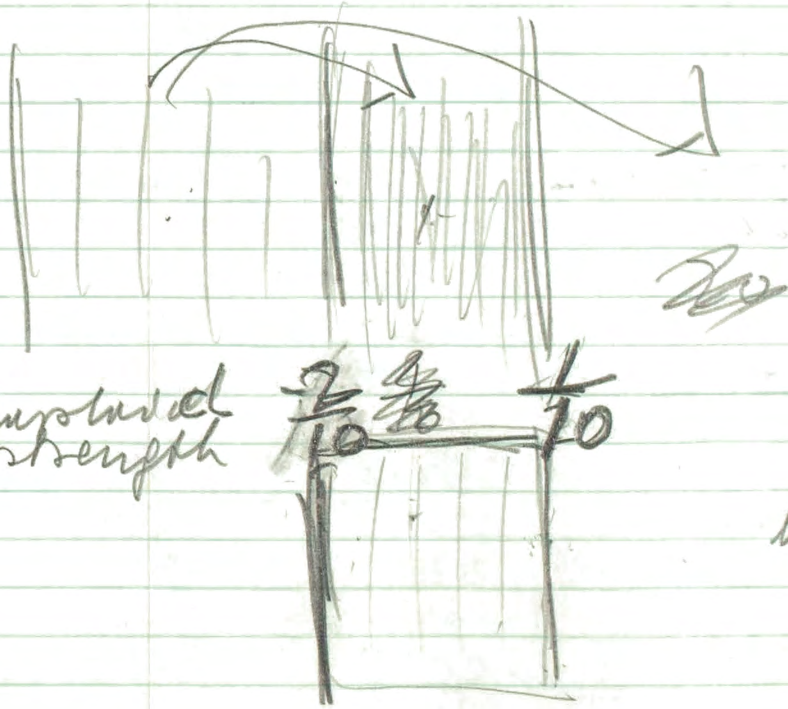
$x\lambda_y = (x+2y)\lambda_z$

$$\frac{\lambda_y}{\lambda_z} = \frac{x+2y}{x}$$

$yz = x\lambda_y - y\lambda_z$

$z^2 = (x+y)\lambda_z - \cancel{yz}$

$z = \sqrt{\lambda_z}$



haploid strength $\frac{2}{10}$ $\frac{4}{10}$

$\frac{2}{10}$

haploid strength 1

x	r=1	r=2	r=3	r=4		r=5
	~~.233~~	~~467~~	~~700~~	~~933~~		
~~15.4~~	~~1.71~~	~~1.71~~	~~1.71~~	~~1.71~~		
	~~1.943~~	~~2.177~~	~~2.410~~	~~2.645~~		
~~15.0~~	~~1.64~~	~~1.64~~	~~1.64~~	~~1.64~~		
	0.22	0.446	0.670	0.893		1.115
15.4	1.71	1.71	1.71	1.71		1.71
	1.93	2.156	2.380	2.603	15.4	2.82
	22	44	66	88		
15	1.64	1.64	1.64	1.64		
	1.86	2.08	2.30	2.52	15	
	211	422	633	844		
14	1.48	1.48	1.48	1.48		
	1.691	1.902	2.113	2.324	14	
	203	406	610	813		
13	1.32	1.32	1.32	1.32		
	1.523	1.726	1.930	2.133	13	
	193	386	58	772		
12	1.16	1.16	1.16	1.16		
	1.353	1.546	1.74	1.932	12	
	183	366	55	732		.915
11	1.00	1.00	1.00	1.00		1.00
	1.183	1.366	1.55	1.73	11	1.92
	171	342	513	685		.855
10	0.852	0.852	0.852	0.852		.852
	1.023	1.194	1.365	1.537	10	1.707

Lutnoth (Oscar's)

III between 67 and 68 (East side)

Budapest 77 and II Ave

70 and II Ave (the old Hungary)

(Hamburger) 66th str at IInd Burgoyne

① # bands in salivary chromosome

$$\ln\frac{1}{f} = \frac{x^2}{4m}\left(1-\frac{x}{2m}\right) + r\frac{x}{2m}\left(1-\frac{x}{2m}\right)$$

$r = 0$

$m\left(\frac{x}{2m}\right)^2$	$\left(1-\frac{x}{2m}\right)$	x	$\frac{x}{2m}$	I	f^*	$1/f^*$	$\frac{I}{r}$
2.58	0.665	15.4	0.335	1.71	0.181	1/5.5	0.223
2.44	0.674	15	0.326	1.64			0.22
2.12	0.696	14	0.304	1.48			0.211
1.84	0.717	13	0.283	1.32			0.203
1.565	0.739	12	0.261	1.16			0.193
1.31	0.761	11	0.239	1.00			0.183
1.09	0.782	10	0.218	0.852			0.171
2.78	0.652	16	0.348	1.81			0.227
0.884	.8045	9	0.1955	0.710			0.157
.696	.826	8	0.174	0.575			0.1437
.532	.848	7	0.152	0.451			0.129
.389	.870	6	0.130	0.338			0.113
.274	.8913	5	0.1087	0.244			0.097
.174	.913	4	.087	0.159			0.0795
.097	.935	3	.065	0.0907			0.0607
.0437	.9565	2	.0435	0.0417			0.0416
.01088	.97825	1	.02175	0.01067			0.0213
.0000	1.000	0	0	0			0

2000 cal / gm day

$\frac{2000}{50}$ cal / gm per 30 min = 40 cal / gm per 30 min

1 gm sugar per gm luck

4,000 / gm per 30 min

~~1000~~ $\frac{100}{10^6} = 2\,10^{-4}$

$\frac{30 \quad 30 \text{ yrs}}{50 \times 365 \cdot 30}$

$= 100 \times 30 \times 180$

$3000 \times 180 = 55$ years

3

~~25~~

$\frac{1}{25{,}000}$

$4\,10^{-5}$ | 10^{-8}

1,500

$\frac{\frac{1}{2}\,10^6}{1500} = \frac{10^3}{3}$

$\boxed{300} \times 10^{-8} = 3\,10^{-6}$

30 gm

$\frac{75 \text{ kg}}{5} = 15 \text{ kg}$

$\frac{15}{30} =$

$$\frac{7}{100} \times \frac{59}{100} \times \frac{5}{100} = \frac{3.5}{1000} \cdot \frac{59}{100}$$

$$= \frac{2}{1000}$$

$$e^{-n} = \frac{2}{1000}$$

$$n_1 > 6.25$$

$$n_2 > 12.5$$

$$n_1 > 2$$

a′b′c′d′ / a′b′c′d′ = viable

a″b″c″d″ / a″b″c″d″ = viable

a′ b′ c″ d″ / a′ b′ c″ d″ = 4% lethal

$$\frac{1}{m}\ln\frac{1}{f} = \eta^2\left(1-\eta+\frac{7}{12}\eta^2\right)$$

$$\eta = \xi$$

$$\ln\frac{1}{f} = m\xi^2\left(1-\xi+\frac{7}{12}\xi^2\right) + r\,\xi(1-\xi)$$

$$\ln\frac{1}{f} = m\left[\xi^2-\xi^3+\frac{7}{12}\xi^4\right) + r(\xi-\xi^2)$$

$r=0$

$$m\left[2\xi-3\xi^2+\frac{4\times 7}{12}\xi^3\right]\frac{\Delta X}{2m} = \Delta r(\xi-\xi^2)$$

$$\xi = \frac{x}{2m}$$

$$\boxed{\frac{\left[\xi-\frac{3}{2}\xi^2+\frac{14}{12}\xi^3\right]}{\xi-\xi^2}\Delta X = \Delta r}$$

$$\frac{1-\frac{3}{2}\xi+\cancel{\frac{14}{12}\xi^2}}{1-\xi}\Delta X = \Delta r$$

$$\Delta X = \frac{\Delta r\,(1-\xi)}{1-\frac{3}{2}\xi}$$

$$\Delta X = \Delta r\,(1-\xi)\left(1+\frac{3}{2}\xi+\frac{9}{4}\xi^2+\dots\right)$$

$$\Delta X = \Delta r\left(1+\frac{1}{2}\xi\right)$$

$\frac{16}{92}$

Curves, contd.,

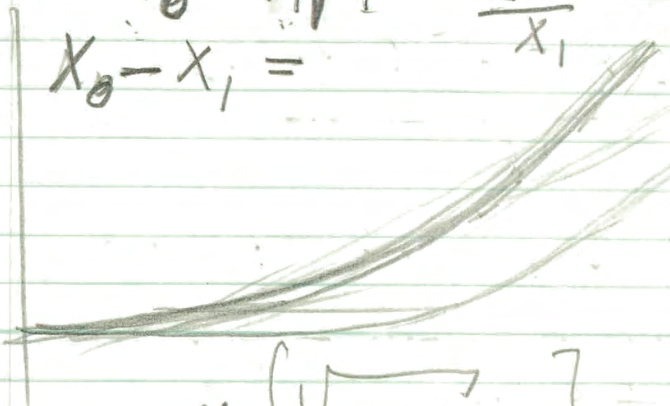
$$\frac{\text{lnt}}{\varphi} = \frac{x_1^2}{4m}\left(1-\frac{x_1}{2m}\right) + \frac{r x_1}{2m} =$$

$$= \frac{x_0^2}{4m}\left(1-\frac{x_0}{2m}\right) = \frac{x_1^2}{4m} + \frac{r x_1}{2m}$$

$$X_0^2 = X_1^2 + 2 r X_1 = X_1^2 + X_1^2 \, 2\frac{r}{X_1}$$

$$X_0 = X_1\sqrt{1+\frac{2r}{X_1}}$$

$$X_0 - X_1 = X_1\sqrt{1+\frac{2r}{X_1}} - X_1$$



$$= X_1\left[\sqrt{1+\frac{2r}{X_1}} - 1\right] \approx X\sqrt{\frac{2r}{X_1}} = \sqrt{X_1}\sqrt{2r}$$

for $X_1 \ll 1$

$$\frac{\text{lnt}}{\varphi^*} = \frac{x^2}{4m}(\quad) +$$

$$\frac{(X+1)^2}{4m}\left(1-\frac{X+1}{2m}\right) = \frac{x^2}{4m}(\qquad) + r(\qquad)$$

Again —

$$\boxed{\frac{d\ln\frac{1}{f}}{dx} = m(\xi^2-\xi^3)+r(\xi-\xi^2)}$$

$\frac{d}{dx}$

$$0 = m(2\xi-3\xi^2)+\frac{dr}{dx}(\xi-\xi^2)+r(1-2\xi)$$

$$-\frac{dr}{d\xi} = \frac{m(2\xi-3\xi^2)+r(1-2\xi)}{\xi-\xi^2}$$

$$= \frac{m(2-3\xi)+\frac{2r}{x}m(1-2\xi)}{1-\xi}$$

$$-\frac{dr}{dx} = \frac{dr}{d\xi}\frac{d\xi}{dx} = \frac{1-\frac{3}{2}\xi+\frac{r}{x}(1-2\xi)}{1-\xi}$$

$$= 1-\frac{3}{2}\xi+\xi+\frac{r}{x}(1-\xi) = 1-\frac{1}{2}\xi+\frac{r}{x}(1-\xi)$$

$$-dx = dr\,\frac{1}{1-\frac{1}{2}\xi+\frac{r}{x}(1-\xi)}$$

$$\boxed{-dx = dr\,\frac{1}{1-\frac{x}{4m}+\frac{r}{x}\left(1-\frac{x}{2m}\right)}}$$

$$\approx dr\left[1+\frac{x}{4m}-\frac{r}{x}\left(1-\frac{x}{2m}\right)\right]$$

$$dr\left[1+\frac{x}{4m}-\frac{r}{x}+\frac{r}{2m}\right] \times$$

$$\frac{13.5}{46} = 0.293$$
0.707

$$-dx = dr\left[1+\frac{x+2r}{4m}-\frac{r}{x}\right]$$

$12\% - 30\% = -18\%$

$$1+\frac{17.5}{92}-\frac{2}{13.5}$$

$$1+.19-0.148 = \underline{1.04}$$

De Novo (H)

$$\ln\frac{1}{p^*} = \cancel{\ln ...}\; m(\xi^2-\xi^3) + r(\xi-\xi^2)$$

$$\frac{d}{dx}\ln\frac{1}{p^*} = 0 = \frac{1}{2}2\xi - \frac{3}{2}\xi^2 + \frac{dr}{dx}(\xi-\xi^2) + \frac{r}{2m}(1-2\xi)$$

$$\xi = \frac{x}{2m}$$

$$\frac{d\xi}{dx} = \frac{1}{2m}$$

$$\boxed{-\frac{dr}{dx} = \frac{1-\frac{3}{2}\xi}{(1-\xi)} + \frac{r}{x}\,\frac{1-2\xi}{(1-\xi)}}$$

$$\boxed{-\frac{dr}{dx} = 1-\frac{3}{2}\xi(1+\xi) + \frac{r}{x}(1-2\xi)(1+\xi)}$$

$$\boxed{-\frac{dr}{dx} = 1-\frac{1}{2}\xi + \frac{r}{x}(1-\xi)}$$

$$-\frac{dr}{dt} = \frac{1}{\tau}\left[1-\frac{1}{2}\xi + \frac{r}{x}(1-\xi)\right]$$

$$-\Delta t = \frac{\tau\Delta r}{1-\frac{1}{2}\xi + \frac{r}{x} - \frac{r}{x}\xi}$$

$$\Delta t = \tau\Delta r\,\frac{1}{1-\frac{x}{4m}+\frac{r}{x}-\frac{r}{x}\xi}$$

O.K.

x	r=0	r=1	r=2	r=3	r=4
		.157	.314	.471	.628
9	.710	.710	.710	.710	.710
	.710	.867	1.024	1.181	1.338
		.144	.288	.432	.576
8	.575	.575	.575	.575	.575
	.575	.719	.863	1.007	1.151
		.129	.258	.385	.516
7	.451	.451	.451	.451	.451
	.451	.580	.709	.836	.967
		.113	.226	.339	.452
6	.338	.338	.338	.338	.338
	.338	.451	.564	.677	.790
		.097	.194	.291	.388
5	.244	.244	.244	.244	.244
	.244	.341	.438	.535	.632
		.0795	.159	.2385	.318
4	.159	.159	.159	.159	.159
	.159	.2385	.318	.3975	.477
		.0607	.1214	.182	.2425
3	.0907	.0907	.0907	.0907	.0907
	.0907	.1514	.2121	.2727	.3332
		.0416	.0832	.1250	.1663
2	.0417	.0417	.0417	.0417	.0417
	.0417	.0833	.1249	.1667	.2080
		.0213	.0416	.0629	.0832
1	.01067	.01067	.01067	.01067	.01067
	.01067	.03197	.05227	.07357	.09387

Alfrey (Mirsky)

VAN POTTER Wire.

G. B. Brown (Sloan Kettr.)

N. O. Davidson [Glasgow]

[illegible] 5 fluoro deoxyuridine
fluoro uracil / fluoro uridine

6 Deaza 5 OHo norleucine

14

$$-dx = dr \frac{1}{1 - \frac{x+2r}{4m} + \frac{r}{x} - \frac{1}{2}\left\{\frac{1}{2} - \frac{r}{x}\right\}^2}$$

$$\frac{1}{1 - \frac{17.5}{92} + \frac{2}{13.5} - \left(\underbrace{\frac{1}{2} + \frac{r}{x}}\right)\Big\}^2}$$

0.148
8.5

0.65×8.6

$\boxed{0.190}$
8.5

$$1 - \frac{.245}{148}$$

O.K.

$\frac{13.5}{46} = 2.15$

400 rep gives one fault

90 ~~80~~ rep gives one mutation

90 rep gives one ~~break in~~ diploid
mutation in diploid or
90 reps give a lesion in $\frac{1}{10}$ DNA
9 reps give lesion in total
D.N.A. — ~~60 reps~~ 30 reps
give break , ~~Fx~~ 1 break ≃
4 lesions. —

1 break / 30 reps cause
in diploid 9 reps cause lesion .

18 reps cause lesion in
haploid
18 × 50 reps per coli
≃ 1,000 and 3 nuclei 3000 reps
kills coli

C-4

DNA - Fox 1 gene = 2 molldon

Coli (per nucleus) $6\ 10^{-15}$ gm

(Stent)

2,000 genes

Fox Pneumococcide 2×10^{-15}

= 700 genes

3 base pairs per amino acid

100,000 for enzyme

Coli genes = 2000 ~~[illegible]~~ factor 50

$6\ 10^{-15} \times 3\ 10^{-12}$ 500 times more in mammals

DNA in mammalian cells haploid is ~~[illegible]~~ 10000 genes.

in Man 10,000 genes, 60 rep one break

~~15 rep~~ 30 ~~[illegible]~~ rep in Man 1 ~~break~~ break

or 160 to ~~[illegible]~~ rep one break per haploid set

or in coli

$\boxed{50 \times 60}$ to $\boxed{\cancel{50 \times 120}}$ =

| 1 coli = 3 nuclei

~~[illegible]~~

comes to 45000 rep for coli

Kollday

$\frac{1}{2}$

$\frac{1}{5}$ $\frac{1}{2}$ $\underline{23}$

$\underline{\underline{2.3}}$

Brazil Amadillo

16

Texas 4

TiTi Patterson
80 Austin ret.

1.) reduction bone marrow
lymphatic tissue } H.

2.) loss of reg. power of liver
3.) collagen change
4.) role of ~~cont~~ continued growth in keeping young
5.) accumulation of insoluble material (pigment)
6.) decrease in size of organ (liver, kidney, brain)
7.) dehydration

Muller – Bridges? Grants.
Mac Dermott Cornell [does metabolic rate go down in slowly growing rats.]
~~Atwood Diploid – Haploid Larvae~~

Atwood Transplants
Curtis' sick mice
Why not irradiate brain? Coleman & Kohl Science
Rate?

10^{-9} Muller when do mutations occur?

Atwood $\frac{1}{e}$ Dose for killing nuclei?
"

Roger J. Williams (Texas)

Upton
Arnold } Upton | Henry Kahn Berkeley (now)

DNA ~~·~~ problem. —

bacteria

Lesion to break ratio — 50 rep × 2 × 1000 for 1 break in coli
~~350 rep~~ ≥ 100,000 rep
killing 5000 per nucleus

(1 break = 20 lesions.)

for Lord assume { 400 rep = 1 fault
{ 400 rep = 5 mutations
~~1/100 break = 15 mut~~
$\frac{8}{100}$ break = $\frac{160}{100}$ mutations

better assume:
365 × 2 = 730 rep = 1 fault
730 rep = 5 mut.

20 × $\frac{14.6}{100}$ break ≃ 3 mutations

De Novo
70 rep makes 0.25 in haploid (10^4 genes)
35 " " 0.25 in diploid
$\boxed{140 \text{ rep}}$ " 1 mut in diploid
5 × 140 rep " 1 fault.
700 rep " 1 fault in diploid

In bacteria 5 × 280 ~~rep~~ makes 1 mut in haploid
for 2000 genes (same sensit. as mammal) = 1400 rep
bacteria less sensit. by factor 6 = 10^4 rep

280 rep in man) one mut in haploid
fly 2800 ~~rep~~
1400
4200 rep for one mut in haploid (10^4 genes)

Checking

doubling dose 70 rep

mut rate $\mu_t = \underline{0.25}$

70 rep makes ~~0.25~~ 0.5 in

~~[illegible]~~ diploid or ~~[illegible]~~

140 rep makes 1 mut

and 5 × 140 = 700 rep makes one doubl –

140 rep makes 3 chromosome break = 1 mutation. –

Te Summary ; de Mana ;

$$\ln\frac{1}{q} = m(\xi^2-\xi^3) + r(\xi-\xi^2+\xi^3)$$

$$0 = m(2\xi-3\xi^2) + \frac{dr}{d\xi}(\xi-\xi^2+\xi^3) + r(1-2\xi+3\xi^2)$$

$$-\frac{dr}{d\xi} = m\,\frac{2\xi-3\xi^2}{\xi-\xi^2+\xi^3} + r\,\frac{(1-2\xi+3\xi^2)}{\xi-\xi^2+\xi^3}$$

$$\frac{2\xi-3\xi^2}{\xi-\xi^2+\xi^3} = \varphi(\xi)$$

$$-\frac{dr}{d\xi} = m\,\varphi(\xi) + \frac{r}{\xi-\xi^2+\xi^3}\left[1-\varphi(\xi)\right]$$

$$= m\,\frac{(2-3\xi)}{1-\xi^2+\xi^2} + r\,\frac{(1-2\xi+3\xi^2)}{\xi-\xi^2+\xi^3}$$

$$-\frac{dr}{dx} = \frac{dr}{d\xi}\,\frac{1}{2m}$$

$$-\frac{dx}{dr} = \frac{1-\frac{3}{2}\xi}{1-\xi+\xi^2} + \frac{r(1-2\xi+3\xi^2)}{x-x\xi+x\xi^2}$$

$$-\frac{dx}{dr} \simeq 1-\frac{1}{2}\xi + \underbrace{\frac{r}{x}\,\frac{1-2\xi+3\xi^2}{1-\xi+\xi^2}}_{\frac{r}{x}(1-\xi)}$$

O.K.

second order

Mouse haploid (2000 genes)
5000 rep = 1 mut.

fly 10^4 genes 1000 rep = 1 mut (hap)
Man Man 100 rep = 1 mut (hap)
500 rep = 1 fault (hap)

Man haploid spont rate
$10^4 \times 10^{-5} = 0.1$
30 rep = 10^{-5} / gene

42. Muller:
O.K. O.K. O.K.
50 rep. to immature germ cells makes 0.025 in haploid or 0.05 in diploid
i.e. 1000 rep in fly makes 1 mutation in diploid.
If man 15 times more sensitive:
$\frac{1000}{15} \approx$ 70 rep makes one mutation in diploid and 5 x 70 $\approx$ 350 rep makes one fault.
Assumption. Man and fly equal number of genes. —

If 70 rep makes one mutation in diploid
Doubling Dose = 35 rep $\approx p_t = 0.25$

$$\ln f = (m-r)\ln\left[1-(1-e^{-\xi})^2\right] - r\xi \qquad H$$

$$\cancel{\ln f} = m\ln[\quad] - r(\xi + \ln[\quad])$$

$$0 = \frac{m}{[\;]}\frac{d}{d\xi}[\quad] - \frac{dr}{d\xi}(\xi + \ln[\quad])$$

$$- r\left(1 + \frac{1}{[\;]}\frac{d}{d\xi}[\quad]\right).$$

$$[\;] = 2e^{-\xi} - e^{-2\xi}$$

$$\frac{d}{d\xi}[\;] = -2e^{-\xi} + 2e^{-2\xi}$$

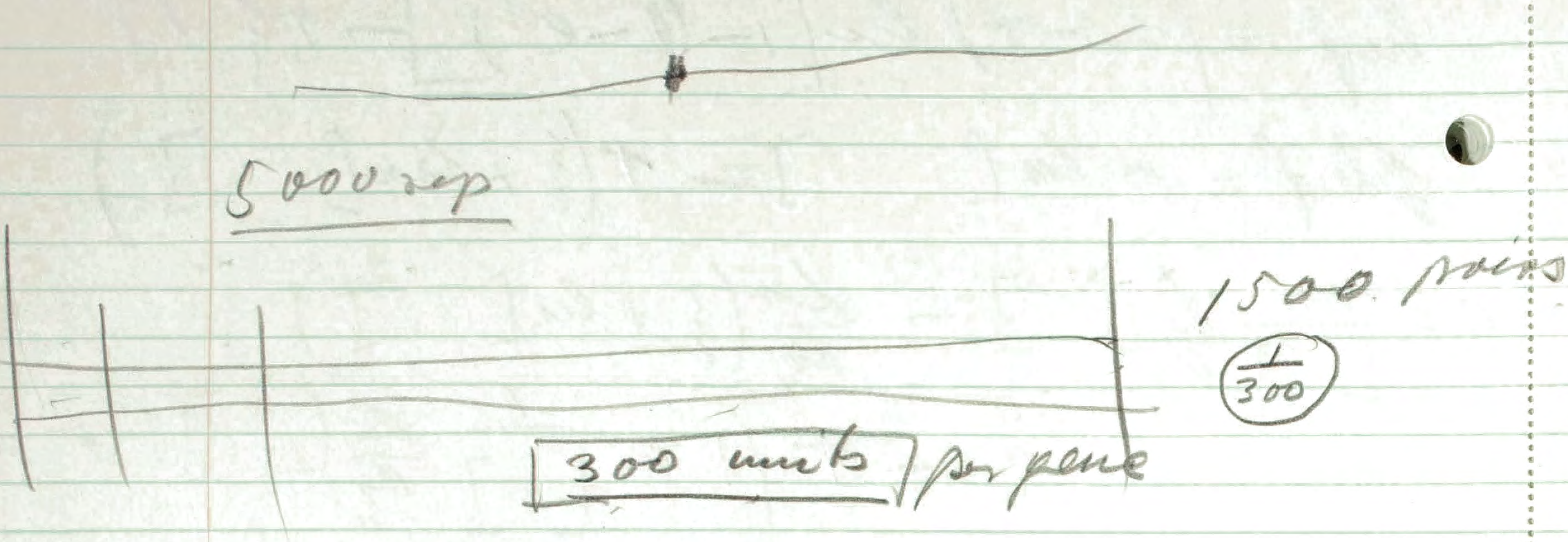
$$0 = \frac{-2e^{-\xi}+2e^{-2\xi}}{2e^{-\xi}-e^{-2\xi}} - \frac{1}{m}\frac{dr}{d\xi}(\xi + \ln[\quad])$$

$$-\frac{r}{m}\left[1 + \frac{-2e^{-\xi}+2e^{-2\xi}}{2e^{-\xi}-e^{-2\xi}}\right]$$

$$-\frac{1}{2m}\frac{dr}{d\xi} = \frac{1}{2}\,\frac{\dfrac{2e^{-\xi}-2e^{-2\xi}}{2e^{-\xi}-e^{-2\xi}} + \dfrac{r}{m}\left[1 + \dfrac{-2e^{-\xi}+2e^{-2\xi}}{2e^{-\xi}-e^{-2\xi}}\right]}{\xi + \ln[\quad]}$$

$$-\frac{dr}{dx} = \frac{e^{-\xi}-e^{-2\xi}}{(2e^{-\xi}-e^{-2\xi})(\xi + \ln[2e^{-\xi}-e^{-2\xi}])} +$$

$$+ \frac{r}{2m\xi + 2m\ln[2e^{-\xi}-e^{-2\xi}]}$$



$$1 - e^{-\frac{300\ 5\ 10^5}{\text{Dose}}} \qquad \text{Dose} = 10^4$$

$$\left(1-(1-e^{-\xi})^2\right)^{300 \times 2000}$$

$$\xi = \frac{\text{Dose}}{300 \times 5 \times 10^5} =$$

$5\,10^{+5}$ dry rep $\approx$ 1 single str. break

3% DNA $\qquad 10^{-12}$ cc

$\boxed{3\ 10^{-14}\ cc}$

Lerman
Demerec, B/r
Interpret /46

$\boxed{4\,10^8 \text{ rep per gene}}$

2000 genes 1 mut $\boxed{2\,10^5 \text{ rep}}$

$2\,10^{-4}$ mut 80,000 rep
1 mut. ~~4~~ $4\,10^8$

Lerman dry X-rays. — $\boxed{\text{UHX 11}}$

$\boxed{5\,10^5 \text{ rep in act. dose}}$

2000 $2.5\,10^2$

X-rays on
Arabidopsis Avery Alexander
Genetics Vol 42 p. 42/57

2.8×10^{-8} mut / rep / gene
$3.6\,10^7$ rep to
produce mut in a
given gene

~~[illegible]~~ $\frac{3.6 \times 10^7}{10^4}$ = dose needed for one mut.
in haploid

3.6×10^3 rep = 1 mut. in haploid

$1.8\,10^3$ rep = 1 mut in diploid

0.050 ~~50,20~~

$\frac{1}{1000 \text{ rep}}$

1 mut

$\frac{0.25}{5}$ $\frac{200}{}$

$\frac{200}{5}$

$\frac{50}{}$ 50

50^2

Mouse

a/rep N_t = mut/rep

$$\text{mut/rep} \times \frac{N_1}{N_t} \times 365 \times \tau = \delta^*$$

doubling dose D_0

$$\frac{\mu t}{D_0} \times \frac{N_1}{N_t}\ 365\tau = \delta^*$$

Russell 600 rep 300 rep

25×10^{-8} per rep

$25\ 10^{-4}$ per rep

1000 rep 2.5 mut in haploid
5 " in diploid

$\frac{1}{5}$ 1 fault per 1000 rep

1 fault = 6×365 days life short. λ rep

~~1 rep~~ = δ^*/rep = 2 days / per rep

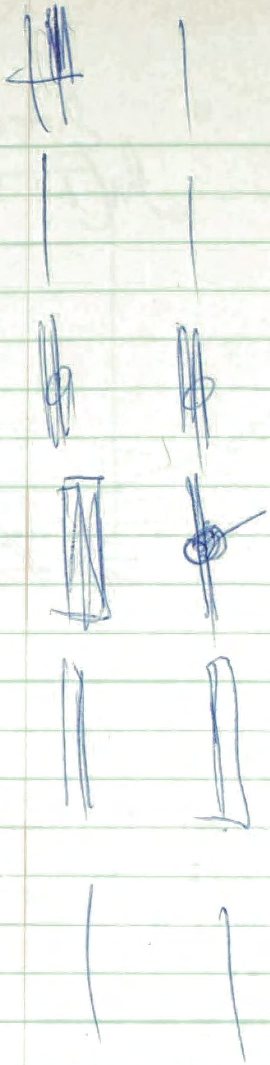
~~Don~~ $\mu t = 0.1$ $(\mu = 10^{-5})$

$\frac{2.5}{1000}$ mutations in haploid / rep

400 rep ~ 1 mut

Doubling of dose 40 rep 0.1 mut

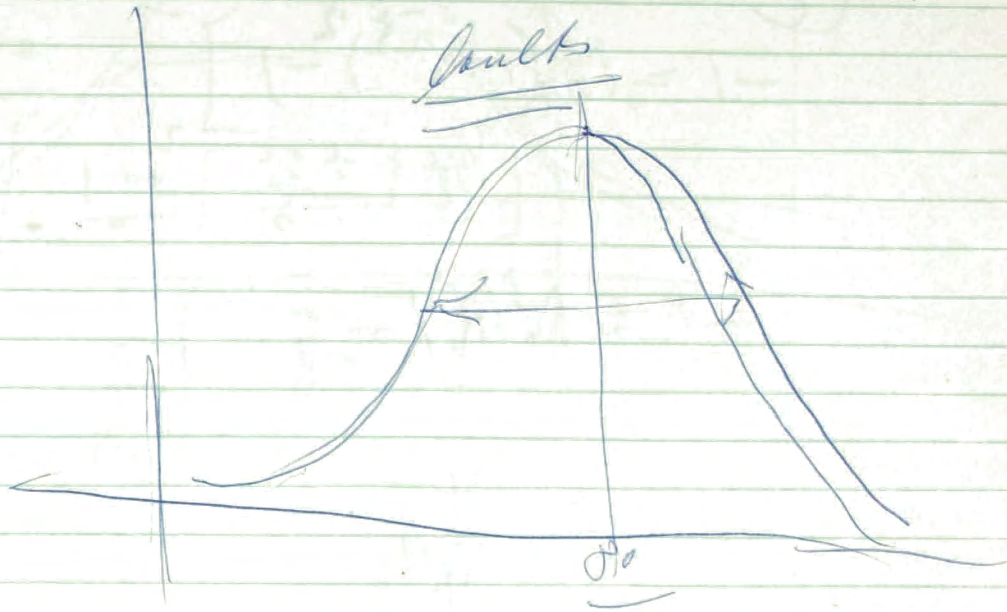
$D_0 = 40$ rep



10,000

[illegible] vegetable

Adults



σ_0

2 - 4

$n = 2 \cdot \sigma$

$\tau = \frac{\sigma}{\sqrt{n}}$

6 years

SK 6-5975

$$\frac{1}{e} = \left[1-\left(1-e^{-\xi}\right)^{2}\right]^{N}$$

$\ln(1+x) = x$

$$-1 = N\ln\left[\left(1-e^{-\xi}\right)^{2}-1\right]$$

$$\left[\left[\cancel{1+}\,\xi+\frac{\xi^2}{2}\right]^{2}-1\right]$$

$$-1 = N\ln\left(1-\xi^{2}\right)$$

$\cancel{\frac{1}{30}}$

$$\xi^{2} = N$$

$$\xi = N^{1/2}$$

$\frac{1}{30} = \xi$

$\frac{1}{1000}$ ~~per day~~

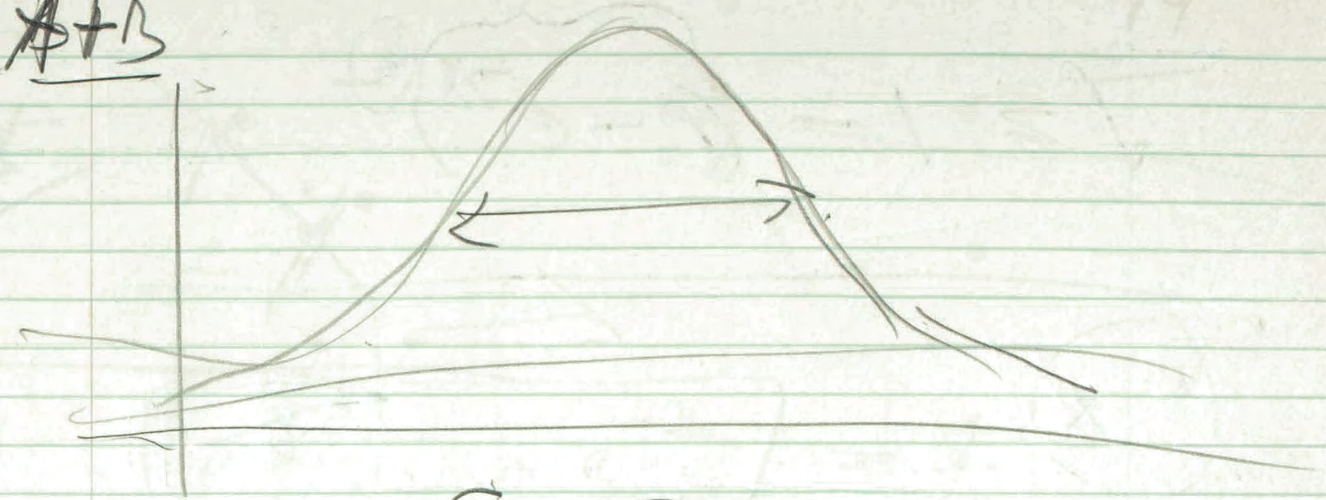
$\frac{1}{1000}$ per day

$6\tfrac{1}{2}$ 30

$\frac{1}{30} = \frac{\cancel{1}}{1000}$

$\boxed{30 \text{ days}}$

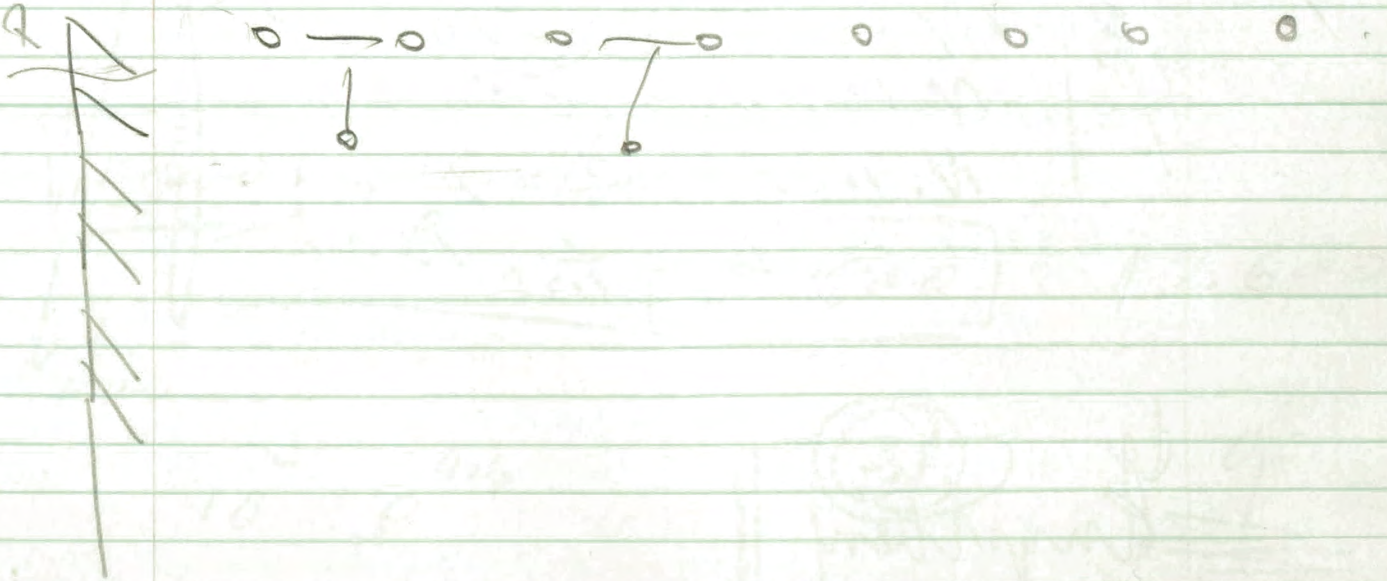
A ; $\cancel{A}+B$



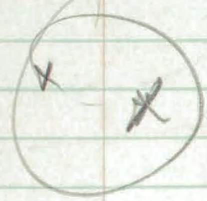
$$\frac{\sigma}{\sqrt{n}} = \bar{\sigma}$$

$$\frac{\sigma}{\sqrt{A}}$$

$$(A+B)^{1/2}\frac{\sigma}{\cancel{\sqrt{A+B}}}$$



$f = 1 - \left(1 - e^{-x}\right)$



$$25 \times 10^{-8}$$

$\underline{D}$ $N \; 25 \times 10^{-8} = 1$

Σ $N \; 5000 \times 25 \times 10^{-8} = 1$

$N \; 125 \; 10^{3} \; 10^{-8} = 1$

$N . 125 \; 10^{-3} = 1$

$N = \frac{1}{.125} \; 1000$

Engelberg

14

$$e^{-x} \times x e^{-x} = \frac{1}{10}$$

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

$$\frac{1}{\frac{1}{n}+1}$$

$\boxed{30{,}000}$ $\frac{30000}{3.4}$

$\boxed{30}$ $\frac{3.4}{}$

e

$\boxed{8800}$ is $\frac{1}{e}$ base

$\boxed{5{,}600}$ 17,600

$\frac{1}{100}$ 2500

10^2 $e^{4.6}$

3.1

9

NIH Computation
White females 1949-50

census,

$_{60}\Delta_{\text{Total}}$ = 10.18 years

$_{40}\Delta_{\text{total}}$ = 13.37

Ratio 1.313

Synes/Dowes, All in a Lifetime. —

Muller wants 600 rep/10 hours
or 60 rep/hour
for neutrons. —

W. L. Russell Proc. ~~Nat Acad~~ Sc. Vol 43 p 324
(apr) 1957

Mouse 0.61 day/rep

Man 20 days/rep

Mouse lives 800 days

$\frac{800}{.61} = 1300$

Man lives 70 years = 25,000

$\frac{2500}{20} = 1300$

Broad ... for ... sperm have to ... times as ... . —

Assume

15 days if ... is given to both male and female parent

Csizmás Lajos

2131

Roll WH. Hall 6-4455 7 pm Sat.

Oliver ; Drosophila   a single dose of 2000 R

1.) male ; mature sperm
large doses (or more)
as many deletions, as point mutations

2.) Spermatogonia
$\frac{1}{5}$ point mut. (compared to 1.))
almost no deletions

3.) immature (prior to fertilization) oocytes
about 1/2 [0.6] times as sensitive as 1.) to recessive lethals &
Ratio of del. to rec. lethals
1 del (small) to 2 rec. lethals
no inter chrom. translocations.

4.) oogonia 1/3 of oocytes [or ~ $\frac{1}{5}$ of 1.)]
— no deletions. —

Russel 300 R
over say 2 months between $\frac{1}{4}$ to $\frac{1}{2}$
with γ Rays. —

of Muller [X-rays on spermatogonia ~~spermatocytes~~]
1/01 ~~to almost 1/3(?)~~ $\frac{1}{10}$ of several gene
deletion per point mutation

Robert JUNGK
Wien 19, Hohe Warte 29 ~~42 56~~ 21

David L. Hill V.P. American Management Council
515 Madison Ave., Plaza 3-8980
New York 22, N.Y.

Nicolussi (Jan) 52-70-802 (Home)
Frau → 63-56-91 Klappe 455.
Bundeskanzler dmt

(Burlington Vt 1935
Lunch on Presidentia Res.)
4.7% three month
7% [illegible]
→ 15 million volt X-ray
[illegible]

Henriette [illegible]
72 ~~44~~ 42 23
III ~~Eslarngasse~~ Eslarngasse 1.

Optiker Wilen I Operngasse 16
73 43 53
III. Landstrasse Hauptstrasse 21

[illegible] 21 Budapest 5

Livingston
9201 Burn Tree Rd
~~EM 2-2838~~
EM 5-0484

Bradley
Forward Burn Tree right II [illegible]

~~[illegible] of Mrs [illegible] (Harvey)~~
St 3-1977 Miss Roscoe
Sterling
711 ~~3~~ 14th NW [illegible] 306

Riga 73145
[illegible]