Cal Tech

Sycamore 6-7121

Goldberger
Olympic
245270
San Fr.

ML512

Sycamor 67121

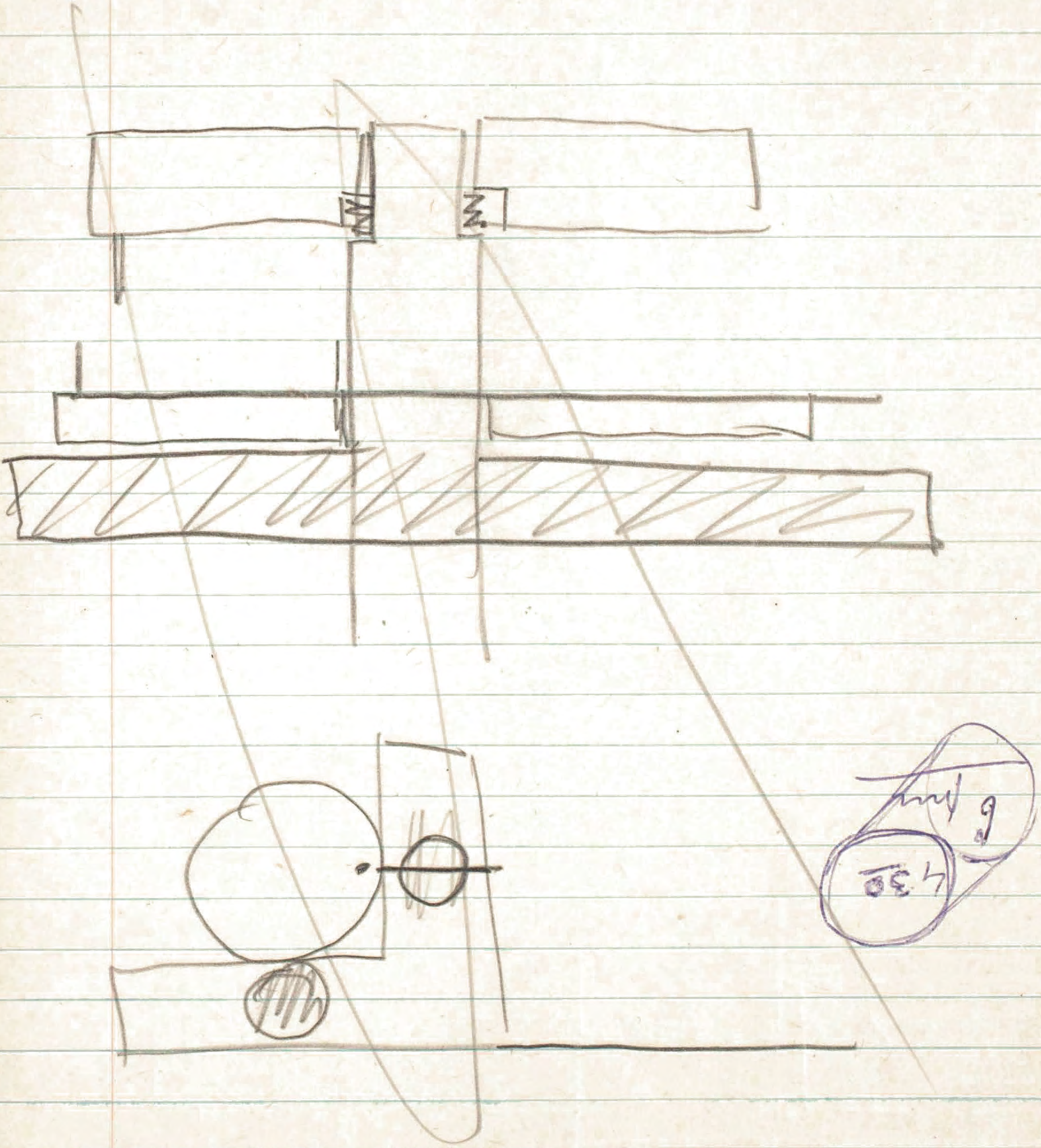
Tatum 416

Tatum Da 21504
home
Da-26576
40 Twitty (Vicker)

Russel Varian
Sigrud Varian

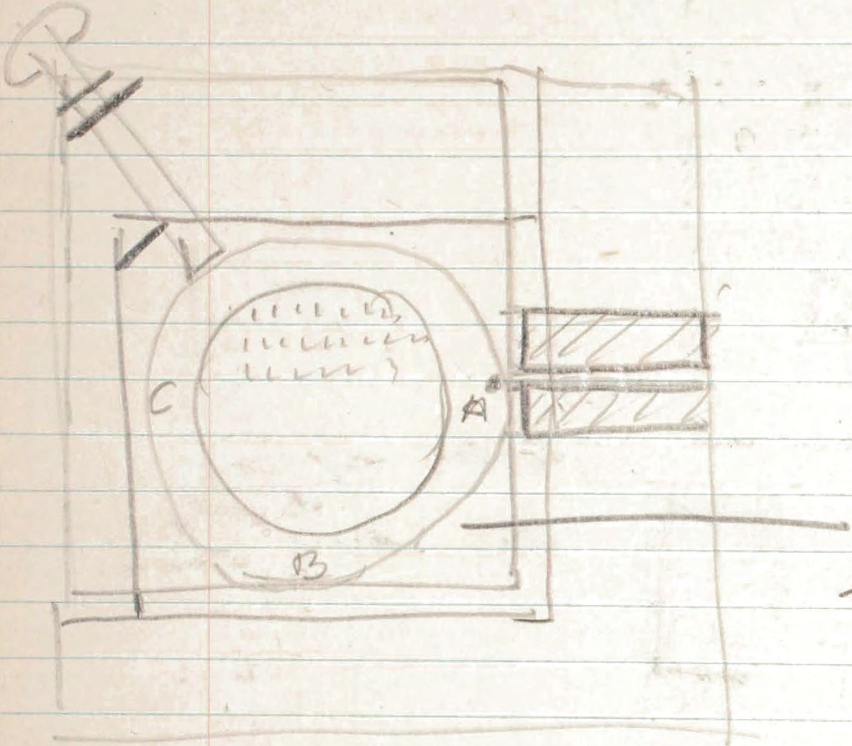
Simon Hankin
Stanford

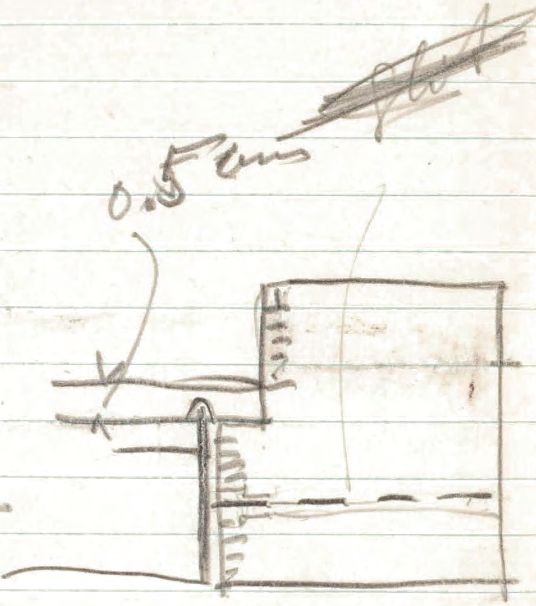
L. SZILARD
6200 Drexel Ave
Chicago

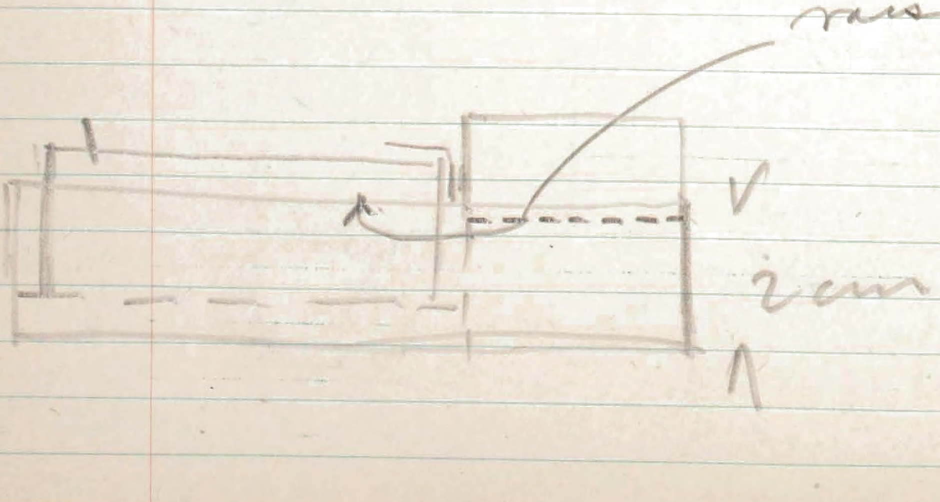


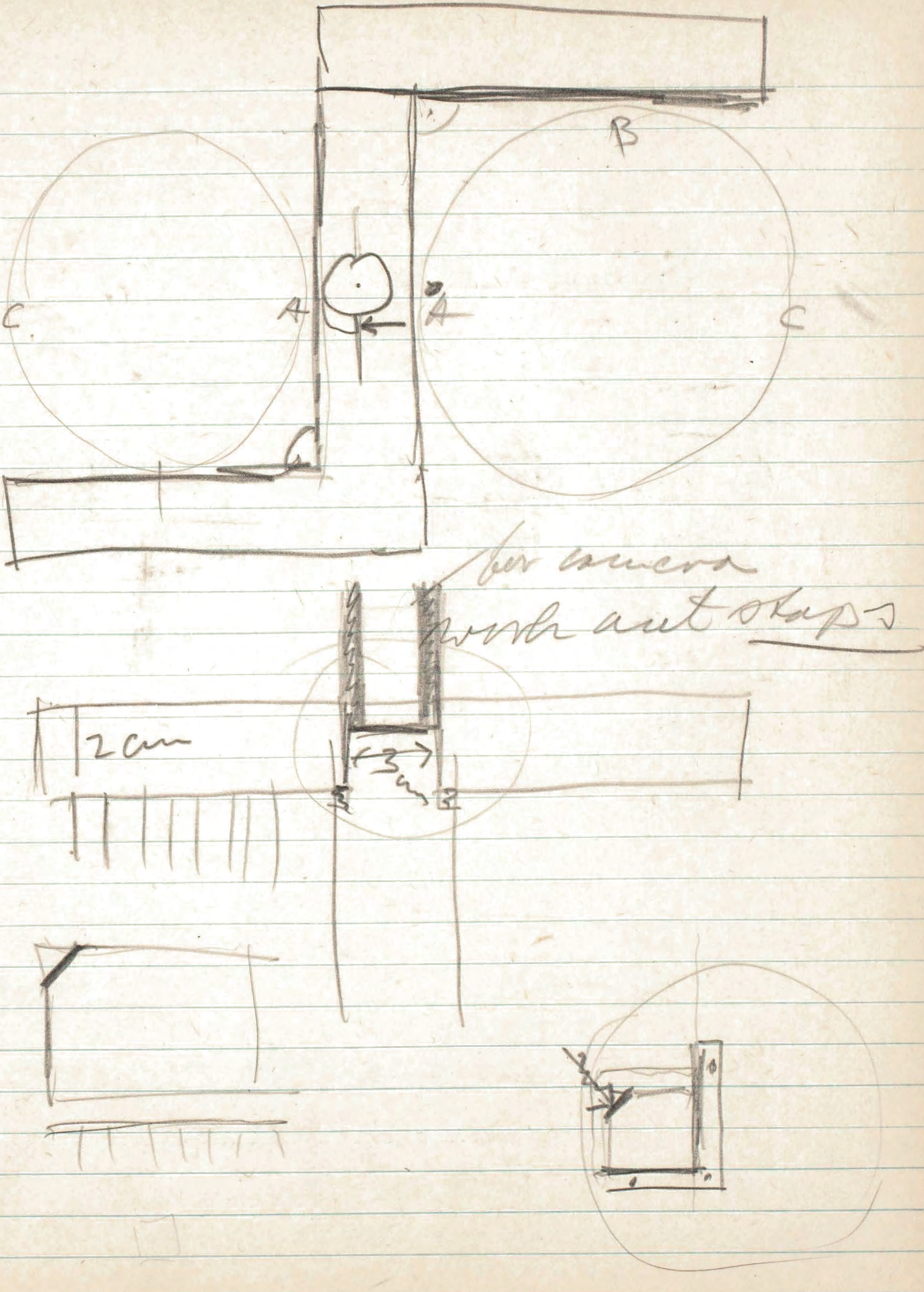
4 30
6 pm

Holder for sprag

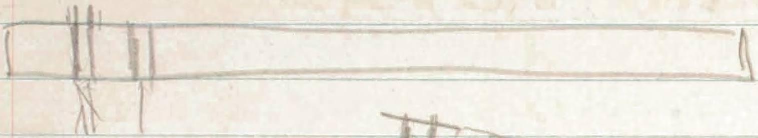


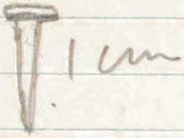


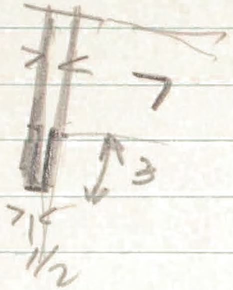




for camera
work out stops

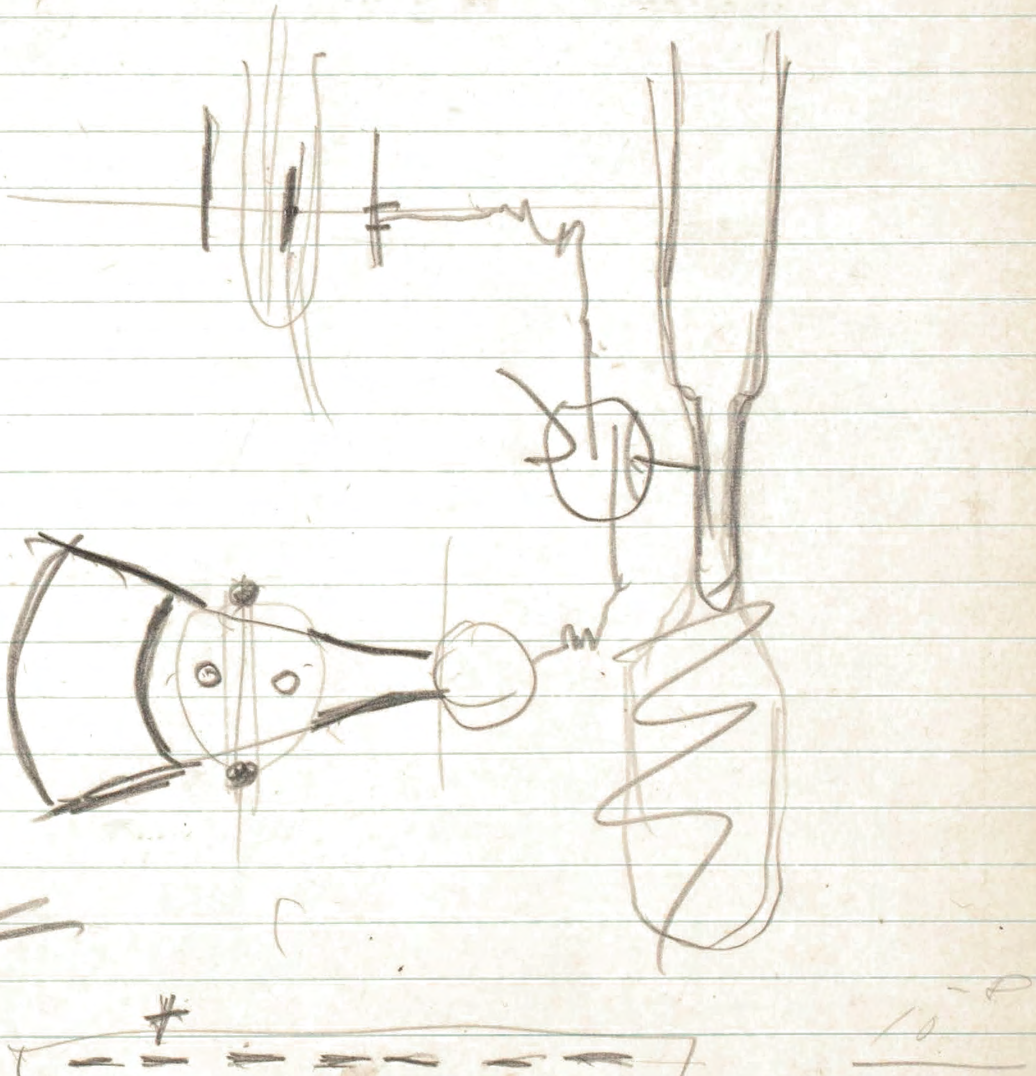



1 cm

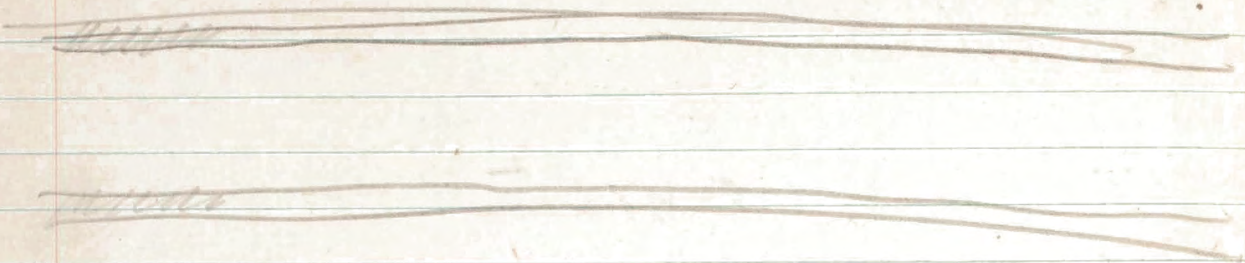

7
3
1/2

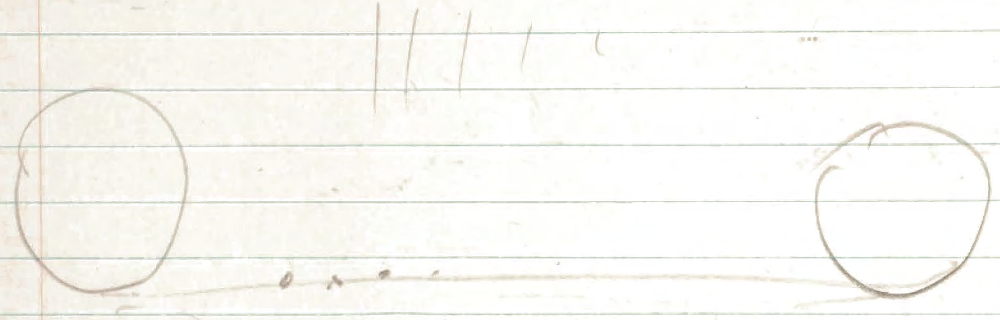
Nephelometer control

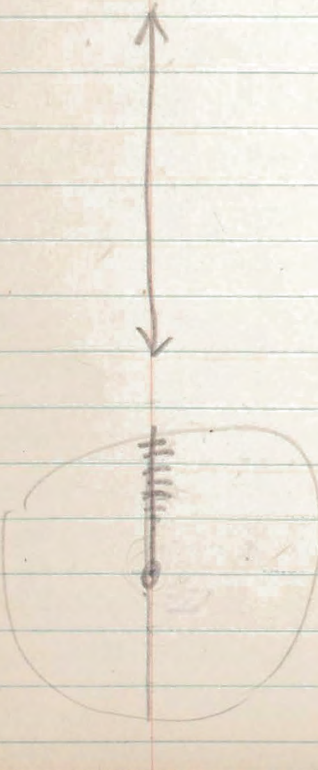
Lock in



No 2





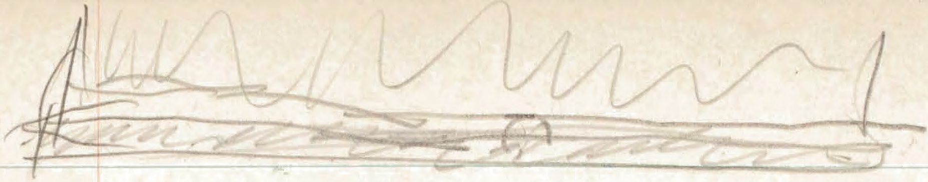


~~7,8~~ 7,5

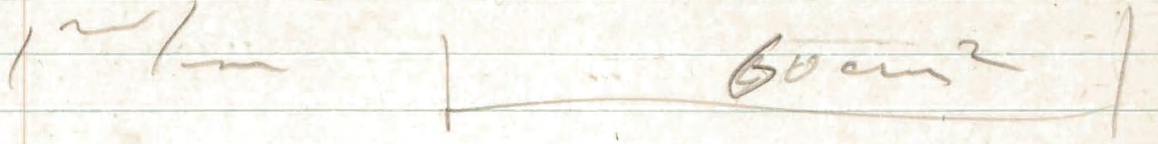
30 cm² × 50

1500 cm²

3000 × 2



No 2



6×10^{12}

10γ/liter

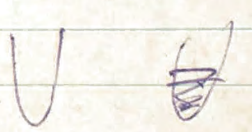
$\frac{1}{1000}$ gm/cc

10^8

10^{-4} gm/cc

Q=0

$$10^8 e^{\alpha t} = e^{2\alpha t}$$



$$e^{\alpha t} = 10^8$$

$$\alpha t = 8 \times 2.3 = 18.4$$

$$18.4 \times 30 =$$

30 min

A B

$\frac{dA}{dt} = \alpha A - \gamma A$ $\frac{dB}{dt} = 2\alpha B - \gamma B$

$\frac{dA}{A(\alpha-\gamma)} = dt$

$A = 10^8 e^{-(\alpha-\gamma)t}$ $B = e^{-(2\alpha-\gamma)t}$

$10^8 e^{-(\alpha-\gamma)t} = e^{(-2\alpha+\gamma)t}$

$2.38(-\alpha+\gamma)t = (-2\alpha+\gamma)t$

~~$8\alpha t = 2\alpha t$~~

$(8)(2.3) = (\alpha-\gamma)t$

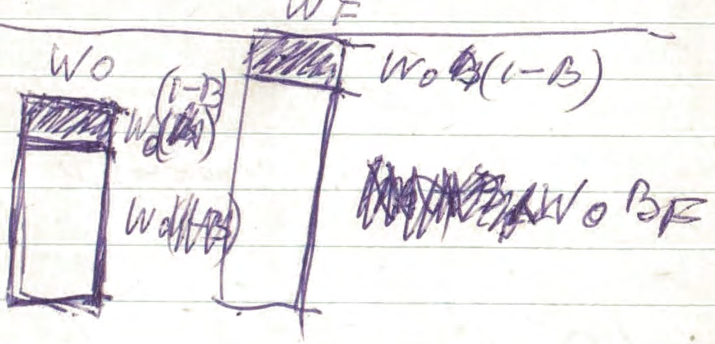
6924 Millbrook /

Parkview 3024 /
Lower 7 Car 51
WR
6pm Union Station
18 Market

effective dose

$A = (1 - e^{-\beta D(t_0)})$ is number of defectors

$\lambda = \frac{W(t)}{W(t_0)}$

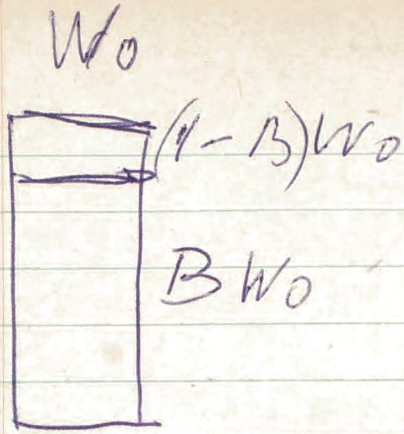


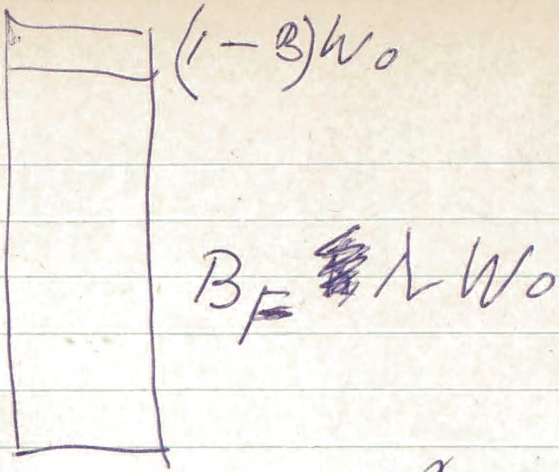
$W_0(1-B) + \lambda W_0 B_F = \lambda W_0$

$\frac{1-B}{\lambda} + B_F = 1$

$B_F = 1 - \frac{1-B}{\lambda}$ ~~[illegible]~~

$B_F = \frac{\lambda - 1 + B}{\lambda}$





$B_F = B^*$

~~$B_F = \frac{B_F \lambda W_0}{(1-B)W_0 + B_F \lambda W_0}$~~

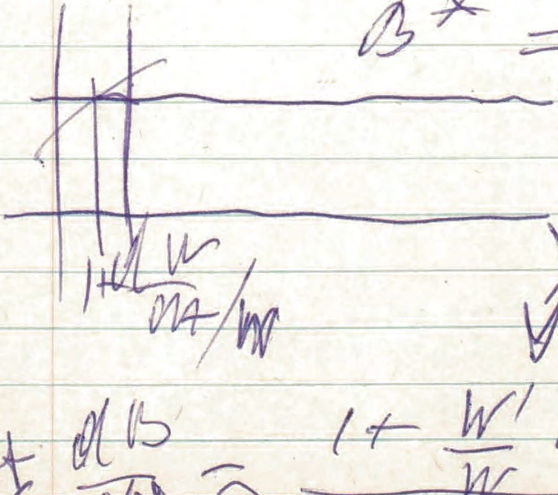
$B_A \lambda W_0$

$B^* \lambda W_0 + (1-B)W_0 = \lambda W_0$

$B^* + \frac{1-B}{\lambda} = 1$

$B^* = 1 - \frac{1-B}{\lambda}$

$B^* = \frac{\lambda - 1}{\lambda} + \frac{B}{\lambda}$



$\lambda = 1 + \frac{\frac{dW}{dt}}{W} \Delta t$

Part $\frac{dB}{\ } = \frac{1 + \frac{W'}{W}\Delta t - 1}{1+} + \frac{B}{1 + \frac{W'}{W}\Delta t}$

page

Brody page 681 quotes
to 18.9 (see also Brody p 492
p 684 quote (31))

Child C. M
"Senescence and rejuvenation"
Chicago 1915

Mc Cay ~~C.M~~ ~~Maynard L A~~
quoted on p 683 (47)

Aging after retarded growth
J.N. 10. 63 1935
J. Nut

Mc Cay see Brody p. 692

$B_2 = e^{[illegible]} B_1$ →

part $\frac{dB}{dA} = \frac{W'}{W}\Delta t \left(- B\frac{W'}{W}\Delta t \right)$

$\frac{W'}{W}\Delta t - B\frac{W'}{W}\Delta t$

part $\frac{dB}{dA} = (1-B)\frac{W'}{W}$

other part $B = e^{-\rho r t} = -\rho r e^{-\rho r t}$

~~$\frac{dB}{dA} = (1-B)\frac{W'}{W} - \rho r$~~

~~$\frac{dy}{dx} = \left[\frac{W'}{W} - \rho r\right] - \frac{W'}{W} y$~~

~~$y = e^{qx}$~~ ~~$ye^{qx} = [\;] - \frac{W'}{W} q x$~~

total $\frac{dB}{dA} = (1-B)\frac{W'}{W} - \rho r e^{\cancel{B}t}$

$= \frac{W'}{W} - \left[\rho r + \frac{W'}{W}\right] B$

$\left(\frac{dA}{dA} = W\frac{W'}{W} - \left(\lambda + \frac{W'}{W}\right) B \right)$ [illegible] for even 10^{-5} for 20 days

for something that lives 250 days

$k = \frac{1}{250}$

$\delta = \frac{1}{2500}$ for $r = 1$

$\delta r t \approx 2{,}500$ ~~4~~ times ~~as~~ to be [illegible]

Life would be $\frac{250}{2}$ days

$$\boxed{r \approx 20}$$

$1/2 = \delta D$

$2\,10^{-4} D$

$$\frac{1}{2} = \cancel{2}\,10^{-4}\, r \cdot \frac{250}{\cancel{2}} = \cancel{10}$$

$$r = \frac{10^4}{500}$$

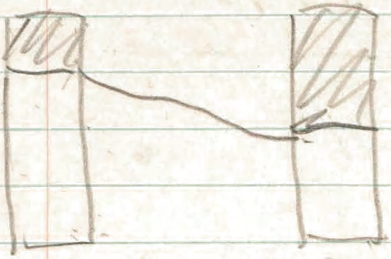
when $B = 4/5$ it matches up at

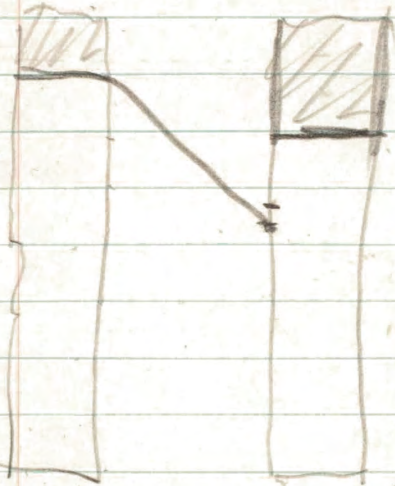
per day: $\frac{W'}{W} = (2\,10^{-4} \times 20 + \frac{1}{250})\,4$

if $B = \frac{N}{N+1}$

$$\boxed{\frac{W'}{W} = (2\,10^{-4} \times 20 + \frac{1}{250})\,N}$$

H





gain by
delayed growth

---

for $B = 4/5$

$\frac{dB}{dt} = 0$ if

$$0 = \frac{dB}{dt} = \frac{W'}{W} - \left(\delta r + \frac{W'}{W} + k\right) B$$

for $B = 4/5$

$$0 = \left(1 - \tfrac{4}{5}\right)\frac{W'}{W} - (\delta r + k)\,\tfrac{4}{5}$$

$$\frac{W'}{W} = (\delta r + k)\frac{B}{1-B}$$

$\boxed{\text{age}_{\underline{\text{ees}}} = -\ln B}$

$$\left(1-\frac{w'}{W}\right)e^{-\lambda t}+\frac{1}{\lambda}\frac{w'}{W}=B$$

1

$1-$

[illegible]

Try again

$$\frac{dB}{dt}=\frac{w'}{W}-\lambda B$$

$$\left(1-\frac{w'}{w}\right)e^{-\lambda x}+\frac{w'1}{w\lambda}=B$$

$$-\lambda(\quad)e^{-\lambda x}=\frac{w'}{W}-\frac{w'}{W}-\lambda(\quad)e^{-\lambda x}$$

$$B=\left(1-\frac{w'}{W}\frac{1}{\lambda}\right)e^{-\lambda t}+\frac{1}{\lambda}\frac{w'}{W}$$

$t=0 \quad B=1$

$$\frac{W'}{W} = \left(4\,10^{-3} + \frac{1}{250}\right) 4^{H}$$

$$\frac{W'}{W} = \left(\frac{2}{250}\right) 4 = \frac{8}{250} \sim \frac{1}{30}$$

Measurements on placenta permit determination of [illegible]

rat doubles in 40 days
or about 3% per day

~~$Kt_r + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 = \Sigma$~~

~~can we calculate the α-s?~~

$$\frac{dy}{dx} = a - by$$

~~[illegible]~~

$$\boxed{ce^{-\lambda x} + d}$$

~~[illegible] $= a - bce^{-\lambda x}$~~

$$-c\lambda e^{-\lambda x} + \underline{d} = \underline{a} - bce^{-\lambda x}$$

$$\lambda = b$$

$$c = (1 - d)$$

for

$\mathcal{B}_L = \frac{1}{e}$

$\frac{1}{e} = \frac{1}{\quad}$

$e = 1 + \frac{\gamma r + k}{\frac{w'}{w}}$

$$\boxed{\approx 1.75\ e - 1 \geqq\equiv \frac{\gamma r + k}{w'/w}}$$

$\frac{1}{e^{\varepsilon}}$

for $k = 0$

$\gamma = 2\ 10^{-4}$

$r = 10 \text{ (day)}$

$\gamma r = 2\ 10^{-3}$

$\frac{w'}{w} = (e-1)\ 2\cdot 10^{-3}$

for $r = 0$

$k(\text{min}) = \frac{1}{22{,}000} \qquad e^{-k\,60\times 365}$

$1/k \cong \frac{18000}{3600}$

$\frac{w'}{w} = \frac{1}{17}\ \frac{1}{22000} = \frac{1}{37400}$ per day

15400

~ for star 10/8

H

~~for~~ $\cancel{B = e^{-\mathcal{E}}}$

$\cancel{e^{-\mathcal{E}} \left(1 - \frac{w'}{w}\frac{1}{\lambda}\right) e^{-\lambda t} + \frac{w'}{w}}$

~~where~~ $\cancel{\lambda = \left(k + f r t + \frac{w'}{w}\right)}$

$\cancel{-\mathcal{E} = \ln\left(1 - \frac{w'/w}{k + f r t_r + \frac{w'}{w}}\right)}$

$\cancel{t - \lambda_? t + \ln \frac{w'}{w}}$

limiting ~~[illegible]~~ ~~[illegible]~~ (nontoly)

$$\frac{dB}{dt} = 0$$

$$\frac{w'}{w} = \left(f r \cancel{t_r} + k + \frac{w'}{w}\right) B$$

$$B_L = \frac{w'/w}{f r + k + \frac{w'}{w}} = \frac{1}{1 + \frac{f r + k}{\frac{w'}{w}}}$$

$$B_L >> 1/e$$

[illegible] 10^6 / gmole

5000 ev

Ra $\frac{1400 \text{ years}}{4\ 10^{10} \text{ sec/gm}}$

$4\ 10^4 \times 3,600$ 1400 ev

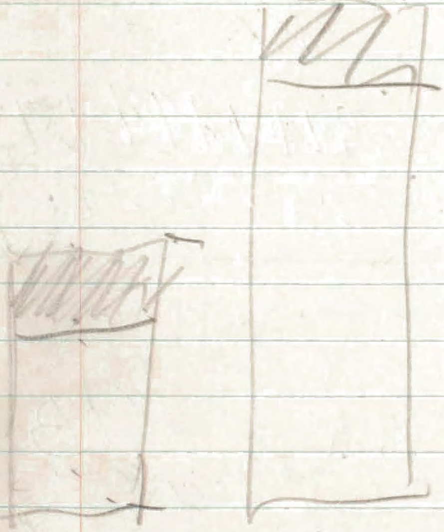
$4 \times 3.6 \times 1.4$ 10^{10} years

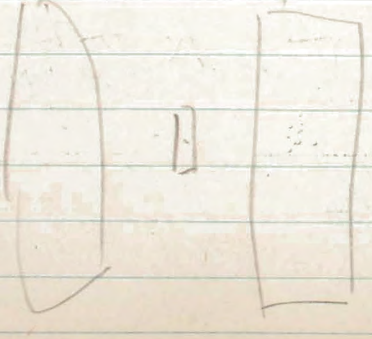
$$e^{-\gamma t} \quad e^{-\alpha \delta} = \frac{1}{e} \quad 2/3 \qquad e^{-\alpha\delta}$$

$$\| \quad \frac{\Delta T}{T_0} = \alpha D$$

$$\frac{\frac{dW}{dt}}{W}$$

$$\frac{1}{1000}$$





From growth curve

$$W = 1 - e^{-kt}$$

$$\frac{dW}{dt} = k\cancel{t}e^{-kt}$$

$$\frac{dW}{dt}/W = k e^{-kt}$$

for e^{-kt} large t

Otherwise

$$\frac{k e^{-kt}}{1-e^{-kt}} = \frac{k}{e^{kt}-1}$$

$$k = \frac{1}{\tau}$$

1000 × 20   20 000 days

365 × 60

$\overline{T}$ Horse 30, Cow 26 dog 9 Cat & guinea pig 6

J. S. Friedenwald Problem of aging

12 years | $e^{-k\,12\text{ years}} = 2/70$

$k12 = \ln\frac{70}{2}$ $\frac{1}{k} = \frac{12}{\ln 70/2} = \frac{12}{\ln 35}$

$$1 - e^{-hT}$$

$$\frac{dw}{dt} = he^{-T} + \frac{1}{2}\,\frac{1}{1000}\,\frac{1}{\tau_0}$$

10^4 kg

$$\frac{280 \text{ day}}{\ln 10^{10}}$$

$$\frac{8}{100} \qquad \frac{100}{8} = \boxed{12}$$

Rogers 1936

Comp. Physiology

E. Baldwin

Comp. Biochemistry

Buddenbrock Wolfgang von

Grundriss vergl. Physiologie
der Tiere

More accurate comparison

50 mutants for 5000 r ([illegible]) or 1 mutant for 1000 r

delayed mutants 100 - 200 more

or say 150 mutants for 1000 r

senile mutants: $1.15\,10^7$ for 1000 r

or

ratio per mut to B/1 $\dfrac{1.15\,10^7}{150}$

$= \dfrac{1.15}{1.5}\,10^5$ senile/B/1

per division: 0.7 B/1

or per division $\dfrac{0.7 \times 1.15 \times 10^5}{1.5}$ senile

$\sim \frac{1}{2}\,10^5$ seniles/div

8 days for doubling weight

$e^{-\delta t} = 1 - \delta t$

for $t = 8$ $\delta t = \frac{1}{2}\,10^{-3}$

$\delta = \frac{1}{1.6}\,10^{-4}$ $T = \frac{1}{\delta} = 1.6\,10^4$ days

Record

Mouse	6 years
Rabbit	8 years
Deer	15 years
Man	100 years

H

16000 days

$\frac{16000}{365}$ years ≈ 45 years

45 × 365 =

or 8[illegible] for doubling of
≈ 50 years

18000 | 50
14400 | 44
 | 40

	Tg	Life
Mouse (Maus)	21 d	3 - 3½ years
Rat (Hausr.)	21 d	2½ years
Guinea pig	63 d	4-5 years
Rabbit	30	5-7 years
Pferd	350 d	40-50 years
Haus Huhn	22 d	20 years

Albino Rat' on 14 day (from Donaldson see p 173)
179% rate of increase

Stotsenburg Anat. Rec. vol 9 p 667

Pig : Prenatal growth of the pig
Lowrey, Lawson G. 1911
Am Journ Anat vol 12 pp 107–138

$$1-\sum_k \left(1-e^{-\alpha D_k}\right) \bar{B}_k \frac{W_k}{W_F} = B_F$$

$$1-\sum_k \alpha D_k B_{k,1} \frac{W_k}{W_F} = B_F$$

If αD_k small $\ll 1$

$$B_{k+} = 1-\sum_i \alpha D_i B_i \frac{W_i}{W_k}$$

checked

Murray A jr p41 Vol 9
J. Gen. Physiol.

$$\frac{\frac{dW}{dt}}{W} = 0.7$$ doubles in one day

from 5th to 6th day

wet weight (5) 206 mg

(6) 424 mg

formula $\text{weight} = 0.668\, t^{3.6}$

t in days

compare man $\boxed{50 \text{ years}}$

doubles 8.7

$$\frac{50 \text{ years}}{8.7} \approx 6 \text{ years}$$

but $\frac{dW}{dt}/W$ not yet maximum!

Rabbit Friedenthal

0	0·0000020
0.3	0·00000034
0.6	0.0000007

doubles in the 0.3 day

Figures may include placenta, membranes and liquids

Sheep	[illegible] length
21	2·0
28	3.1

max

Pig	Lowrey weight gm
27	0.400
3< 30	0.796
2< 32	1.898
33	2.241
3< 36	3.136
2< 38	5.040
40	6.963

Pig	Warwick
22	0.5
29	1.2
30	1.66

32	2·2
40	8.8

Needham
Vol III.

H

Chick (wet)

	Schmalhausen 1926	1930 Byerly
1 day	0.0002	0.0007
2	0.003	0.004
3	0.020	0.029

Mouse McDowell, Allen & McDowell

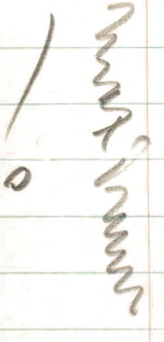
8	0.00008
9	0.00147
10	0.00860

Albino rat

13	0.040
14	0112

Guinea pig Draper

17	0.0050
18	0.0150



Chomin etc Fehling Eckhardt & Braun

Rabbit	Length		Weight
6	0.26	mm	
7	1.7	mm	
13	~~0.06~~		0.06
14			016

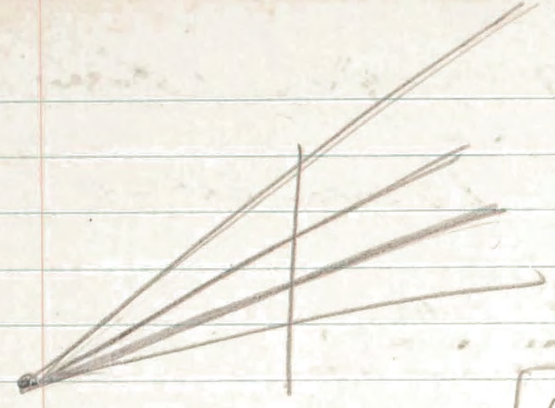
from Needham

Cow	Hammond	Buchanan
1 month	0.1	0.77
2	9.2	8.3
3	87	109
4	720	599

Mean days	Friedenthal
15	0.001
19	0.027
30	0.720

Rothenberg Wa 3 2500 Ext 7238

Rothenberg



30

1800 gm

60 gm

78 (2/2)

4.25 2500

1.6 kg

60

Man |
rat |

(Man rat 15 gm excreted as (N)
+ 10 mgm. /kg/time / kg weight
at o time / one shot !)
about 35% excreted of N15

Much higher Protein diet 35 gm

Man 70 kg rat 10 gm
80% excreted

normal diet

Rat 15% of 12 gm / day

low —

high 10 gm casein

rats weight **250 gm**

Rat urine N · 3% of total N

casein has glycine? 1-2%

glycine content of man
of rat 10% of total N

Calc 15% of 12 gm = 2 gm

normal diet

$\frac{2}{100}$ glycine rat }

$\frac{150}{100}$ glycine man

ratio rat gets 75 times less or since rat weighs 70 × 4 times less

rat 4 times as fast as man

glyc man $\frac{35 \text{ gm}}{10}$ | rat $\frac{10}{100}$ gm

$\frac{350}{100}$ rat $\frac{10}{100}$

at 45 days : 0.5 gm

~~[illegible]~~ $\frac{4\times10^6}{2\times4}$ ~~[illegible]~~ 10^5

$11.5 = \mathbf{16}$ or

ca 3 days
doubling
time

diameter 0.2 mm / m Human ova

$\frac{1}{2}\left(\frac{2}{100}\right)^3$ gm $= \frac{1}{2}\,8\,10^{-6} = \boxed{4\,10^{-6}}$ gm

Baby 10 kg $= 10^4$ gm

Ratio $\frac{1}{4}\,10^{10}$

log Ratio $= 2.3\times10 - 1.5 = \boxed{21.5}$

for doubling $n = \underline{30}$ or 280 days

$\approx$ 100 days

$e^{0.693} = 2$

$e^{\beta\tau} = e$ — $\beta\tau = 1$

~~$\beta\tau = 1$~~

$e^{\beta\tau} = 2$ $\qquad \beta\tau = 0.69$

$\tau = \underline{0.69\,\frac{1}{\beta}}$

$\frac{4\,10^{-2}}{4\,10^{-6}} = \frac{1}{4}10^{+8}$

2500

$3^n = 2\times5000$

0.03 to 0.04 gm N / kg of urine
sugar fed

say 2.5 gm / 70 kg man

30 gm Protein intake min for 70 kg

say 10% of Protein is N

~~30 kg is [illegible]~~ 1/2 is skeleton

leave 35 kg "meat" 2.5 kg protein

and say 250 gm N

or assuming 10% rate of reconstr. $\tau = 10$ days for man

Michaelsohn Rukda

rat 250 gm
man 70 kg

$\frac{W_1}{W_2} = \frac{1}{280}$ $\sqrt[3]{280}$

$$\begin{array}{r} 6.5 \times 6.5 = \\ \hline 390 \\ 325 \\ \hline 42.25 \times 6.5 \\ \hline 24750 \\ 20125 \\ \hline 267 \end{array}$$

$\boxed{\text{Rukda 43}}$

Arch Schmalhausen !!

p. 346 Roux Archiv f. Entw. Mechanik d. Organismen 108 — 1926

by weight

1	0.00006
2	0.00045
3	0.00136
4	0.0034
5	0.0110

~~Mouse~~

10	0.0086
11	0.0329
12	0.0762
13	0.1298

Mouse [from Allen, [illegible] [illegible] Proc. of the Soc. for exp. Biology and Med. 1927, XXIV pp 672

compare wt / of [illegible] [illegible]

Pearl

Biological Aspects of Death [pages 110 to 112B
Vol 7 of the Encyc Brit, 1940]

quotes

C. M. Child Senescence and Rejuvenescence 1915

E Korschelt Lebensdauer Altern und Tod (1922)

R. Pearl The rate of living (1928)

! Geo. P. Bidder
Nature Vol CXV 1925
passim

M. A. C. Hinton Voles and Lemmings British Mus 1926

" ~~When cells show~~
When cells show characteristic senescent changes it is perhaps because they are reflecting, in their morphology and physiology, a consequence of their mutual association in the body as a whole and not any necessary progressive process inherent in themselves "

" In short senescence appears not to be a primary or necessary attribute of individual cells as

Literature H

from

Raymond Pearl
Scientific Monthly Mar 1921
(Science Press
The Biology of Death I The problem
Longevity of animals

Lower Invertebrate	24h to ?	
Insects	24h to	17 years
Fish	?	267 years
Amphibia	?	36 "
Reptiles	?	175 "
Birds	9	118 "
Mammals	1.5 to	>100 "

Lowell Lectures Minot
Charles Sedgwick

// p Natural death occurs normally and necessarily only in animals composed of many cells //

Pearl Biology of Death 1922
(Monographs on exp. biol.)
(J. B Lippincott Phil. Pa)

C.M.
McCay et al
Growth of trout
Journ Nut, 1, 233 1929
" "
aging after retarded growth
J. Nut. 10, 63 (1935)
" " 18, 1, (1939)

Jane G. Calder. Metabolism
and morphogenesis
Doctor Thesis. Dept. of Zoology
Univ of Missouri 1942
quoted p. 46 Brody

N/Cal ratio for cold blooded
animals: Bonnet R. Arch. Intern
Physiol, 37, 105, (1933)

1939 C. M. McCay Problems of aging
Williams and Wilkins Co Baltimore
(McCay Animal Nutr. Lab, Cornell –

Literature

such, but rather of the body
as a whole. —"

Friedenthal (from Kent)

Ceph. factor $\dfrac{\text{Brain weight}}{\text{Total mass of body protoplasm}}$

$$\approx \frac{\text{Brain weight}}{(\text{Body weight})^{2/3}}$$

			yrs
mouse	0.045	6	4
Rabbit	0.066	8	4
deer	0.216	15	4
man	2.7	100	4

Metabolism Max Rubner
Das Problem der Lebensdauer
und seine Beziehungen zu Wachstum
und Ernährung München 1908 p 203

N metabolism
Terroine and Sorg-Matter
Arch. Intern. Physiol. 29, 121 (1920)
30 115 (1928)
Smuts J. Nut. 9, 403 (1935)
Bonnet, R, Arch. Intern. Physiol.
37, 105 (1933)

Rat $\frac{1}{100}$

[illegible]

$10 \times 1 + 20\ 1 + 40 \times 1 + 60\ 1 +$
$70 \times 1 + 80\ 1 + 80 \times 2 + 100 \times 2$

out of 12 month

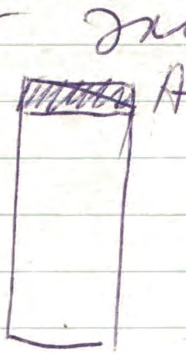
10	1
20	2
40	3
60	4
70	5
80	6
85	7
90	8
[illegible]	[illegible]
93	9
95	10
97	11
100	12

$\frac{880}{100}$ = 8.8 month in place of 12

or 4 months saved out of 12 first months
rat lives [illegible] say 3 years
[illegible] or 1/9 saved

Ageing of young animals H

For young animals



$$e^{-\gamma t} = 1 - \frac{\gamma t}{A}$$

$$\text{age} = \frac{A}{\gamma}$$

and if it grows $\frac{W_i}{W_F}$

~~[illegible]~~ t

$$\text{age} \sim \frac{1}{W_F}\int_0^t W(t)\,dt$$

20
30
60
75
60
120
50
55
120

590/70

8 years in place of 10 or 11 years found

2 years	10 kg
4 years	15
7 "	20 kg
10 years	25 kg
12 year	30 kg
15 year	40 kg
16 years	50
17	55
19	60

$$\frac{1}{70}\{2\,10 + 2\cdot15 \times 3\times20 + 3\times25 + 2\times30 + 3\times40 + 1\times50 \times 1\times55 + + 2\times60\}$$

compare with 19

mean ages 11 years

Mean lives 66 years?
1/6 [illegible]

$$\frac{\frac{d}{dt}N}{N} = 0.08 = \frac{\frac{d}{dt}N}{\underbrace{0.03 \times 70{,}000}_{2100}} = \frac{x}{2{,}100}$$

$$x = 2.100 \times 0.08 = \underline{168\ \text{gm/day}}$$

$$\frac{2.5\ \text{gm}}{168} = \text{efficiency} = \frac{1}{67.2}$$

~~16 / 2.5~~ 2.5

168) 4
67.2 × 2.5
1344
336
1679

~~14.7 cc~~

~~Protein N =~~

Human milk 1.3% Prot
Cow 3–4% "

Baby 1.75 ounces Cows milk
19.25 ounces × 30 cc
600 gm

> 70
2.5 gm

$\boxed{\text{18 gm Protein}}$
$\boxed{\text{3 gm N}}$

Cows milk $\underline{\text{20 cal}}$ per 30 cc ~ 30 gm
$\simeq$ 0.9 gm prot = 0.15 gm N

4800 cal ‖ 240 × 0.15 N = 24.1.5 = $\underline{\text{36 gm N}}$

0.05 gm / kg

$\frac{\text{2 days}}{\text{40 kg}}$ (page 51) (page 47)

$$\frac{3 \times 0.04\ \text{gm} \times 40}{3 \times 1.6} = 5\ \text{gm/day}$$

[N metabolism] | M

Protein = 6.5 N

N endogenous from T.W 0.03 to 0.04 gm/kg
or ~2.5 gm / 70 kg man

6.5 × 2.5
130
325
1625

= 16.25 gm Protein / day

→ 0 kg

$$\frac{\frac{d}{dt}(\text{Prot W})}{\text{Prot W}} = (\text{assume for man})\ 0.08$$

~~0.08~~

or $T_h = 12.5$ days

[12.5 × 0.7 = 8.75 day for ~~T_2~~ doubling]

Assume 35 kg ~~Prot~~ Protoplasm
7% 2.45 kg Protein

$$\frac{\frac{d}{dt}\text{Prot}}{\cancel{2.45}} = \frac{\cancel{0.08}\ 0.08}{\cancel{2.45}}$$

2450

$$\frac{d\,\text{Prot}}{dt} = \cancel{0.}\ \frac{8}{10\cancel{0}} \times 245\cancel{0} = 196\ \text{gm}$$

2450 × 8
19600

196 × efficiency = 16.25

$$\text{efficiency} = \frac{16.25}{196} \approx 8\%$$

3% Nitrogen in body || 65% water extravascular
1/20 blood plasma | 91 to 92% is water || 600 cc Blood

out of 100 kg
[~~[illegible]~~ 12.5 kg Protein; 8 kg N.

Nitrogen also see Brennemann

Holt:

Butz

Protein per

2 to 2.5 gm / kg and day

900 gm 30 day

30 gm / day

$\boxed{0.9 \text{ gm N}}$ 5.85 kg

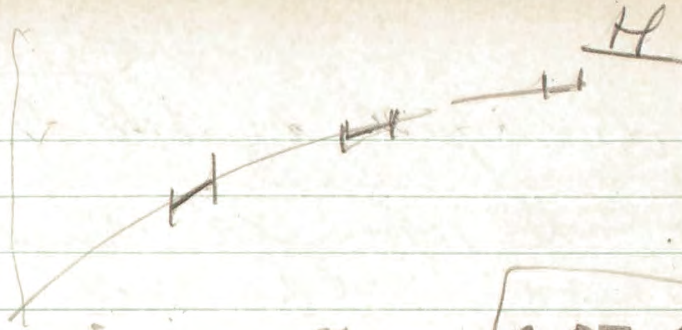
[illegible]

$\frac{970 \text{ gm}}{6} = \boxed{1.6}$

0.65

1.25%

[page 50] [illegible]



77 lb gain per day $\boxed{0.57 \text{ lb}}$

need $\boxed{0.77 \text{ lb}}$

assuming milk

$\cancel{\frac{12}{32}}$ $\frac{1}{4 \times 6}$ $0.77 = N$

$\frac{77}{100 \times 24} = \frac{77 \times 4}{100 \times 24}$ $\cancel{\frac{0.77}{24}}$ $= 0.3 \text{ lb}$ ~~N~~

$\frac{3}{100}$ lb intake

~~0.1 N~~

difference

0.2 lb

~~N or~~

[~~00~~ gm N]

Complete [illegible]

3.4 kg	4.4 kg	5.3 kg	6.1 kg	6.8 kg	7.3 kg	8.1 kg
birth	1	2	3	4	5	6

Hoobler's | Vol 10 153–171 (1915)

Nitrogen storage || Protein need of infants

Amer Journ of the diseases of children

this milieu)

changed by it, in which the state of all the different kinds of somatic cells together determines the composition of the milieu. ~~Then~~ Under such circumstances if we observe with progressing age / characteristic increasing morphological and physiological changes in the somatic cells of the individual organism in ~~we~~ we may / and probably should interpret them as the ~~[illegible]~~ consequence of the mutual association of the somatic cells in the body as a whole and we have no reason to ~~be~~ attribute these changes to ~~any~~ some process of ageing which characterises the individual cells out of which the body is

Article K

The current idea about ageing ~~and death~~ seems to be be ~~that~~ ~~resulting death~~ ~~[illegible]~~

ageing occurs normally and necessarily only if we have to deal with an organism which is composed of many diversified cells and that it does not occur in microorganisms.

~~[illegible]~~

~~Ageing is then attributed to~~ the fact ~~that in the higher~~ we ~~animal for instance, you~~ ~~can~~ have an internal milieu in an organism, which is composed ~~which is~~ of many cells, ~~which in a higher animal for~~ ~~instance, through~~ each kind of ~~cells~~ ~~makes~~ ~~influences all the milieu~~ and is affected and in ~~by it~~ ~~and changed~~ by time ~~in the one hand~~ ~~many ability all the differently~~.

~~[illegible] of cells the state of [illegible] whether together the composition of the milieu~~

higher organisms.

According to this view cells in a bacterial culture or somatic cells in a tissue culture undergo "metabolism" as well as the somatic cells in the body of an animal. There is however this important difference between a bacterial culture or tissue culture on the one hand and an animal on the other hand: cells which undergo "metabolism" which make them unstable or "senile" are rapidly and replaced in the former type composed. —

That present most ~~[illegible]~~ people are however inclined to go as far as to say that the cause (no) cause for the process of aging of the organisms lies not in some local property of the individual cells but in the association of the cells in the body as a whole. —

~~If~~ In this paper we shall attempt to take the opposite view. We shall take the view that ~~a~~ a basic process which somatic cells and ~~[illegible]~~ single cell organisms such as for instance bacteria have in common and which transforms them into non mobile or "senile" cells is also the ~~[illegible]~~ basic cause for the aging of the

is proportionately to the dose
and for radio r we have
(100 to zero say 150)
½ "mutants" per 10^8 bacteria
"Resistant"
(over and above the naturally
occurring mutants)

The fraction of the ~~two~~ those
bacteria which remain
viable if irradiated by
X-ray a certain dose
D obeys ~~[illegible]~~ a simple law
formula i.e. ~~this formula~~
~~[illegible]~~ the viable fraction
is found to be $e^{-\alpha D}$ [600000 r reduce to $\frac{1}{1000}$
$\alpha = 1.15\,10^{-4}$, $v = e^{-\alpha D}$
where D is the dose in r units
and ~~[illegible]~~ α has the value
~~[illegible]~~ If we start with 10^8
bacteria cases we will produce
$1.15\,10^7$ non viable bacteria

arose by the non mutated viable cells and these have these ~~[illegible]~~ senile cells do not accumulate in that part of the culture which is retained in the tube. In the body of an adult animal ~~the~~ however ....

In bacteria these non viable mutations are not easily observable under natural (physiological conditions but we can calculate their number by making ~~under~~ some simple plausible assumptions. —

If a culture of the B/r strain of B.coli is exposed to X rays a certain fraction of the bacteria mutates into a variant which is resistant to the Bacteriophage T1. This fraction

According to ~~our~~ the assumption underlying this article ~~[illegible]~~ similar ~~[illegible]~~ mutations to "non viable" occur in the somatic cells of an animal.

The number of viable cells of the animal body is then given by $v = e^{-ft}$ and we shall assume that on the average ~~death~~ death ~~occurs when~~ from old age occurs when $v = e^{-\varepsilon}$ (for $\varepsilon = 1$ $v = \frac{1}{e}$) Writing for the average ~~[illegible]~~ lifetime L_0, $f = \frac{\varepsilon}{L_0}$

Effect of X rays!

If we now ~~expose an animal~~ ~~to [illegible] repeated small doses~~ ~~to X rays giving it a total dose D~~ ask what will happen if we expose ~~the an~~ the animal

The ratio of "non viable" mutations M
to "phage resistant" mutations is
therefore $\frac{1.15\, 10^7}{150}$

In the absence of any x radiation
the natural mutation rate
to phage resistance is 0.7 per
~~pb~~ division in 10^8 bacteria
~~and of one as~~ ~~Non viable~~
~~therefore~~ the corresponding mutation
rate to "non viable" is not observed
and is not easily observable but
if we assume that the ratio
of ~~this t~~ these two types of
mutations is the same whether
the mutations are produced ~~by~~
by x rays or occur naturally
The natural non viable mutation
rate per (division ~~per~~ in) 10^8 bacteria should be
$$\frac{1.15 \times 10^7}{150} \times 0.7 \sim \frac{1}{2} 10^{+5}$$
or one in 2000 divisions should
lead to a "non viable" ~~[illegible]~~
cell, — [~~[illegible]~~ $\frac{\frac{1}{2} 10^5}{10^8} = \frac{1}{2} 10^{-3} = \frac{1}{2000}$

"sensitive" to X-ray with respect of ~~non viable~~ mutations to "non viable" as ~~[illegible]~~ B coli B/r the value of α will be ... of the ... cells or more sensitive α will be larger than ... The average lifetime L_r of the irradiated animal can be calculated ~~[illegible]~~ by equation v again

~~[illegible]~~ $-\varepsilon$

with $e^{-\gamma t}\, e^{-\alpha D(t)} = e^{-(\gamma t + \alpha D(t))}$ $= e^{-\gamma\left(t+\frac{\alpha}{\gamma}D\right)}$

and since ~~[illegible]~~ $=e$

we can calculate L_r from

$$\gamma L_r + \alpha D(L_r) = \varepsilon$$

with $\gamma = \dfrac{\varepsilon}{L_0}$

$e^{-\gamma\left(t+\frac{L_0}{\varepsilon}\alpha D\right)}$

or $L_0 \dfrac{\alpha}{\varepsilon} D$ is time equivalent of dose

or $$\frac{L_r}{L_0}\varepsilon + \alpha D(\Delta t) = \varepsilon$$

or $$\frac{L_r}{L_0} + \frac{\alpha}{\varepsilon} D(\Delta t) = 1$$

or $$\frac{\alpha}{\varepsilon} D(\Delta t) = 1 - \frac{L_r}{L_0} = \frac{L_0 - L_r}{L_0}$$

for $\varepsilon = 1$ $\alpha D(\Delta t) = \dfrac{L_0 - L_r}{L_0}$

of the B/r $1.15\,10^{-4}\, D(\Delta t) = \dfrac{L_0 - L_r}{L_0}$

H

during its lifetime repeatedly to small doses of X-rays. — We speak ~~my~~ of small doses because it is necessary for the purposes of these considerations to avoid causing physiological (or symptomatic) changes of any organ which would leave the animal ~~diseased~~ diseased and ~~to leave to~~ important for try to separate as far as possible, such physiological ~~ps~~ changes from the mutational changes which may be ~~too~~ induced in the individual ~~cell~~ somatic cells of the animal.

Clearly the ~~number~~ fraction of the viable cells in the animal at any given time will be given by

$$v(t) = e^{-ft} e^{-\alpha D(t)}$$

if ~~D(t)~~ gives the dose (X rays in r) (which the ~~any small~~ animal received up to the time t × ~~If~~ If the somatic cells of the animal are equally

$$\frac{\alpha}{\varepsilon} D \, \frac{(L^* + \Delta)}{L^*} = \frac{L_0^* - L_r^*}{L_0^*}$$

$$\frac{1}{1-\frac{\Delta}{L_0}}$$

$$\downarrow \; \frac{L_0}{L_0 - \Delta}$$

or

$$\frac{L_0}{L_0-\Delta} \, \frac{\alpha}{\varepsilon} D = \frac{L_0^* - L_r^*}{L_0^*}$$

~~not changes~~
independent of ~~species~~ chosen origin for time
~~of ower of α and ε work~~ ~~or depends~~
~~independent of species~~

$$\text{or} \left\{\frac{\alpha}{\varepsilon\left(1-\frac{\Delta}{L_0}\right)}\right\} D = \frac{L_0^* - L_r^*}{L_0^*}$$

The factor of D is as can be seen dependent on $\underline{\Delta}$. —

Shifting of origin of Time scale

In the formulae given above t ~~had to~~ should be counted from birth or ~~perhaps~~ ~~a~~ even better from a prenatal point in time when the early stages of differentiation have been reached. ~~[illegible]~~

[There ought to be made however a small correction ~~which will be~~ owing ~~this correct value [illegible] in con~~ owing ~~to the fact that [illegible] that the~~ ~~[illegible] fundamental — [illegible]~~ to the fact that in the basis of our ~~fundamental~~ basic assumption growth can be expected to affect ageing in a manner which is calculated below.—] If we choose to count time t^* not from $t=0$ but $t=\Delta$ ~~[illegible]~~ ~~[illegible]~~ $t^* = t - \Delta$ and ~~[illegible]~~ ~~express the~~ measure the ~~[illegible]~~ life expectancy with and without X-ray exposure L^*_0 and L^*_r from $t=\Delta$. We have from

$$\frac{\alpha}{\varepsilon} D = \frac{L_0 - L_r}{L_0}$$

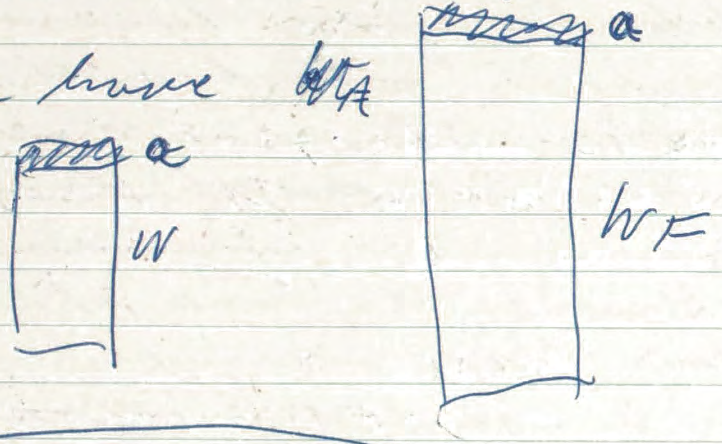
$$\frac{\alpha}{\varepsilon} D = \frac{L^*_0 - L^*_r}{L^*_0 + \Delta}$$

from which we may write:

~~$$\frac{\alpha}{\varepsilon} D \frac{L_0}{L_0 - \Delta} = \frac{L^*_0 - L^*_r}{L^*_0}$$~~

If the animal suddenly increases its weight by growth ~~by a fa~~ its weight from W to W_F

we have W_A



$$\boxed{s_F = s\,\frac{W}{W_F}} \qquad v_F = 1 - s_F$$

$$v_F = 1 - s\,\frac{W}{W_F} = \cancel{[illegible]}$$

$$\cancel{[illegible]}\ (1-v)$$

$$= 1 - (1-v)\,\frac{W}{W_F}$$

$$v_F = 1 - \frac{W}{W_F} + v\,\frac{W}{W_F}$$

$$\boxed{v_F = v\,\frac{W}{W_F} + \frac{W_F - W}{W_F}}$$

~~[illegible]~~ Influence of growth on "Aging"

Under the assumption that in a growing animal the non viable fraction ~~of the cells~~ ~~[illegible]~~ does not share the growth and that growth ~~[illegible]~~ ~~means~~ ~~[illegible] is~~ [illegible] ~~either~~ the increase ~~in the number of the viable cells account for the increase of weight~~ of weight ~~th~~ results from the increase in the ~~number~~ fraction of viable cells ~~[illegible]~~

one can calculate the effect of growth on the age of the animal both under natural conditions and if the animal is exposed to X radiations. Let v be the fraction of the viable cells and s the fraction of the senile cells (v+s=1) ~~[illegible]~~ then with an without exposure to X-rays

Now for young growing animals (with an without exposure to X-rays) we may on the basis of our assumption write for t_F, W_F

$$t_F^{eff} = \frac{1}{W_F}\int_0^{t_F} W(t)\frac{\Delta s}{f\,\Delta t}\,\cancel{dt}\,dt$$

~~As of there is no X ray~~

where $\frac{\Delta s}{\Delta t}$ is the increment of s that would take place in the absence of growth

~~By~~ for constant daily dose r

$$\Delta \cancel{\frac{ds}{dt}} = f\,\cancel{t} + \alpha r t$$

$$\frac{1}{f}\frac{ds}{dt} = \cancel{1} + \frac{\cancel{\alpha} r}{f}$$

$$t_F^{eff} = \cancel{1+}\frac{\alpha r}{f}\,\frac{1}{W_F}\int_0^{t_F} W(t)\,dt$$

or in the absence of irradiation

$$t_F^{eff} = \frac{1}{W_F}\int_0^{t} W(t)\,dt$$

~~At~~ Man aged 8 years saving (11 years) in the first 12 years [~~[illegible]~~]

Ageing of a young growing ~~bl~~ animal

For a young animal we may write

$$v = e^{-ft} = 1 - ft$$ ~~[illegible]~~

~~and [illegible]~~

~~no~~ ~~or $ft = 1 - v$~~

~~and if $v = s$, $ft = s$~~

$$s = 1 - v = 1 - e^{-ft} \approx ft$$

or for the effective age t^* of a young animal we may write

$$t^*_{eff} = \frac{s}{f} = \left[s \frac{L_0}{\varepsilon} \right]$$

$$\Delta t_{eff} = \frac{\Delta s}{f}$$

~~Now in a growing [illegible] growing animal the [illegible] growing the weight w and defining s~~

for a 0

~~[teff is defined by [illegible]~~

[teff defined as $v = e^{-f t_{eff}}$

~~[illegible]~~

or $s = 1 - e^{-f t_{eff}}$ and for young animals $s \approx f t_{eff}$]

$$v_\ell = \frac{1}{1 + \frac{\alpha r + f}{\frac{W'}{W}}}$$

~~if we choose~~

~~$v_e = \frac{1}{e}$; $\underset{1.7}{\underset{\backsim}{e-1}} = \frac{\alpha r + f}{\frac{W'}{W}} = \frac{\alpha r + \frac{\varepsilon}{L_0}}{\frac{W'}{W}}$~~

for $v_\ell = e^{-\varepsilon}$ at which death mainly occur

$$e^{\varepsilon} = 1 + \frac{\alpha r + f}{\frac{W'}{W}}$$

$$e^{+\varepsilon} - 1 = \frac{\alpha r + f}{\frac{W'}{W}}$$

for small ε

$$\varepsilon = \frac{\alpha r + \frac{\varepsilon}{L_0}}{\frac{W'}{W}}$$

$$1 = \frac{\frac{\alpha}{\varepsilon} r + \frac{1}{L_0}}{\frac{W'}{W}}$$

$$\frac{W'}{W} = \frac{1}{L_0} + \frac{\alpha}{\varepsilon} r$$

Whereas a rat ages 8.8 months in the first 12 months or a saving of 3.2 months.—

$\div$

Ageing of growing older animals with ~~[illegible]~~ or without α radiation

$$\frac{dv}{dt} = (1-v)\frac{W'}{W} - (\alpha r + f)v$$

$$\frac{dv}{dt} = \frac{W'}{W} - \left(\alpha r + f + \frac{W'}{W}\right)v$$

$$\boxed{v = \left(1 - \frac{W'}{W}\frac{1}{\lambda}\right)e^{-\lambda t} + \frac{1}{\lambda}\frac{W'}{W}}$$

$$\boxed{t = 0 \quad v = 0} \qquad \lambda = \alpha r + f + \frac{W'}{W}$$

Limit for $v = v_e$ for $t = \infty$

$$\frac{dv}{dt} = 0 \qquad \frac{W'}{W} = \left(\alpha r + f + \frac{W'}{W}\right)v_e$$

~~[illegible]~~

$$\frac{\varepsilon}{n} = \frac{\alpha r + \frac{\varepsilon}{L_0}}{\frac{W'}{W}}$$

$$\frac{W'}{W} = \left(\frac{\alpha}{\varepsilon} r \cancel{m} + \cancel{m} \frac{1}{L_0}\right) n$$

For no irradiation

$$\frac{W'}{W} = \frac{n}{L_0} \quad \text{for } n = 2$$
$$L_0 = 1000 \text{ days}$$

$$\frac{W'}{W} = \frac{2}{1000}$$ or in a month 6% growth

~~[illegible]~~

With irradiation which would increase rate of ageing by factor k

$$\frac{W'}{W} = \frac{nk}{L_0}$$

for $\varepsilon = 1/2$ $k = 2$ $\alpha = 10^{-4}$

$L_0 = 1000$ days $r = 5$

$100   250 hrs   300 Watt

2.5 degree

~~10 KW~~

1 kg Water   2.5°C = 10 KW sec

300 Watt ~ 33 KW sec

$99

250 hrs. = 500 x 30 min.

$100 gives 500 x 60 acts

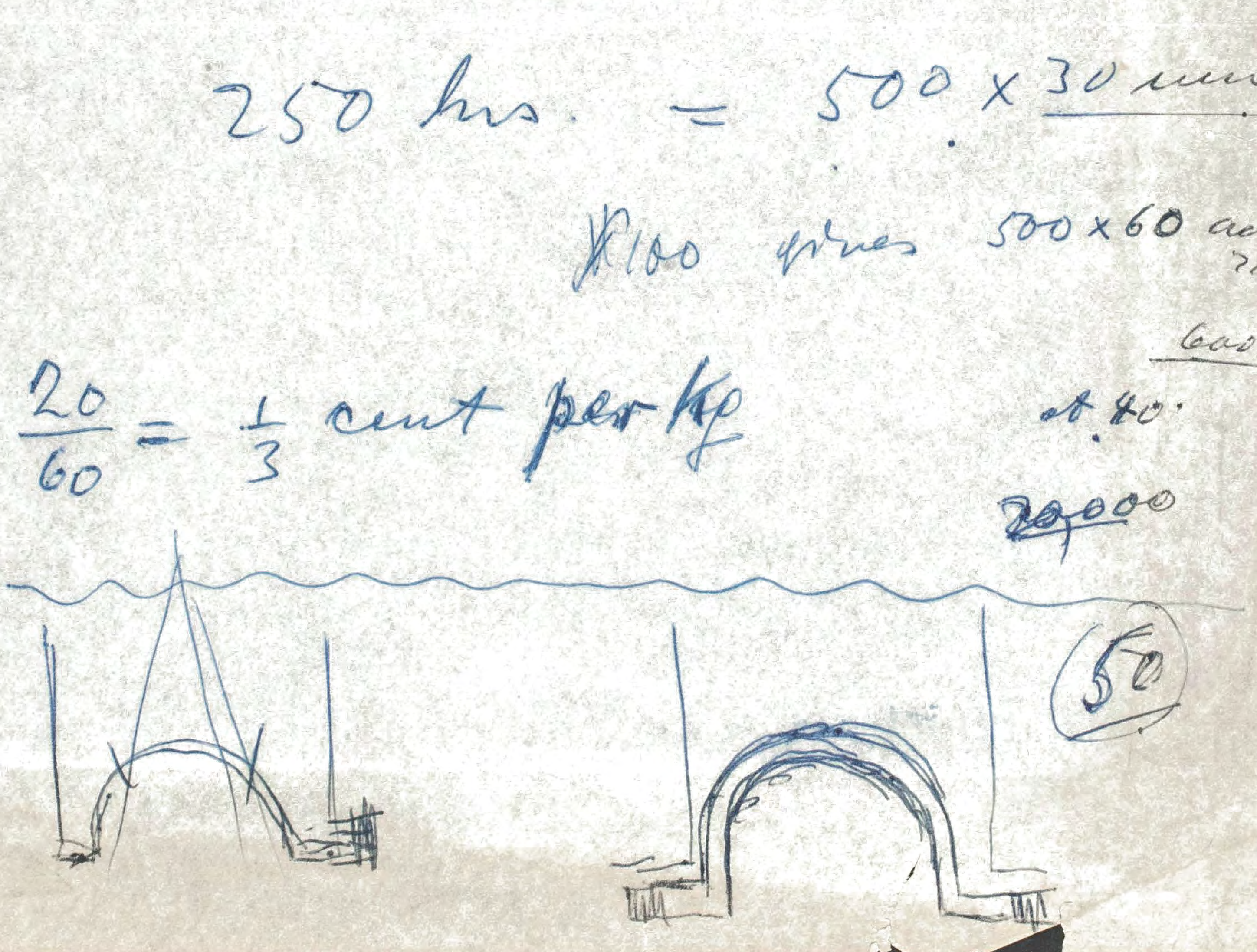
7u

6000

at .40

20,000

$\frac{20}{60}$ = $\frac{1}{3}$ cent per kg


㊿

For a daily dose v_2 which R doubles the daily ageing from the natural rate $\frac{w'}{w} = \frac{2}{L_0}$

$$\frac{1}{L_0} = \frac{\alpha}{\varepsilon} v_2$$

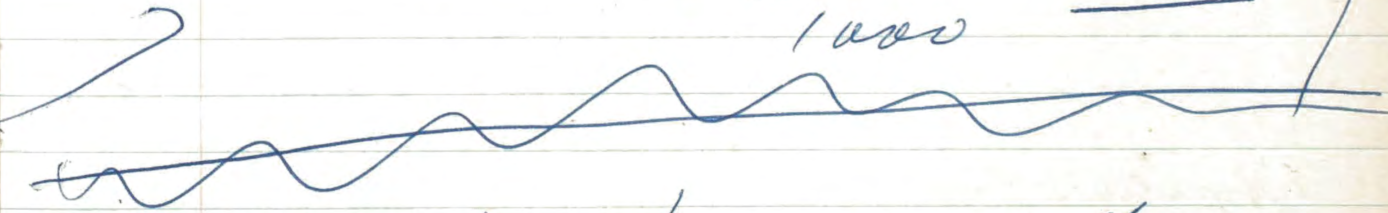
make $v_2 = \frac{\varepsilon}{\alpha L_0}$

for instance

for ~~rats~~ ~~to~~ ~~do~~ an animal ~~mouse~~ having $L_0 \sim 1000$ days

$\varepsilon = 1/2$ $\alpha = 10^4$

$$v_2 = 1/2 \frac{10^4}{1000} = \underline{5r}$$



~~Ok~~ or for $L_0 = 1000$ days

$$\frac{w'}{w} = \frac{1}{500}$$

Better take it in this form

$v_l = e^{-\frac{\varepsilon}{n}}$ $v_d = e^{-\varepsilon}$ at which death occurs

and for small

$\frac{\varepsilon}{n}$

Mean survival between
50 to 100 days Brady p510
8.7 days doubling time
$k = 0.08$

for $\varepsilon = 1$ [illegible] 0.08

[illegible] ~~$v = e^{-\frac{t}{8.7}}$~~

$v = e^{-\frac{1}{2000}\frac{t}{8.7}}$

[illegible], for $\varepsilon = 1$

$L_0 = \frac{[illegible]}{2000 \cdot 8.7}$ days

$= 17,400$ days $=$ 48 years

to this add 11 years
prolongation leading to 59 years

But weight multiplies by e
per day (~~[illegible]~~ on about 13th day) doubles in 0.7 day

$\varepsilon = 1 \quad L_0 = \frac{[illegible]}{0.7 \cdot 2000} = 1400$ days
$= 3.85$ years

and for $n = 2$ we get
12% growth
per months

Remark earlier of
for mammals $\varepsilon = \frac{1}{3}$ for
instance then $\frac{1}{\varepsilon}$ becomes
~~[illegible]~~ more than 2 is for
B/r and mammalic cells
~~[illegible]~~ less numbers
than bacteria
taking for man doubling
time as 0.7 days we
~~[illegible]~~ get for short life times
Better assume only a fraction of man viable are sterile

Mon and sat.

N - expectation for mammals
Birds have other ε What about [illegible]

Oxygen consumption
of man at rest 250 cc/min
or in ten days, per kg

Sugar 32 gm 125 cal

2000 cal per man per day
~~2000~~ in ten days 20000
in ten days per kg 300 cal

76 gm sugar ~~[illegible]~~
this would build up

1 kg bacteria if they build 100 kg
bacteria build 100 to 200 gm dry weight
burn at least 76 gm sugar in the process

1 lbs meat 909 Cal
1 kg 2300 Cal
~~[illegible]~~
Man produces 30 Cal/day kg →
in 10 days 300 cal
to build 1 kg takes 2300 cal
in 100 days 3000 cal
just enough to rebuild his weight
+25% or so

N ~~[illegible]~~ ~~[illegible]~~ excretion 30 sugar/day
out of 30 gm this is 1000 times
less than rebuilding

Animals

Nitrogen exc / kg Creatinine N

Chapter 13 Brody

Kcal [illegible] Cal/kg/day 200

Total N	Kg	N/kg/day	~~Cal/day/kg~~ N/kg	Urea 35 mg/kg
Mouse	.015	12.85	860	
Common Rats	0.1	56.4	564	
Rabbits	1.88	405	215	
Pigeon	0.260	121	420	
Chickens	0.800	230	290	
		Cal/kg/day	mg/day	
[illegible] 0.250		~~250~~	~~250~~	
Rats 0.025			8.50	
0.050			12.5	

Rat 100 gm 56 mg/gm/day ~ 360 mg/gm

0.3 gm

Protein

[illegible]

3 gm

giving 0.3

every day

10 days to ~~[illegible]~~ 1/2

~~$\frac{\ln(1+x)}{} = \varphi$~~

~~$1+x = e^{\varphi}$~~

~~$Q = 1+x$~~

$J_{11}t'' =$ ≈ $\frac{1}{5} - \frac{1}{5e} = \frac{e^{\varepsilon}-1}{5}$

in place of ε.

Giving $\varepsilon - \frac{[e^{\varepsilon}-1]}{5} \approx \frac{4}{5}\varepsilon = \underline{\underline{0.8\varepsilon}}$

very rough

less rough for $\varepsilon = 1$

$1 - \frac{1.73}{5} = 1 - 0.34 = \underline{\underline{.66}}$

$\ln(1+x) =$

$x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4}$

$\ln\left(1+\frac{1}{5}\right) - \ln\left(1+\frac{1}{5e}\right) = \frac{1}{5} - \frac{1}{5e^{\varepsilon}}$

$- \frac{1}{2}\left(\frac{1}{5}\right)^2 + \frac{1}{2}\left(\frac{1}{5e^{\varepsilon}}\right)^2$

$+ \frac{1}{3}\left(\frac{1}{5}\right)^3 - \frac{1}{3}\left(\frac{1}{5e^{\varepsilon}}\right)^3$

article

M.

Delayed growth

$$v = e^{-gt}$$

$$g_{11} t'' = -\ln v \qquad v = 1-s$$

$$= -\ln(1-s)$$

$$s_1 = 1 - e^{-gt}$$

$$s_2 = (1 - e^{-gt})\frac{w}{w_F}$$

$$g_{11} t'' = -\ln\left(1 - \frac{w}{w_F} + \frac{w}{w_F} e^{-gt}\right)$$

for instance $gt = 1$

$$\frac{w}{w_F} = \frac{1}{6}$$

$$= -\ln\left(\frac{5}{6} + \frac{1}{6} e^{-1}\right) =$$

$$= -\ln\left(5e^{1} + 1\right)\frac{1}{6e^{1}}$$

$$= \ln\frac{6}{5} - \ln\left(\frac{5e+1}{5e}\right)$$

$$= \ln\frac{6}{5} - \ln\left(1 + \frac{1}{5e}\right)$$

$$\downarrow$$

$$\ln\left(1+\frac{1}{5}\right) - \ln\left(1 + \frac{1}{5e}\right)$$

Buchanan & Fulmer
Physiology and Biochemistry
of Bacteria Vol I chap III

In man $\boxed{150}$ cal ~~makes~~ per day by Prot

in 12·5 days 1880 cal

to burn 1 kg prot 14,700 gm

supplies cal $\frac{1}{8}$

Bread p 741
Fat 9,353 Cal/kg

Porter 355, 366-81
of dry weight
10.5% N ~
8% Ash

C. C
Anderson
Bacteriological
Chemistry
1946
The Williams
& Wilkins
Co Baltimore

$\boxed{74.8 \text{ water}}$

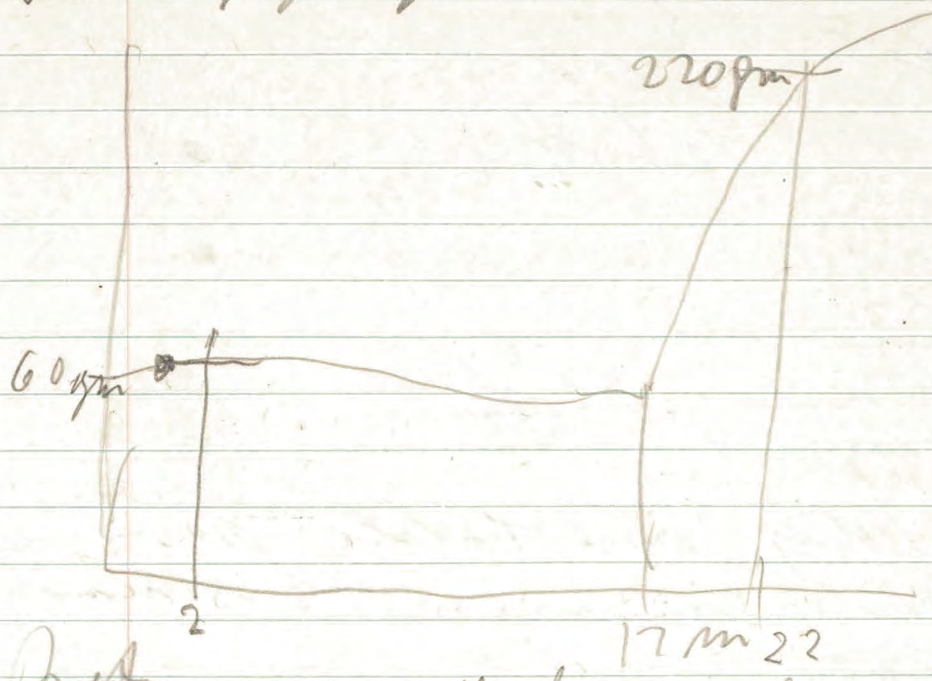
Of Wet weight

Fats ~~[illegible]~~ 4%
Carbohydr 4%
Cellulose 1%
Protein ~~[illegible]~~
7.42
~~[illegible]~~
~~[illegible]~~ %

Total weight
dry
25.2 gm
of which
~~[illegible]~~ Prot
~~[illegible]~~ Fat
~~[illegible]~~ Carbohydr
~~[illegible]~~

Fat 4
Carboh 5
Prot 7.42
16.42

Arbuckle
Brody p ~~7~~23 4



T B Osborne 1928
Osborne and Mendel L.B
Jr Biol. Chem. 18, 95 (1914)
23, 439 (1915)

$\frac{W}{W_F} = \frac{220}{60} = 3.66$

Remarks

25% ratio of dry weight of bacteria of sugar consumed. Assuming that this is calorically like ~~Meat~~ protein

1 gm Protein = 14.7 cal
1 gm sugar = 3.9 cal

ratio $\frac{\text{Prot}}{\text{Sugar}}$ = 3.8

If 1 gm sugar makes 1/4 gm prot

neglecting fat etc.

$$\frac{320}{400} = 80\%$$

assuming 12.5% fat $\left[\frac{12.5}{4}\,9\right.$

$$\begin{array}{r} 320 \\ +\ [illegible] \\ 27 \\ \hline 347 \end{array}$$

$$\frac{347}{400} = 86\%$$

150 Cal / day available per ~~kk~~. kg Protein or in 12.5 days = 1880 Cal

$$(\underbrace{1880 + 14{,}700}_{16580})\,\alpha = 14700$$

$$\begin{array}{r} 1880 \\ 14700 \\ \hline 16580 \end{array}$$

16580

87%

Porter p 356

H

assume Protein
10.5 % N of dry weight
Protein 6.25 × 10.5 = 66 % of dry weight

Carbohydrate ~~fat Prot 13 fat~~ 26
assume Carbohydrate : fat : prot
4 : 4 : 20
13 % 13 % 65 % of dry weight

65
26
91%

100 gm Carbohydrat [illegible]
gives 13 gm Carbohydr.
13 gm Fat
65 gm Protein

4400 cal input
13 cal Carbohydr
31 cal Fat
240 cal Prot
284

[4400 cal)
[9500 cal]
[14500 cal

$\frac{284}{4400} = 0.07$

highest figure for bacteria
87.5 percent protein
of dry weight
$\frac{1}{4}$ 87.5 gm 14.500
= 320 cal

for k = 1 on the other hand

$$v = \left[e^{-3.3} + (1-e^{-3.3}) \frac{2.3}{3.3} \right]$$

compared with

compare − ln [ ] with

$-\Sigma$

	tot mgm N/kgh	day	Cal/kgh day
Mouse	34.8	810	12
Rat	18.8	450 *	7.8
Pigeon	18.8	450	6.5
Chick	10.6	255	4.6
Rabbit	9.0	215	3.4
Dog	6.7	160	2.4
Man	2.2	53 *	0.933

	Urine N mgm/day	Ur N/kg	Cal/day/kg
Rat .100 kg	22	220 }	83
.104	31.5	300 }	
Man 70 kg	3500.—	50	25
60	2130	35	
Guinea pig .410	66	160	86

Delayed growth

we assume $\frac{w'}{w}$ = const

in $t = T_0$ (lifetime) animal is allowed

to increase weight by factor 10

$$w = e^{\beta t}$$

$$e^{\beta T_0} = 10$$

$$\beta T_0 = 2.3$$

$$\boxed{\frac{w'}{w} = \frac{2.3}{T_0}}$$

$$\lambda = ~~[illegible]~~ \frac{\varepsilon}{T_0} + \frac{2.3}{T_0}$$

$$\lambda = \frac{\varepsilon + 2.3}{T_0}$$

$$v = \left(1 - \frac{2.3}{\cancel{T_0}} \frac{\cancel{T_0}}{\varepsilon + 2.3}\right) e^{-\frac{\varepsilon + 2.3}{T_0} T_0} + \frac{2.3}{\varepsilon + 2.3}$$

$$v = e^{-\lambda t} + \left(1 - e^{-\lambda t}\right) \frac{1}{\lambda} \frac{w'}{w}$$

$$v = e^{-\frac{\varepsilon + 2.3}{\cancel{T_0}} \cancel{T_0}} + \left(1 - e^{-(\varepsilon + 2.3)}\right) \frac{2.3}{\varepsilon + 2.3}$$

for small ε

$$e^{-2.3} +$$

$$\left(1 - \frac{1}{\frac{\varepsilon}{2.3} + 1}\right) e^{-(\varepsilon + 2.3)} + \frac{1}{\frac{\varepsilon}{2.3} + ~~[illegible]~~}$$

$$\frac{\varepsilon}{2.3} e^{-2.3} + 1 - \frac{\varepsilon}{2.3} = 1 - ~~[illegible]~~ \frac{\varepsilon}{2.3}\Big[\underbrace{1 - e^{-2.3}}_{0.9}\Big)$$

assump $e^{-\varepsilon} = 1 - \varepsilon$

or about half as old

[illegible]

[illegible] Coli 4000 r bits ½

or ½ ion in "volume"

1 [illegible] r gene 1.7 dams in 10^{-12} gm

4 000 r genes 7 000 dams in 10^{-12} cc

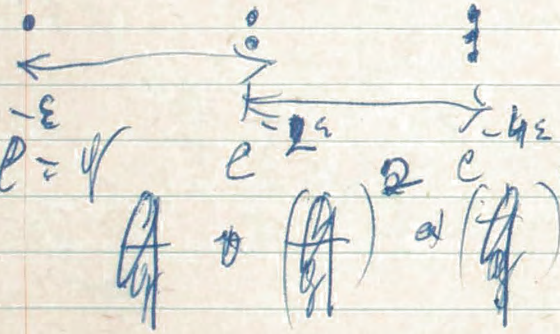
or "volume" $= \frac{10^{-12}}{14000} = \frac{1}{1.4} 10^{-16}$

or "length" [illegible]

$= \frac{1}{(15)^{1/3}} 10^{-5}$ cm

$\frac{1}{2.5} \cdot 10^{-5}$ cm

Phage exp. Mutation rate



ψ is probability of escaping phage

$e^{-\varepsilon} = \psi \quad e^{-2\varepsilon} \quad e^{-4\varepsilon} \quad \ldots \quad 2^{n}$

$\psi + (\psi)^2 + (\psi)^4 + \ldots (\psi)^2$

$(\psi)^{2+2^2+2^3+2^n}$

1 2 3

14

Since rat lives comparatively shorter than it ought to (compared with man) length of time of one day corresponds to 12.5 day in man efficiency for protein turnover would be even closer to one / metabolic order 8.5 rather than $\frac{1}{12.5}$

Fission particle problem

let us assume 10 MEV β ray
per fission   cell size: ~~3~~ 5 $\frac{1}{10^4}$ cm
~~[illegible]~~ 10^{-10} cc

1 el Volt = $1.6\ 10^{-12}$ erg

1 r unit about ~~[illegible]~~ $1.7\ 10^{12}$ ions/cc
or $50\ 10^{12}$ e Volt
50×1.6 erg/cc

10^{10} electrons of 10^7 eVolt each
make 10^{17} eV/cc = $1.6\ 10^5$ erg/cc = $160\ 10^3$ erg/cc
or 1600 r

~~1 r : 1.7 ions in 10^{-12} cc~~
50 electron volts in 10^{-12} cc
or ~~[illegible]~~ $5\ 10^{13}$ el volts
in one cc.

10^{10} β particles of 10^7 el Volts produce
10^{17} e volts / cc
in r : $\frac{1}{5}\ 10^4$ = $2\ 10^3$ r

the minimal limit may be

$t^* = t + c$

$\frac{du}{dt^*} = \frac{1}{t^*} - \frac{1}{t}y - \delta y$

$\boxed{t\frac{dv}{dt}} = 1 - y - \delta y t$

$\frac{d(vt)}{dt} = t\frac{dv}{dt} + v \qquad \frac{d\,vt}{dt} - v$

$$\frac{d(vt)}{dt} = 1 - \delta(vt)$$

$$\frac{dx}{dt} = 1 - x$$

$$\boxed{x = 1 - e^{-t}}$$

e^{-t}

$vt = 1 - e$

$*$

$$\boxed{\frac{dx}{dt} = 1 - \delta x}$$

try $x = \cancel{A} - Ce^{-\delta t}$

$\frac{dx}{dt} = C\delta e^{-\delta t}$

$C\delta e^{-\delta t} = 1 - \delta(A - Ce^{-\delta t})$

$\delta A = 1$

$t^* = t + c \qquad x = \frac{1}{\delta} - Ce^{-\delta t^*}$

$x = vt^*$

$vt^* = \frac{1}{\delta} - Ce^{-\delta t^*}$

$v = \frac{1}{\delta t^*} - \frac{C}{t^*}e^{-\delta t^*}$

For fish $\frac{w'}{w}$ may be $\frac{1}{t}$ d/

$$v = \left(1 - \frac{w'}{w}\frac{1}{\lambda}\right) e^{-\lambda t} + \frac{1}{\lambda}\frac{w'}{w}$$

$$\lambda = \alpha r + f + \frac{w'}{w}$$

for $\alpha r = 0$, $\frac{w'}{w} = \frac{1}{t}$

$$v = \left(1 - \frac{w'/w}{f + \frac{w'}{w}}\right) e^{-ft-1} + \frac{\frac{w'}{w}}{1 + \frac{w'}{w}}$$

$$v = \left(1 - \frac{1}{ft+1}\right) e^{-ft-1} + \frac{1}{ft+1}$$

$$\frac{w'}{w} = \frac{a}{b+at} = \frac{1}{\frac{b}{a}+t} = \frac{1}{c+t}$$

$$\frac{dv}{dt} = (1-v)\frac{1}{c+t} - (\alpha r + f)v$$

$$\frac{dv}{dt} = \frac{1}{c+t} - \frac{1}{c+t}v - (\alpha r + f)v$$

[illegible] death [illegible] applying [illegible]

$dt = [illegible]$

for [illegible] at death for $r = 0$

and $v = 1 - \varepsilon$ at death

$$\frac{dv}{dt} = \frac{\varepsilon}{c+t} - f(1-\varepsilon) \qquad f = \frac{\varepsilon}{T_0}$$

$$dv/dt = \frac{\varepsilon}{c+t} - \frac{\varepsilon}{T_0}$$

for small ρt

$$v = \frac{1}{\rho t}\left\{1 - \left[1 - \rho t + \frac{(\rho t)^2}{2}\right]\right.$$

$$v = 1 - \frac{\rho t^*}{2}$$

or ~~ρt~~ t^* for double $(v = 1 - \varepsilon)]$

~~[illegible]~~ calculated from

$$\frac{\rho t^*}{2} = \rho T_0$$

$$t^* = 2T_0$$

I.e a fish would live about twice as long on account of his growth

Fish probably live long on account of low metabolism!

If $C = \frac{1}{\delta}$
for $t^* = 0$

$v = \frac{1}{\delta t^*} - \frac{1}{\delta t^*}(1 - \delta t^*$

$\boxed{v = 1}$

$$\frac{\partial v}{v} = \frac{1}{\delta t^*} - \frac{1}{\delta t^*} e^{-\delta t^*}$$

check $\frac{dv}{dt^*} = \frac{1}{t^*} - \frac{1}{t^*} v - \delta v$

$$\frac{dv}{dt^*} = -\frac{1}{\delta t^2} - \left[\frac{-1}{\delta t^2} e^{-\delta t} - \frac{\delta}{\delta t} e^{-\delta t}\right]$$

$$= \frac{1}{t} - \frac{1}{t}\left[\frac{1}{\delta t} - \frac{1}{\delta t} e^{-\delta t}\right] - \frac{1}{t} + \frac{\delta}{\delta t} e^{-\delta t}$$

$$v = \frac{1}{\delta t^*}\left[1 - e^{-\delta t^*}\right]$$

and $t^* = t + c$ | ~~[illegible]~~

$$v < \frac{1}{\delta t^*}$$

~~Thro~~ for $\delta = 1$

$\delta = \frac{1}{T_0}$

$$v < \frac{1}{t^*/T_0}$$

for $t^* = 2T_0$

~~$v < \frac{1}{\delta t^*}$~~

~~for $t^* = 2T_0$~~

~~$v < \frac{1}{2}$~~

1/e would be death || $v < \frac{1}{2}$

[illegible]

of content is KA $\frac{4\pi R^3}{3}$

time in days =

$$4\pi D t R = \frac{4\pi R^3}{3} K$$

$$t = \frac{1}{D} R^2 \frac{K}{3}$$

for $R = 10^{-4}$

$$t = \frac{1}{3} 10^{-8} \text{ days for } \boxed{k = 1}$$

for nitrogen in bacterium 3% or

~~Ha~~ ~~4s~~

of water has 1 mgm / cm³ = 10^{-9}

~~Ha~~ $\frac{3}{100} \frac{1}{10^{-9}} = 3\,10^7$

or $\frac{1}{10}$ of a day for 1 mgm N / cm³

---

for vitamins in concentration of

$1 : 4\,10^{11}$

$t = \frac{1}{10}$ day

$$\frac{1}{10} \sim 10^{-8} \frac{k}{3}$$

$$k = \frac{3}{10} 10^{8} = 3\,10^7$$

$$\text{conc} = 3\,10^7 \times \frac{1}{4\,10^{11}} = \frac{3}{4} 10^{-4}$$

or ~ 10^{-16} gm / bacterium

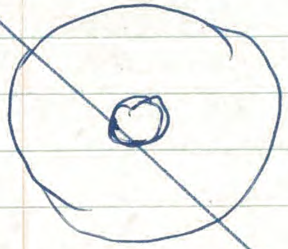
~~X ray Gap~~

~~$\alpha_1 a_1$ $\lambda \alpha_1 a_1^*$ $\frac{\lambda a_1^*}{a_1}$ H~~

~~$\alpha_2 a_2$ $\lambda \alpha_2 a_2^*$ $\frac{\lambda a_2^*}{a_2}$~~

Fish Hubbs La Jolla
Galtshoff Woods Hole

~~Diffusion Problem~~



~~$\frac{d^2 r\rho}{dr^2} = 0$~~

~~$r\rho = ar + b$~~

~~$\rho = a + \frac{b}{r}$~~

~~$\rho = 0$ for R~~

~~for $r = \infty$ $\rho = A$~~ ~~$\rho = A + \frac{b}{r}$~~

~~" $r = R$ $\rho = 0$~~ ~~$0 = A + \frac{b}{R}$~~

~~$b = -AR$~~

~~$\rho = A \left(1 - \frac{R}{r}\right)$~~

~~$\left(\frac{d\rho}{dr}\right)_R = \frac{AR}{R^2} = \frac{A}{R}$~~

~~$y = AD\, 4\pi \frac{R^2}{R}$~~

~~or per day ~ $4\pi RA$~~

C C Anderson
Bacteriological Chemistry
1946 The Williams and
Wilkins Co Baltimore

J. R. Porter
Bacterial Chemistry
and Physiology
John Wiley N.Y 1946

Bee	Ant	Termites	Wasps
Queen diapl [Trans]			
Worker diploid [less than [illegible]]			
Male hapl [[illegible] for [illegible]]			
shorter than male			

Non social insects [ ] Hymenoptera

females; diploid ; male: haploid

Wasps (solitary)
Parasitoids: Ichneumons, ~~aula~~ chalcids etc.
— Parasitize of other insects or their eggs.—
Jean Burnett [Under Thomas Park]

Mosaics: Whiting [University of Pennsylvania] dept of Zool.—
[~~Habrobracon~~ Habrobracon || insect]

Wigglesworth [Insect Physiology]
Culture methods for invertebrate animals: Needham Editor

Pearl (Raymond)
Introduction to Medical Biometry and Statistics W. B. Saunders Co
Philadelphia 1940

Wigglesworth V. B. The Principles of Insect Physiology 1939
~~Ro~~ quotes from above:

74 gm fat/kg burned in 30 days

. 9 × 74 ~~gm~~ Cal/kg month

or ~ [illegible] 22.4 Cal/day and kg

Bee metabolism 5 liter Oxygen per kg hr

$\frac{5}{22} \times 32$ [illegible] gm oxygen burns [illegible] Sugar [illegible]

7 gm [illegible] or 14 gm sugar

or 14 × 4 Cal/kg h = 56 Cal/h kg or 56 × 24 Cal/day kg

in flight it burns 100 gm sugar/kg hr

or 400 Cal/h.

---

death rate $= a e^{\alpha t}$

$$N(t) = e^{-a\int_0^t e^{\alpha t}}$$

$$\int_0^t e^{\alpha t} = \frac{1}{\alpha}\left[e^{\alpha t} - 1\right]$$

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

$$\overline{T} = \int_0^\infty e^{-\frac{a}{\alpha}\left[e^{\alpha t}-1\right]}\,dt$$

$$\frac{-ae^{\alpha t}+a}{\alpha} = y$$

$$\alpha y - a$$

$$\int_0^{+\infty} e^{-y}\frac{dt}{dy}\,dy = \int_{z_0}^{\infty} e^{-y}\frac{1}{\alpha y + a}\,dy$$

$$\frac{dy}{dt} = +ae^{\alpha t} = \alpha y - a\Big|_0$$

p. 367 H

Tenebrio pupa
at 32.7 139.9 hours total CO_2 59 300 cc /Kg ~~hour~~

and 427 cc /Kg hour

1 gm Mol = 22000 liter

427 cc = 1/52 gm Mol or $\frac{12}{52}$ gm C

Drosophila: Dobzhansky T. and Poulson
Z. vergl. Physiology 22 (1935) 473-8
(Temp and Oxygen Cons. of Dros. Pupa)

A. Krogh
1.) The Respiratory exchange of Animals and Man, Monographs of Biochemistry, London 1916
2.) Zeitschr. für allg. Physiol. 16, (1914) 163-90
3.) Kozhantschikov, Moskva Zool. Jahrb. Physiol. 55 (1935) 219-230

say $\frac{1}{4}$ gm C [illegible] Kg or per day

8 gm Carbon /Kg day
If this is ~~[illegible]~~ hydrocarbon or protein
it would yield on burning ~~[illegible]~~
8 x 14 = 110 cal /Kg day or 4 times
that of man
Bee weighs 100 mgm burns in flight
10 mgm sugar /hr
Meal worm (p. 329) 14.8% of wet
weight and half of it is used in
starvation in 1 month ~~at~~ 30 °C

$\frac{\alpha}{a} = K$

$$\frac{d}{dK}\,\overline{T} = \frac{1}{a}\int_0^\infty e^{-y}\,\frac{-1}{\left(\frac{\alpha}{a}y+1\right)^2}\,y\,dy = \frac{1}{a}\,f'\!\left(\frac{\alpha}{a}\right)$$

Habrobracon Greb R. J.

(Mosaics) Biol Bull 65 (1933) 179-86

Murr L., Z. vergl. Physiol (sense of smell) 11 (1930) 210

H. Kaestner Arch. Ent. Mech. 124. (1931) 1-16 (Effect of temp on pigmentation

also Schlottke E. Z. vergl. Physiol 3 (1926) 692
20 (1934) 370

K. Mohanty Biol Rev 10 (1935) 317
~~J. Exp. Biol~~
~~[illegible]~~

(!) Richards A. G. & Miller A. J. N. Y. Entom. Soc. 45 (1937) p. 1-60
Revue

$$\cancel{\int_0^t e^{-y}\frac{dy}{dt}\,dt = \left[e^{-y}\right]_0^t + e^{-y}}$$

$$\cancel{+\,e^{-y}}$$

H

$$T = \frac{1}{a}\int_0^\infty e^{-y}\frac{\cancel{a}}{\frac{\alpha}{a}y+\cancel{a}}\,dy = \frac{1}{a}f\left(\frac{\alpha}{a}\right)$$

$$N(t) = \Big[\quad \prod e^{-a_i} = e^{-\int_0^t a e^{\alpha t}}$$

$$\int_0^\infty e^{-y}\,dy$$

$$\left[-e^{-y}\right]_0^\infty = 1$$

$$\alpha = \frac{1}{\tau_0}$$

$$a = \frac{1}{t_0}$$

death rate $a\left(e^{\alpha t}-1\right)$

$$\cancel{N = e^{-\int_0^t \left(a\left(e^{\alpha t}-1\right)\right)dt} = e^{\frac{a}{\alpha}\left(e^{\alpha t}-1\right)+at}}$$

Bacterial Metabolism
Marjory Stephenson
Longman, Green Co N.Y. C 1930

Drosophila males

assuming ratio of mutations dominant to recessive occurring in all chromosomes together is the same as in X chromosome
~~[illegible]~~ rec = f dom.

~~[illegible]~~
assuming this ratio is same if sperm is irradiated as in the ~~[illegible]~~ case of spontaneous somatic mutations.—

Now we find (for D = 1000 r) dom (lat) — for
dom ~~[illegible]~~ lat (haploid) = 15% || $v = e^{-dr}$
~~[illegible]~~
~~[illegible]~~
and rec. (X chrom) = 3%

$rec_{(lat)} = \frac{15}{100} \times f$ (is total recessive mutations for 1000 r)

and ~~[illegible]~~ dom in (X) = $\frac{3\%}{f}$

Mutation rate of ~~to~~ female cell to nonviable

From Pearl Medical Biometry H
p 229 (1910)
q_x doubles every ten years

and at 90 years value: $\frac{240}{1000}$ per year
(mean about 68 years)
~~difference~~
difference male female about
1 to 2 years in 70 years

$$a\,e^{\alpha t} = \frac{240}{1000} \text{ for } t = 90$$

$$\text{for } t = 10 \quad e^{\alpha 10} = 2$$

$$\alpha = \frac{1}{14.5}$$

10.10

$$\alpha = \boxed{\frac{1}{14.5}}$$

$$a\,e^{\frac{90}{14.5}} = 0.24$$

$$a = 0.24 \times e^{-\frac{90}{14.5}}$$

$$q_x = 0.24\,e^{\frac{t-90}{14.5}}$$

$$\boxed{\frac{\alpha}{a}} = \frac{1}{14.5}\,\frac{e^{90/14.5}}{0.24} = \frac{10^2 \times 10^{0.7}}{3.5}$$

$$= 100\,\frac{5.6}{3.5} = 100 \times 1.6 = \boxed{160}$$

$$90/14.5 = 6.2$$

$$\boxed{q = \frac{1}{160 \times 14.5} = \frac{1}{2320}} \quad \frac{6.2}{2.3}$$

1.76 × 3.15

δ

$$\frac{\text{male rate}}{\text{femal rate}} = 1 + \frac{3 - \frac{3}{f}}{2 \times 15}$$

~~[illegible]~~ for $f = 1$ $\delta = 0$

for $f = 2$ $\delta = \frac{1.5}{30} = 5\%$

for $f = \infty$ $\delta = 10\%$

~~[illegible]~~

this means X chromosome
small fraction of all chromosomes

To compare with Drosophila
Pearl the rate of living
Alfred A. Knopf N.Y 1928
p 156, 157 difference male–
– female
~~[illegible]~~ 2.5 to 6 % in favour
of male

$\frac{2.5}{60}$ $\frac{1.5}{60}$ p. 39 for
mean life male 45.8 days
female 40 – days

Table of Beetles (from Labitte)
on p. 17
out of 18 Beetles
only in 3 cases is ~~[illegible]~~
male longer lived

~~[illegible]~~ %
or 4.7 %
in favour
of male
~~[illegible]~~ for f ~ 2

Drosophila see also
Steinfeld H. Mc. D.
Univ of California Publ. in Zoology
Vol 31, n° 9, pp 131–178 1929

is then proportionate to

rate (fem) $2 \times \frac{15}{100}$

and same rate for male cell

ratio of mutation occurring in X chromosome ~~$\frac{\text{dom}(X)}{\text{dom}(\text{aut})} = \frac{\text{rec}(X)}{\text{rec}(\text{aut})}$~~

$$\frac{\text{dom}(X)}{\text{dom}(\text{aut})} = \frac{\text{rec}(X)}{\text{rec}(\text{aut})} =$$

$$= \frac{3}{15\,f}$$

rate (male)

$$2 \times \frac{15}{100}\left(1 - \frac{3}{15f}\right) +$$

$$+ \frac{15}{100}\,\frac{3}{15f} + \frac{3}{100}$$

$$= \frac{15}{100} \times [illegible] + \frac{15}{100}\left(1 - \frac{3}{15f}\right) + \frac{3}{100}$$

~~female rate = [illegible] 2×15~~

~~[illegible] male rate~~

$$\boxed{\frac{\text{male rate}}{\text{female rate}} = \frac{2 \times 15 + 3 - \frac{3}{f}}{2 \times 15}}$$

$\boxed{1\,r = 83 \text{ ergs} / \text{gm}}$

Fission ~~particles~~ in soln

assume cell size 4.5×10^{-4} cm diameter
$95 \times$ ~~[illegible]~~ 10^{-12} gm ~~or~~ ~~[illegible]~~ 10^{-10} gm ~~[illegible]~~
~~[illegible]~~
or in 1 gm 10^{10} cells, if we want to destroy 1/2 of them we have to use $\frac{1}{2}\,10^{10}$ fissions ~~particles~~ and assuming 10^{7} eVolt per fission β energy we let loose ~~[illegible]~~

$\frac{1}{2}\,10^{17}$ electron Volt / gm =

$$\frac{1}{2 \times 300}\, 4.5\; 10^{-10} \times 10^{17} \text{ erg/gm}$$

$$= \frac{4.5}{6}\, 10^{5} \text{ erg} = 7.5\; 10^{4} \text{ erg/gm} = 9 \times 10^{2}\, r$$

$$\boxed{= 900\, r}$$

This is about 1000 r exposure as against growth by factor 2. At what age does this just balance?

If [illegible], 1000 r ~~[illegible]~~ ~~[illegible]~~ gives factor

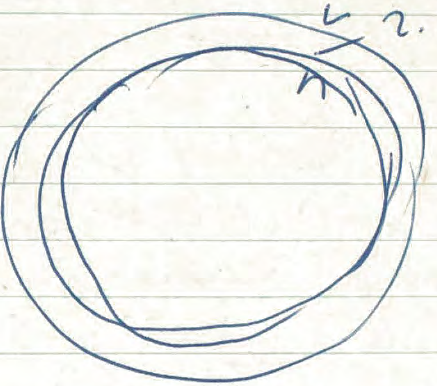
$$v_1 = v_0\, \cancel{2}\, e^{-0.1}$$

$$\Delta F = \frac{S_0 + 1 - (1 - S_0)\, e^{-0.1}}{2} = \frac{S_0 + 0.1 + 0.1 S_0}{2}$$

$$\Delta F = \frac{(1 + 0.1) S_0 + 0.1}{2}$$

and Lüers H. Roux Archiv für H
Entwicklungsmech. Bd 133 pp 88-177, 1935

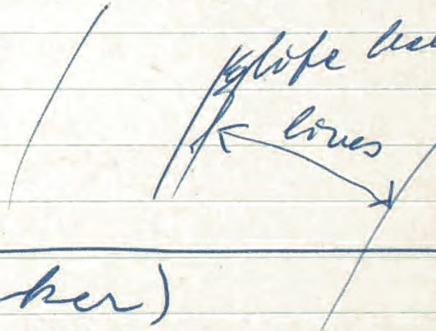
<u>Trees</u>



r 2.5 cm and adds
1 or 2 mm/m
per year

<u>cell doubles in</u>
<u>one day</u>
lifetime should
be compared
with man (8.7 d)
so $\frac{50}{8.7} = 5.7$ years

or ~~lif~~ "life" belt should move
by 1/6th outward every
year



Metabolism (Anker)
Soskin and Levine
Michael Reese Hospital

Attaching heavy metals to Protein
Barron & Globulins; McClintock

<u>Book</u>: Physiology and Biochemistry of Bacteria
Buchanan and Fulmer, Baltimore The Williams and Wilkins Co. –

1 Brooks 1) Timoféeff Ressovsky, N.W.
1937 Mutationsforschung
2) Cold Spring Harbor Symposia
vol 9. (1941)

From Park 1) The Quarterly Review of Biology Vol 10
p. 60 1935 ~~p. 60~~
(Pearl and Miner)
Paul Pelseneer
2.) Memoires Musee Royal d'Histoire Naturelle
de Belgique II ser Vol 3 p. 169 (1936)
(Pearl and Miner) [Pecan Nut Case Bearer]
3.) Amer Nat Vol LXXV p 5 (1941)
[Pearl, Park, Miner Flour Beetle]

4.) Effect of Population on Longevity
Mordon B. Davis Ecology Vol 26 No 4, 1945
5) Park (Thomas) Black Flour Beetle
Amer Nat. LXXIX p 436 (1945).
6. Pearl The Quarterly Review of Biol.
Vol III) No 3 pp 391 Sept 1928

Zoological Record   Henry Wallbrunn
Biological Abstracts

Snodgrass: Book: Anatomy and
Physiology of Honey
Bee

Perry Bamberger (Growth rate of
insects)
Fankhauser G.
Quarterly Rev. of Biology Vol 20 No 1 March
p 20 45

If $s_F =$ ~~[illegible]~~ s_0 H

$$s_0 = \frac{(1+0.1)\,s_0 + 0.1}{2}$$

~~[illegible]~~ $(2 - 1.1)\,s_0 = 0.1$

$$s_0 = \frac{0.1}{0.9} = \frac{1}{9}$$

D.F. Poulson Yale Osborn Zool
Drosophila growth rates
(Am. Nat. 1945) write to him! —

Patterson in Texas

1.) Book: Entomology (an introduction to ...) John Henry Comstock. 1925 Ithaca N.Y. The Comstock Publishing Co. —

2.) Embryology of insects
~~[illegible]~~ Johannsen and Butt
McGraw Hill 1941

Note: from ~~[illegible]~~ George Gardner and Hugh Hurst Utah Acad of Sc. Vol 10 pp 149 1933

1 month corresponds to one year in man he says.

months			
0	1000	0	1000
35	575	35	560
90	25	90	12
		120	1

Neurospora

Drosophila

sperm : $\frac{1}{2}(10^{-4})^3$ cm $\simeq \boxed{10^{-12}\ \mathrm{gm}}$

or a gene assuming 104 genes

10^{-16} gm & mol weight = $60\ 10^6$

(sperm = 0.7 μ × 0.3 μ 0.3 μ

but may be 6×10^6 because only 10% need be genetic material

length of X chrom ([illegible])

$l = 0.4$ mm

vol = $0.13\ \mu^3$

cross sect. $0.00032\ \mu^2$

→ (Human sperm 18 times larger)

gene (140 × 14 × 14) mμ ×

mμ = 10 Å

Tobacco mosaic 280 × 15 × 15 mμ

(Stanley) 1943 Virus diseases, Cornell Univ Press

M. Weight

foot & mouth 4×10^5

influenza 6×10^5

polyo 7×10^5

The Bee from Snodgrass p 305 M

[illegible] Worker [illegible]	days
Hatching egg ~~0-3~~	0-3
From spinning of cocoon to 5th molt	9-11
Molt of pupa	11-20

Queen	days
Molt of pupa	10-15

Drosophila Wright

350 recessives
to 4000-5000 lethals

∴ 8% visible
92% lethals } both for Xrays and spontaneous

---

65 crossover units in X chromos
compared to 280 total crossover units
(about ! $\frac{1}{4.5}$ is in X chrom)

Lethals: in III rd chromosome
(Dobz.) Genetics 194[illegible] [Dros. pseudoobscura]
300 diff loci for lethals

Wright

Chromosome breaks

Catcheside D. G. 1945 Biol Rev. 20. p14-28

0.15 Å $\frac{br/r?}{0.73\times10^{-2}}$

4. Å ~1 10^{-2}

α 2 10^{-2}

Timofeeff Ressovsky **Gene unit**

7th Int. Genetic Congress 1941 p 281

$w^+ \to w$ 8.4×10^{-8} per r

$w^+ \to w^e$ 2.6 〃

$w^e \to w^+$ 0.7

Johnson & Winchester

1934 Amer Nat Vol 34

Stadler (L. J.) C.S.H.S. 1941 Vol 9 168

〃 and Uber S. N. 1942 Genetics 27, p84-118

Ultraviolet

Drosophila	Altenburg
Corn pollen	Stadler
fungi	Hollaender
Liverwort	Knapp

Temperature effect! at irradiating temp

Plough C.S.H.S.

Paul Weiss says see! Harvard

Wetmore
Botany
Head of dept.

Draper recommend
Dr. William Robbins N.Y. Bot. Grds
Field. Inst Chicago Museum

Paul Weiss oxygen uptake of Bacteria : Kenneth Fisher

Book. Plant Physiology
Laboratory Meyer and Anderson
D. Van Nostrand Co Inc
250 ~~W~~ 4th Ave N.Y.C.

not to buy T.B. Robertson
the chemical basis of growth and
senescence 1923 J.B. Lippincott Co Philadelphia

To Buy ?? Electron optics and the
V.K. Zworykin et al Electron microscope [1948]
John Wiley & Sons 440 Fourth Av. N.Y.C.-16

Kaufmann B.P. Genetics 1946, 31.
Ultra red Pr. Nat. Ac. S 1947, 33.

Mustard Auerbach C + J. M. Robson 1947
Proc. Roy. Soc. Edinborough
Review Auerbach et al Science 105, 243 Bd 62
1947 III/254

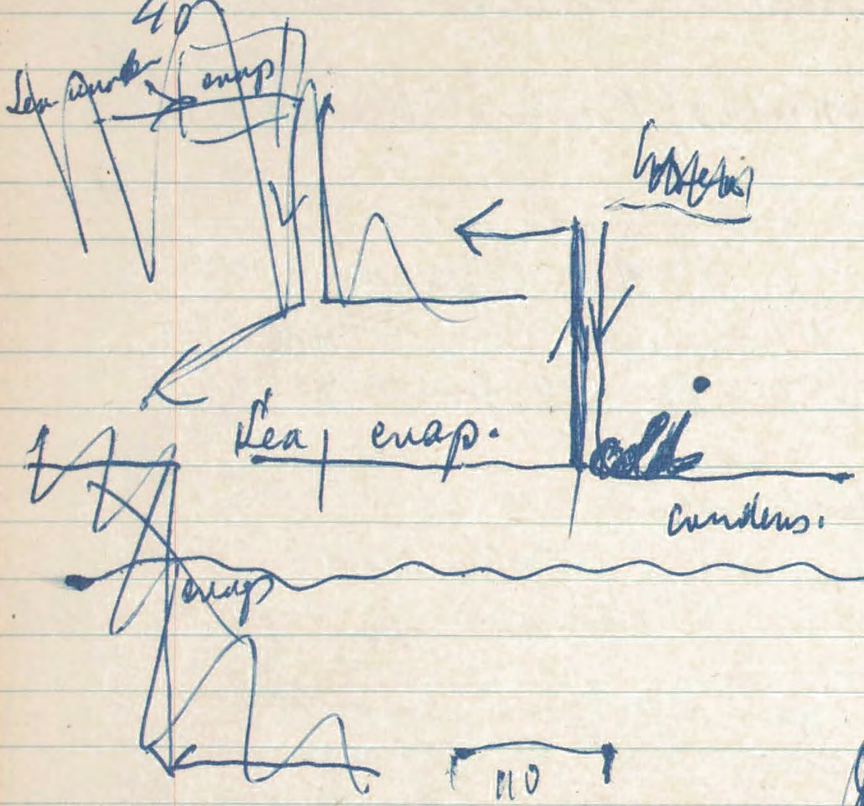
Assuming

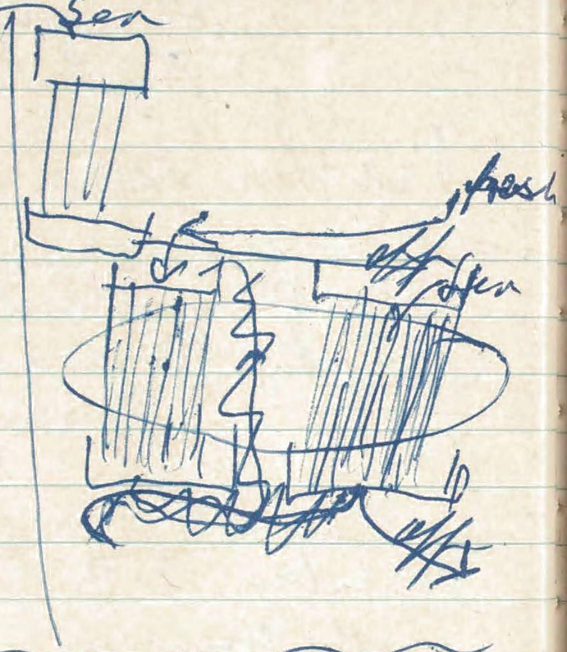
30 meter height to cool per kg

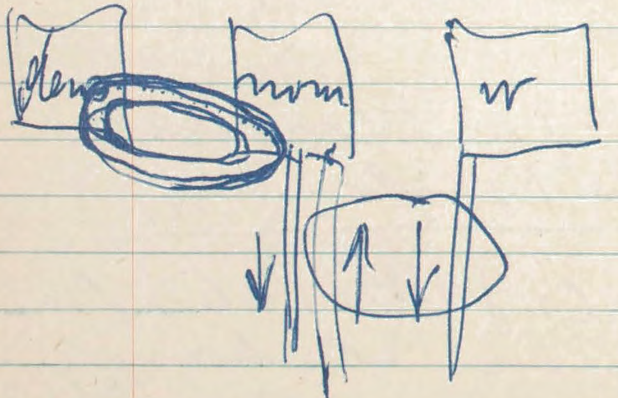
30 kg meter = 30 10^3 10^2 10^3 erg = 300 10^7 erg

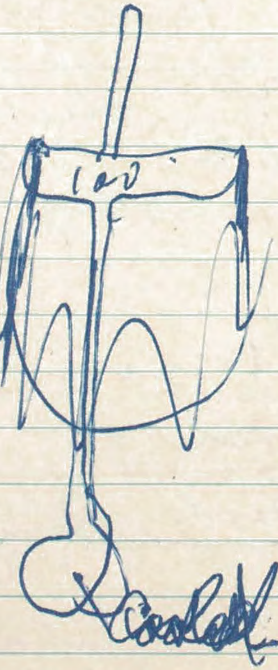
= 300 Joule ; ~~[illegible]~~ 4000 Joule = 1 Kcal

or $\frac{3}{40}$ degree cent.









14

Mutations (neutron-induced)
1944 Farm Genetics 29, 361-369

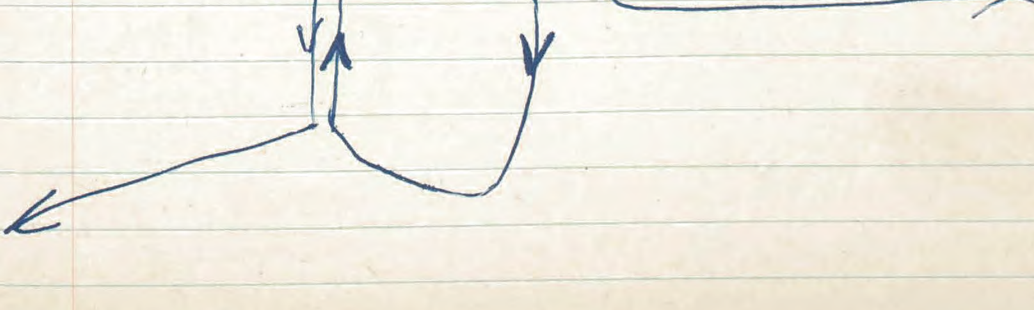
Water purif.

1 acre foot = 0.4 hectar foot = 0.3 × 0.4 10^4 m^3
should be less than $15. –
0.12 10^4 = 1.2 10^3 m^3 or 1200 tons of water

1 kg of coal 10,000 cal
would evap. $\frac{10\,000}{600}$ = 15 kg water

1 ton of coal ($2) ~ 15 ton of water
(or 1500 ton of water ~$200)

Assuming 10° difference "heat" (work) involved is only $\frac{10}{300} = \frac{1}{30}$ of evap. heat or $\frac{200}{30}$ = $6.6
but work will come from heat which drops say 100° (30% eff.) this gives $22 which has to be compared with offer of $15 \cdot \frac{1.5}{1.2} = \frac{2.25}{1.2}$ = 18.7 dollar
It follows that we can not do it with 10°C difference!



1 Liter 1/2 Mol

or 22 Atm $RT \log 1{:}1$

~~At~~ $RT \log\left(1+\frac{1}{N}\right)$

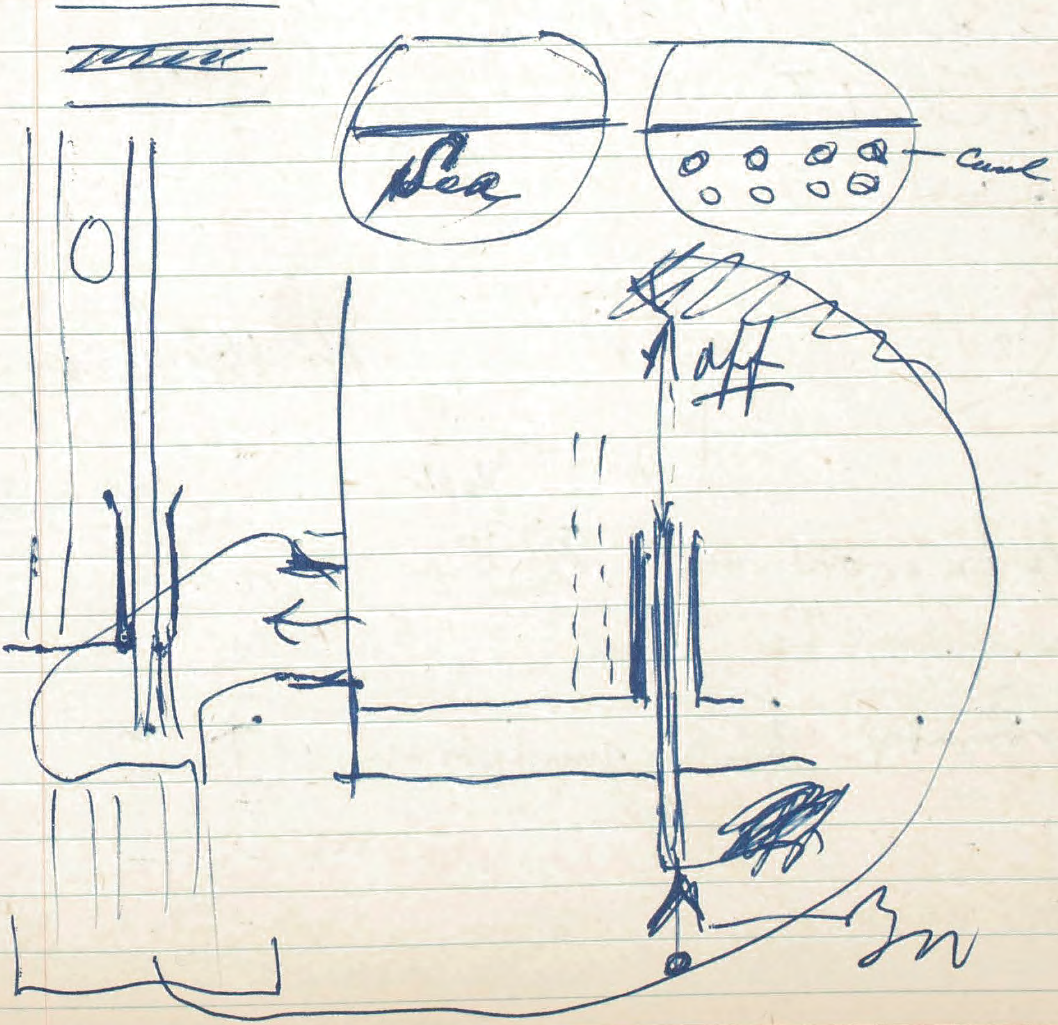
$\ln 1+x = x$

~~e~~ $e^x = 1+x$

for 1 Mol Work = RT

600 ~~cal~~ cal work

3x 300 small cal Hand or $\frac{3}{2000}$ ~~[illegible]~~ of evap. heat



Hershey

mixed $B + B/_2$ cells mixedly B $B/_2$

$\boxed{N(T_2h)}$ $N_1(T_2h) + N_2(T_2)$ $\boxed{N_3(T_2h)}$

1 Exp [also on T_1 T_1h]

x Mixed inf in B with T_2 T_2h

easy for T_2 (on mixed easy for incomplete T_2

~~[illegible]~~ but difficult for incomplete T_2h

here irradiation might help. —

2 Exp * Have incomplete T_2 - T_4 genes
check by back crossing

$\frac{1}{5}$ T_2 1 T_4

$\frac{1}{50}$ incT_2 T_4

2T_2 100T_4

with [illegible]

purify $B/_2$

then cross with T_4 and see
the incomplete T_2

for priority back mutation of T_2h

$\boxed{T_1 \quad T_3 \quad T_7}$ × T_3

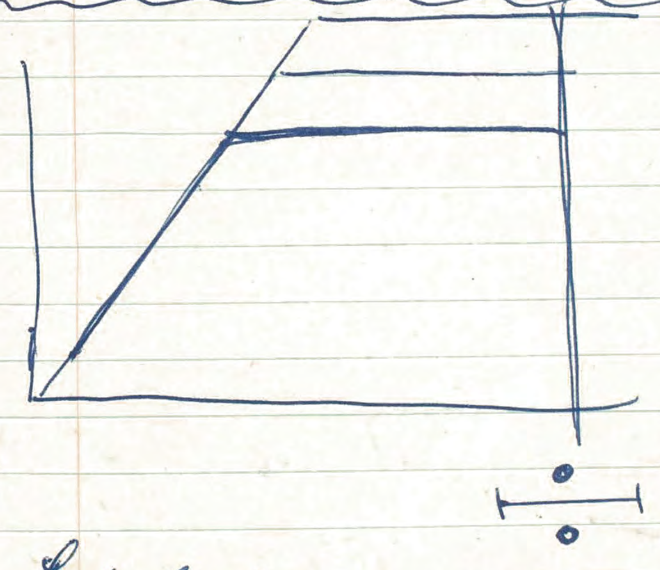
$\underline{M}$ (B) $\underline{L}$

M/3 L/3

T_3L <u>to not attack</u> M/3

LM

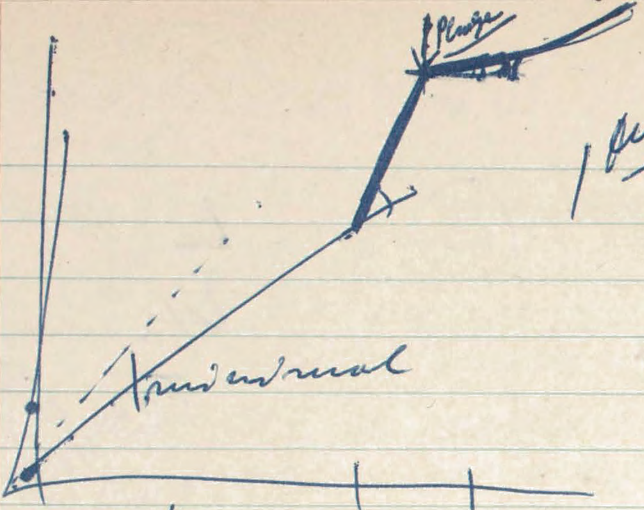
Amino acid analyses on all the mutants (1 h, 3 h, 7 h)



<u>Lederberg</u>

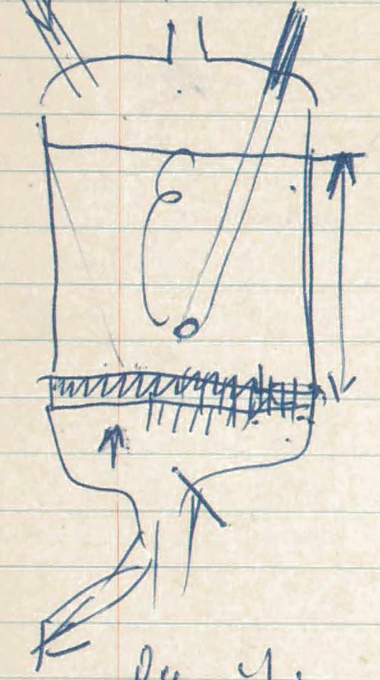
1.) <u>More work</u>
2.) Try it on B with added growth factor
3.) mating type low priority

Mrs. Jackson



random seeds

rate of mutation to the H mutant



limiting

10 mgm / m³

10^{-8} gm / cc

10^{8}

10^{-4} gm, 10^{-5} gm Hg; 10^{-6} gm N.

|| Seitz filters ||

Bio assay | → Stokes recommends:

Food research laboratories Inc
48-14 33rd Ave. Long Island City N.Y.

Shankman Lab. 2023 South Santa Fe
Ave. Los Angeles 21. Cal

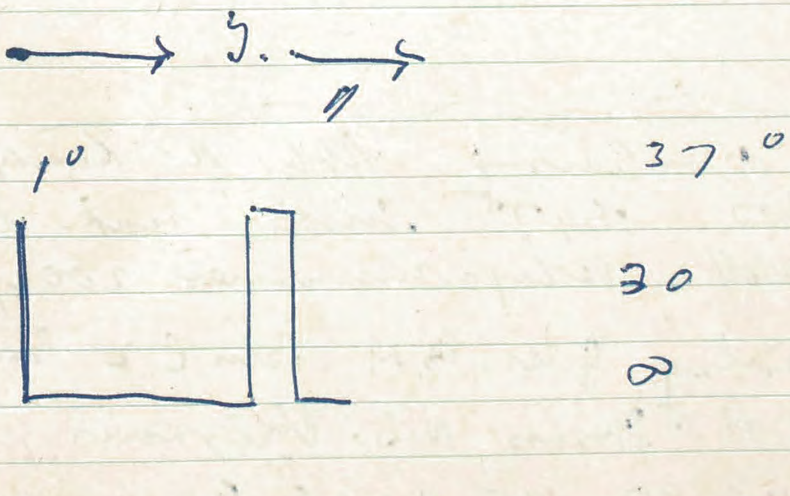
Merck: Vice Pres. in charge of research
Randolph Major

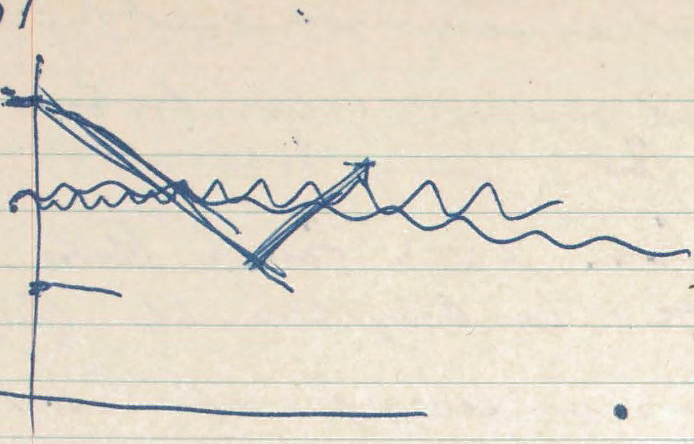
~~Nevin~~ **Niven** Meat Inst. (Univ. of) Chicago

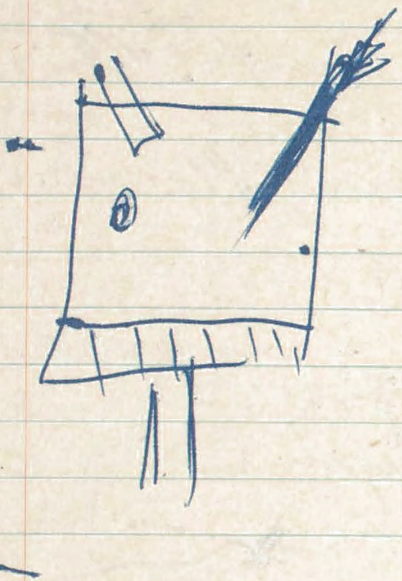
E.E. Snell Dept of Biochem Madison Wisc.

also ask Moser, —

Chicago Albert. L. Lehninger
with Huggins







Cancer Warburg Abh. d. Deutsch Akad. d. Wiss. 1947 Math.-nat. Klasse No 3 [Bestell u Verlags nummer 2002/47/3

Akademie Verlag G.m.b.H Bln C2 Brüderstr 26

see also I.H. Strauss, N.D. Cheronis, E. Strauss Science 108, 113–115 July 30 48

Aldolase

Zymohexase
1gm muscle 1.5 mgm
1gm tumor 0.09 mgm
blood 0.3 γ /cc

Cori St Louis
Sumner (Cornell
Ochoa [N.Y. Univ med. School

Chemostat Rogers, Whittier
Journ. Bact. 20.127 1930

Book Otto Rahn 1932 Physiology of Bact.
Philadelphia P. Blakiston Son, Co
paper J.P. Cleary, Paul J. Beard, C.E. Clifton
(Stanford) Journ of Bact Vol 29, No 2
Febr 1935 p. 205

Book Dynamic aspects of Biochemistry
Baldwin (Ernest) St Johns Coll - Cambr.
Macmillan 1947

General remarks on Chemostat

If we grow under conditions where <u>some</u> factor ~~[illegible]~~ <u>external</u> factor is limiting the growth we can probably do <u>without</u> nephelometric control.

<u>Simplex system</u>

Nutrient contains limiting factor
Rate of admission of nutrient w $\frac{cc}{sec}$ and V(cc) will then determine doubling time.
Doubling time $\tau = \frac{1}{w/V}$

concentration of limiting factor in vessel c
in nutrient a
" " bacteria ρ
content of limiting factor per bacterium B

Influx of limiting factor = outflux

$$\sout{wa \approx w(c + \rho B)}$$

$$a \approx (c + \rho B(c))$$

$$\tau = \frac{1}{f(c)}$$

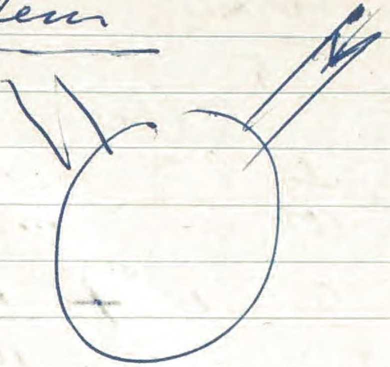
$$\tau = \frac{1}{w/V}$$

(w fixes c
if a is varied ρ will vary)

~~this determines ρ if f(c) is known and if we vary w or if we measure ρ (and know B)~~ by varying w and measuring c we can determine f(c) and by measuring ρ we can determine B

Duplex system

Counting factor A/sec



$A \sim W(c + \rho B)$

$\tau = f(c)$

$\tau = \frac{1}{W/V}$

find plex

[illegible] $+ \rho K\, h(c)$

$W a = W c + \rho V F(c)$

$a_1 = c + \rho \left(\frac{V}{W}\right) F(c)$

$a_2 = c + \rho_2 \tau F(c)$

~~$F(c) = B(c)$~~ of course!

~~If we know a and $\rho B(c)$ we can compute~~

we can keep c constant (by keeping τ const.) and vary a

Thus will vary ρ and permit to determine $F(c)$ without measuring c

$a_1 = c_1 + \rho_1 \tau_1 F(c_1)$ $a_1 = c_1\left(1 + \rho_1 \tau \frac{F(c_1)}{c_1}\right)$

$a_2 = c_2 + \rho_2 \tau_2 F(c_2)$

a_3 etc....

but it will leave undetermined in what unit c is measured ? ? ?

$a \equiv c + \rho_1(a) \tau F(c)$ for all a but $c = x(a)$

for [illegible] $\underline{W}$ $\underline{\underline{10 \times 10^{-9}}}$

$10^7/\mathrm{cc}$ $\rho = 10^{-5}\ \mathrm{gm/cc}$

$\alpha = \frac{1}{100}$

$a \approx 10^{-7}$ $a = 10^{-8} + \frac{10^{-5}}{100}$

$a_1 = c_1 + \frac{\rho a}{\mathcal{L}(c_1)}$

$a_2 = c_2 + \frac{\rho a}{\mathcal{L}(c_2)}$

$$\left.\begin{aligned} a_1 &= c + \rho(a_1)\,\tau\, F(c) \\ a_2 &= c + \rho(a_2)\,\tau\, F(c) \end{aligned}\right\}.$$

O.K.!

T. H. Fry [Nature 1947 ?)
~~[illegible]~~ Telecommun. Res. ?48 not all.
Cambr. Engl ?

2 Megawatts [illegible]
30 % [illegible] 4 [illegible]
[illegible]

$$\frac{a-c}{\rho(a)\tau} = F(c)$$ this must be independent of a which is possible because $c = \varphi(a)$

$$\frac{d}{da}\,\frac{a-\varphi(a)}{\rho(a)\tau} = 0 \qquad \frac{[a-\varphi(a)]\,\rho'(a) - [1-\varphi'(a)]\,\rho(a)}{\rho^2} = 0$$

Let us take $\underline{N}$ and assume constant compos. of Population

$$\frac{dN}{dt} = \alpha F(c)\cancel{N} - w\rho = 0$$

$$\alpha > 1 \qquad \rho = \frac{\alpha F(c)}{w}$$

$$\alpha F(c) = \cancel{w/N} \quad \frac{1}{\tau} \text{ or}$$

~~$F(c) = \frac{w/N}{\alpha}$~~ $\quad F(c) = \frac{1}{\alpha\tau}$

$$a = c + \frac{\rho}{\alpha}$$

$$a - \frac{\rho}{\alpha} = c$$

∂

~~$a - \frac{\rho(a)}{\alpha} + \rho(a)\tau F(c)$~~

or c independent of a

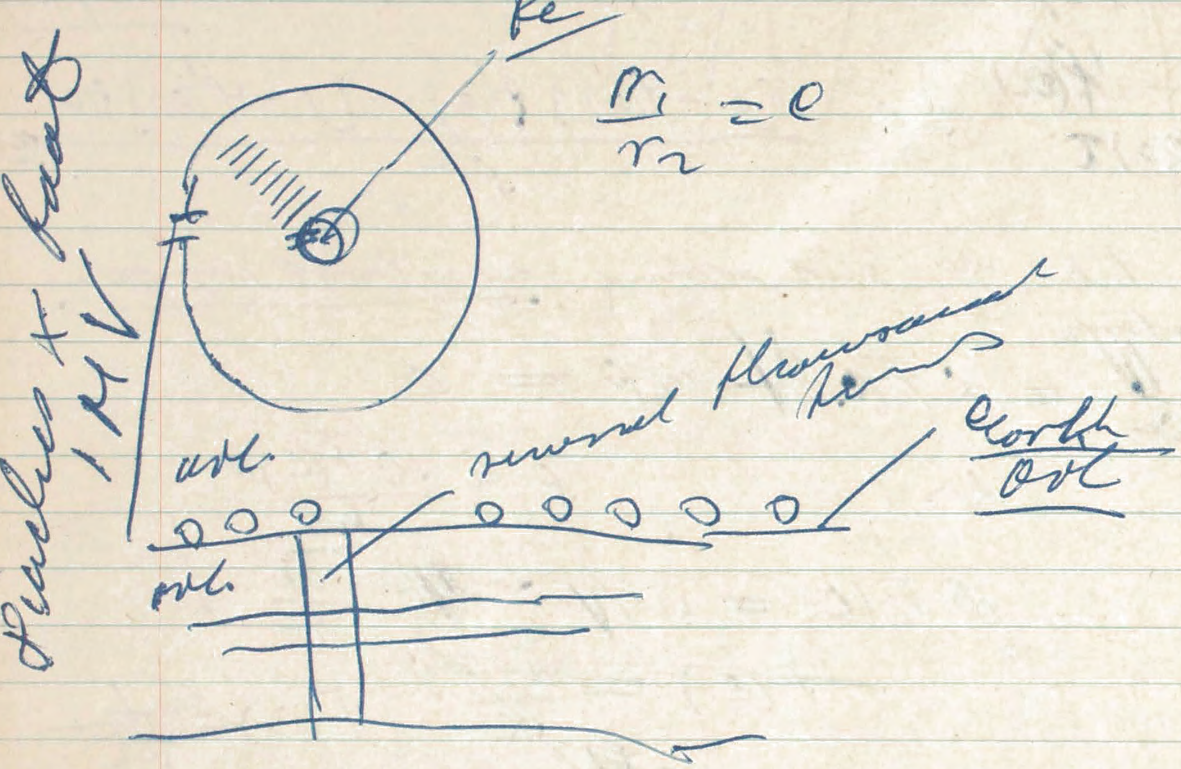
~~[illegible]~~

~~$F(c)N = \frac{a-c}{\rho(a)\tau}$~~

$$a_1 = c_1 + \frac{\rho_0}{\alpha} \qquad F(c) = \frac{1}{\alpha\tau_1},$$

$$a_2 = c_2 + \frac{\rho_0}{\alpha} \qquad F(c) = \frac{1}{\alpha\tau_2}$$

Baker pulse transformer
Berkeley



10^{-6} sec pulse

500 kV / inch in oil safe →

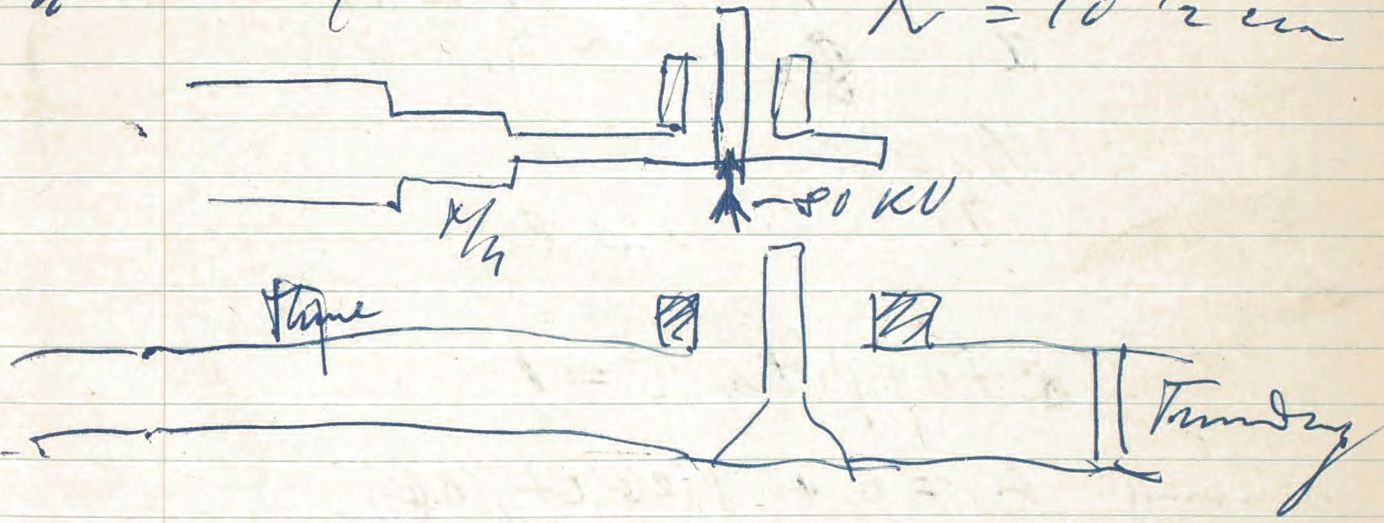
25 KV   2 Magnetrons available

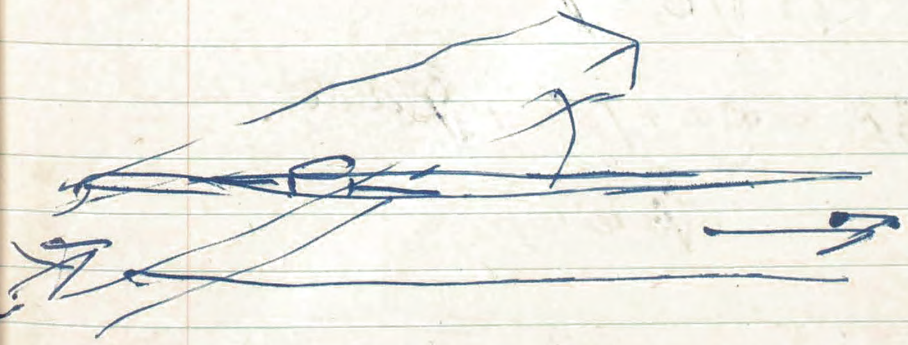
Raytheon   200 dollars

Large power magnetron   300 KW
war surplus

10^{-6} sec ; 1000 pulses/sec.

$\lambda = 10\frac{1}{2}$ cm





Bethe hole coupler
Radiation Laboratory series book
McGraw Hill

Mr Post (Nr 1)
Dr. ~~Mr~~. Becker (Nr 2)

$$\tau = \frac{1}{f(c_1, c_2)}$$

$$a_1 = c_1 + \rho\tau F_1(c_1 c_2)$$
$$a_2 = [illegible] + \rho\,\tau F_2(c_1 c_2)$$

[illegible]

[illegible] $\rho(a_1 a_2 \tau)$

$$(\alpha F_1 + \beta \Phi_2)\tau = 1$$

renaming $A = a + \rho(ab)\tau F(ab)$
$B = b + \rho(ab)\tau \Phi(ab)$

$$(\alpha F + \beta \Phi)\tau = 1$$

$$\alpha A + \beta B = \underbrace{\alpha a + \beta b}_{K(AB\tau)} + \rho(ab\tau)$$

Schwermetalle Otto Warburg
~~Dr. Wer~~ Arbeitsgemeinschaft
Medizinischer Verlage G.m.b.H
Verlag Dr. Werner Saenger Berlin

D.E. Green
Biological oxidations
Camb. Univ. Press 1940

Cold Spring Harbor Symp. Vol 7
1939

Spectra of Pigments also

R.A. Morton applications of absorption spectra

(Hans Erwin. Univ. of Southern Cal.)

Herzberg III Vol.
People at Univ of Illinois (Urbana) (infra red spectra of organic compounds. —

Fearon Textbook of Biochem III rd edition. [1947]

Harrow (Benj) Textbook of Biochem
Publ. Saunders Phil. ~~[illegible]~~ [1946]
Baldwin

Krampitz Western Res. Cleveland
Head of Dept of
~~[illegible]~~ ~~[illegible]~~ Microbiology
used lysozyme to get enzymes
lysozyme from Dr Porsche | Armour & Co | Chicago
Herbert in England Nature 1947

Prep of enzymes | from Tissues E. J. Cohn
Harvard

Cori would know about enzymes as antigens
~~Colowick, Chicago~~ [Univ. of Ill. Med School]
good for enzymes
Velick in Cori's lab, good)

Physiological Reviews
publ. the Am Phys. Soc.
Opston & Smithies Vol 28 No 3
p. 283 July 1948

Book Gen Physiology L. V. Heilbrunn
2nd ed. 1943 W. B. Saunders Philad. Penn

John R. Cann works with Kirkwood
Abstract ([illegible])

Book Stephenson (Marjory)
Longmans, Green & Co N.Y.
Bacterial Metabolism

Sumner & Somers
Chemistry and methods of enzymes
1947 Academic Press Inc N.Y.

Hemoglobin

Macleod 4th edition
1922

1 gm Fe ca 300 gm globin
carries 401 cc of O_2

~~[illegible]~~ 1 liter of water contains at 10^8 bact/cc

1/10 cc bacteria or
1/100 gm dry weight

see David Drabkin
says Bovie
in Philadelphia Pa.

or 4/100 gm sugar has been
burned ~~[illegible]~~

$$\underline{\begin{matrix}12\\16\\2\end{matrix}\quad 30}$$

C O H_2

$\boxed{\text{30 gm sugar}}$ $\boxed{\text{16 gm } O_2}$

so this is
2/100 gm O_2

~~[illegible]~~ 32 gm O_2 = 22 liter
1 liter 1.5 gm
1 cc $\frac{1.5}{1000}$ gm

(10 cc is about right)

400 cc is 40 times longer
so that concentr. reached of 300 gm used
$40\ 10^8 = 4.10^9$

Aaron Novick
241 E Delaware Toledo Ohio
Phone Garfield 2487

Orzack Dept of Sociology
Murray " " " Psychology
Underhill 3-9720
Hot. Durant
Int. House.

[illegible]: Munch
3-[illegible] [illegible].

b.c. Mr. Bell

Monterey Railroad Stat.

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Leave L. A 10

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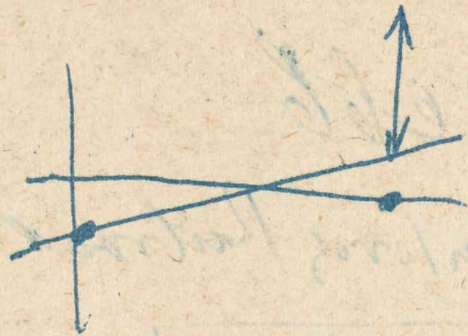

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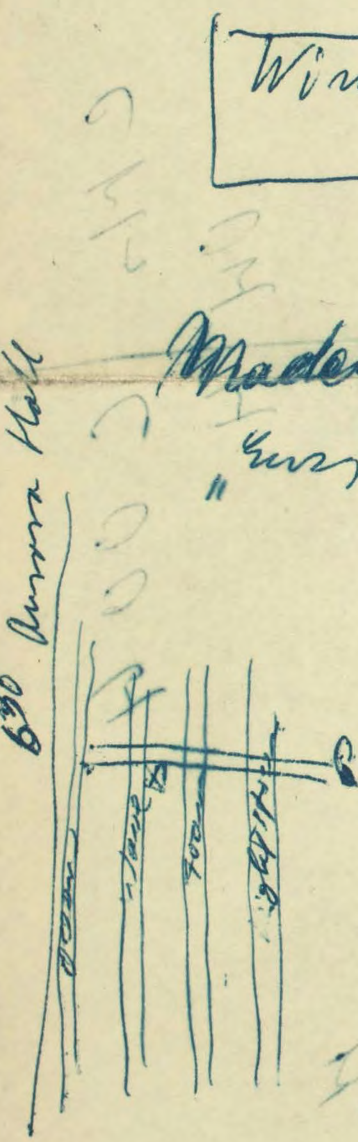

H H_2O_2

$H \quad OH$.

$H \quad H$
$CH_3CH_2CH-COOH$

$H.OH$

O_2

CH_2-CH_2OH , | $H-COOH$ Formic ac

← O_2 →

H_2CO

CH_2-CH_2OH

H_2+CO_2

$CH_3\ CH_2\ CH_2 \mid COOH$

$OH \mid H$

H_2 acceptor

O_2

$CH_3\ CH_2 \overset{H}{\leftarrow} CH_2 - OH$

$CO_2 + H_2$

H_2

$CH_3 \downarrow CH_2$

$H\ OH$

$H_2\ \ O_2H_2$

$CH_3 - COOH$

$OH - H$

$CH_3OH + H_2 \quad CH_4 + H_2O$

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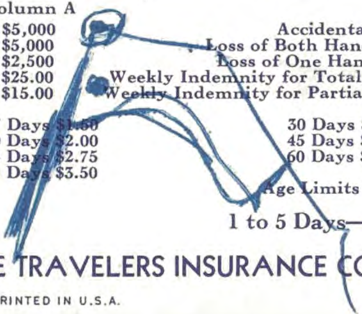

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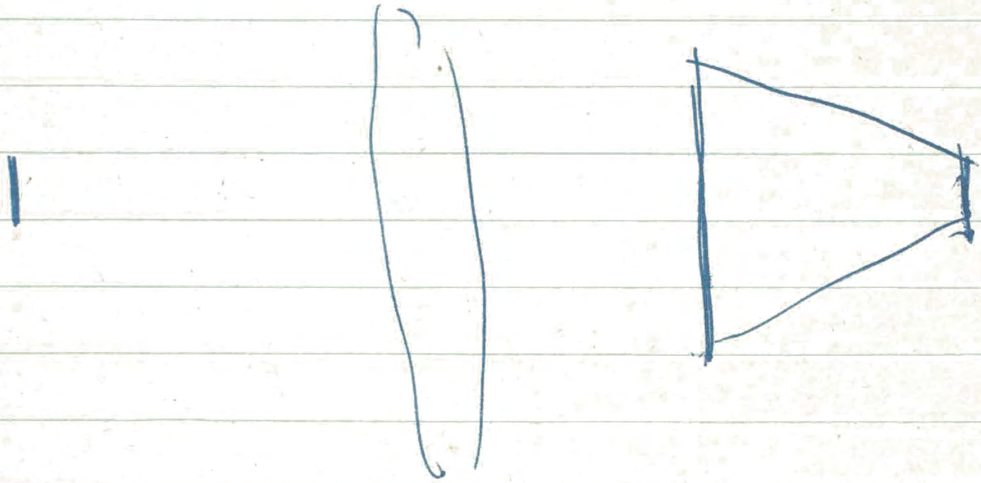

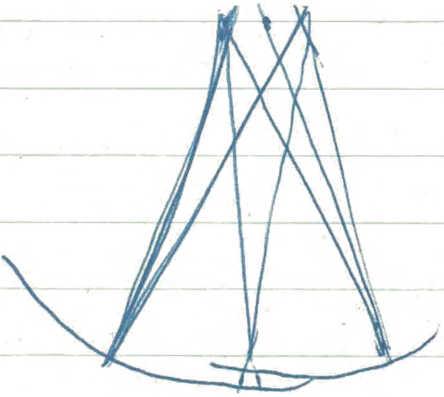

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