SZILARD
1949

Volume I

Return to
6200 Drexel
Ave Chicago

5624
Dorchester
6 pm
+ [illegible]

brain blood barrier \ Heinz \
for idea of cranial hydrocephaly

See Louis Flexner
Carnegie Inst. of Embryology
Baltimore
Johns Hopkins, Medical School Campus

eggs Walter Landauer, Dept of Genetics
Univ. of Conn.
Storrs, Conn.

Teaching Mrs Claire Twiedt
office Ga 7771 Ext 269
Barrack C

eggs
Bulletin 262 Apr 1948
The Hatchability of Chicken eggs
as influenced by environment
and Heredity. —
Walter Landauer
Storrs Agricultural Experiment
Station College of Agriculture
Univ of Conn, Storrs, Conn.

Oxygen sol in water at 0°C

~ $\frac{5}{100}$ of cc per cc

Carbon dioxide ~ $\frac{3}{100}$ $\frac{1}{100}$ CO_2/cc in

equilibrium with atmospheric air

Algae doubling once in 20 hours

compared with chemostat at $\tau = 2$ hours

would be 10 times worse of at equal

~~titer (suitable count) but may be 10 times~~

~~better of at equal~~ on dry substance

per cc but 4 times better of because of

$\frac{1}{4}$ efficiency of Coli — i.e. ~~5 times worse of than coli~~ Algae

since Oxygen in air is

~~for 10^{-8} coli~~ ~~$40 \times 5 \times 10^{8}$ coli =~~

$\frac{1}{4}$ 10^{-1} ~~gm/liter dry substance~~ $\frac{1}{4}$

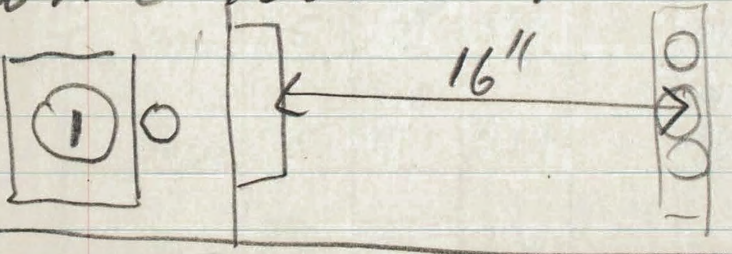
Exp on B/r UV inactivation — light reactivation: —

In these experiments B/r was grown in F to 7 10^8 ~~attenuated to~~ transferred to Saline and left in saline overnight or longer; alternatively it was irradiated in F while growing (titer around 5 10^8). —

UV lamp from bulb to shaker plate 50 cm, (Photocell reads about 58)

UV irradiation in petri dish, 6 inches, and 20cc is put in

Spot light standard position with 1000 Watt bulb



Photocell reads 90

Graph No 1 shows inactivation curves for B/r in saline and F

Effect of UV and Light on mutants

First experiment on B/r phage resistant mutants:
See graph 2, Exp of Apr 2nd/49 II.
2.5 min UV on B/r resting in Saline regrown and plated for multiplication of:
500 in Dark we have 24000/10^8 (T1)
400 in Light 5000/10^8 (T1)

~~Double mutants with UV~~

* corrected for spont mutants
T7/T1
5*
5
4.5
4*
4
6
apr 20↓
2
2.5

B/r
UV 0, 30, 50, 80 sec UV
4/22/49 Dark and light
Mutants after regrow
1:20 dilution before regrow

$\frac{\text{Mutants Dark}}{\text{Mutants Light}}$

B/r graph 3

	T1	T6	T7
30	3.0	5.1	4.4
50	(5.6) ~~2.8~~	(4.8) ~~2.4~~	(7.0) ~~3.5~~
80	9.8 (8)	9.4	8

	UV	×10⁻⁷ Assay	×10⁻⁷ Regrow Assay	Multipl	Gen	T1	T1/10^8	T6	T6/10^8	T7	T7/10^8
	0	10	310	600		2000	64.5	1100	35.5	5700	184
D	30sec	6	120	400		10,000	835	10,000	835	45,000	3750
D	50sec	4.5	130 ~~130~~	560		28,000	2150	20,000	1540	135,000	10,400
D	80sec	2.2	100 ~~100~~	880		66,000	6600	63,000	6300	320,000	32,000
	0	8	110 ~~120~~	225		800	88	—	—	—	—
L	30sec	8.5	135 ~~130~~	320		3700	274	2200	163	11,500	850
L	50sec	7.5	110	294		(4200) ~~8600~~	(382) ~~780~~	(3500) ~~7000~~	(320) ~~640~~	~~33,000~~	(1500) 3000
L	80sec	6.5	75	230		5000	670	5000	670	30,000	4000
apr 20 ↓	0	11	—	—	—	—					
D	80	2.3	70	600		56,000	8000	ratio T7/T1 2 to 1		106,000	15000
								2.5 to 1		11700	2500
L	80	(5)?	46	(180)?		4760	1000				

4-26-49	Assay before UV	Assay after UV	Regrow Assay	Multiplication	T_1	$T_1/10^8$	T_7	$T_7/10^8$	T_7/T_1
40 F	1.15×10^8	3×10^7	1.6×10^9	500	50,000	3100	150,000	9400	3
40 S	6.3×10^7	4.4×10^7	9.8×10^9	2300	92,000	920	274000	2800	3
80F	1.15×10^8	2×10^6	1.5×10^8 2×10^8	750 1000	16,300 18,200	11000 9100	34,200 34,400	22,800 17,200	2
80S	6.3×10^7	2.2×10^7	7×10^9	3200	372,000	5330	800000	11400	2
80S(Bn)	6.3×10^7	2.2×10^7	1.8×10^9	820	97,000	5450	500000	27800	5 !!

Vary I. for fixed UV

B/r graph 4 shows for 1 hrs 4
light at 37° again reactivation
by light after 3 min inactivation
(titer drops from 10^8/cc to 650/cc)
for different light intensities. —

Saturday Apr 30th

M

Experiment with back-mutation of threonineless (W) strain

on Apr 25th/49, 80 sec UV dropped titer from $1.2\ 5\ 10^{7}$ to $1.5\ 10^{6}$ giving by penicillin plating with 0.003 mgm/l threonine on plate 3560 mutants/cc [same with ten times more threonine]

this would give $\frac{3560}{1.5} \times 100/_{10^8} = 240{,}000/_{10^8}$

with no U.V on 0.01 mgm/l plate 20×3 colonies

[illegible]

B/r UV series, regrowns for dose² law

Exp Apr 30/49

UV	Assay	Regrow dilut	~~Internal dil~~	Internal dil	Regrow assay	Multipl	T1/10^8	Cor T1/10^8	T6/10^8	Cor T6/10^8	T1	multipl	Cor T4/10^8	
0	1.3×10^8	5/100	~~4/10~~	3/20	2.9×10^8	135	70	70	30	30		155	370	
15	1.2×10^8	1/20	~~2/20~~	4/20	3.4×10^8	265	164	94	162			265	1280	
30	1.1×10^8	½/20	~~1~~	12/20	4.6×10^8	270	610	540	542			290	3790	
80	4.6×10^7	½/20	~~½/20~~	1	3.2×10^8	270	6000	6000	6000			270	55,000	
160	6.9×10^4	10/100	1	1								850	175,000	
Repeat														
0														
80	3.4×10^7 wwa				1.2×10^8	1500	7200		58000		1000	1500	25000	
160	5.5×10^4 wwa				4.4×10^6	800	32500		28000		165	800	126000	

B/r
graph 5

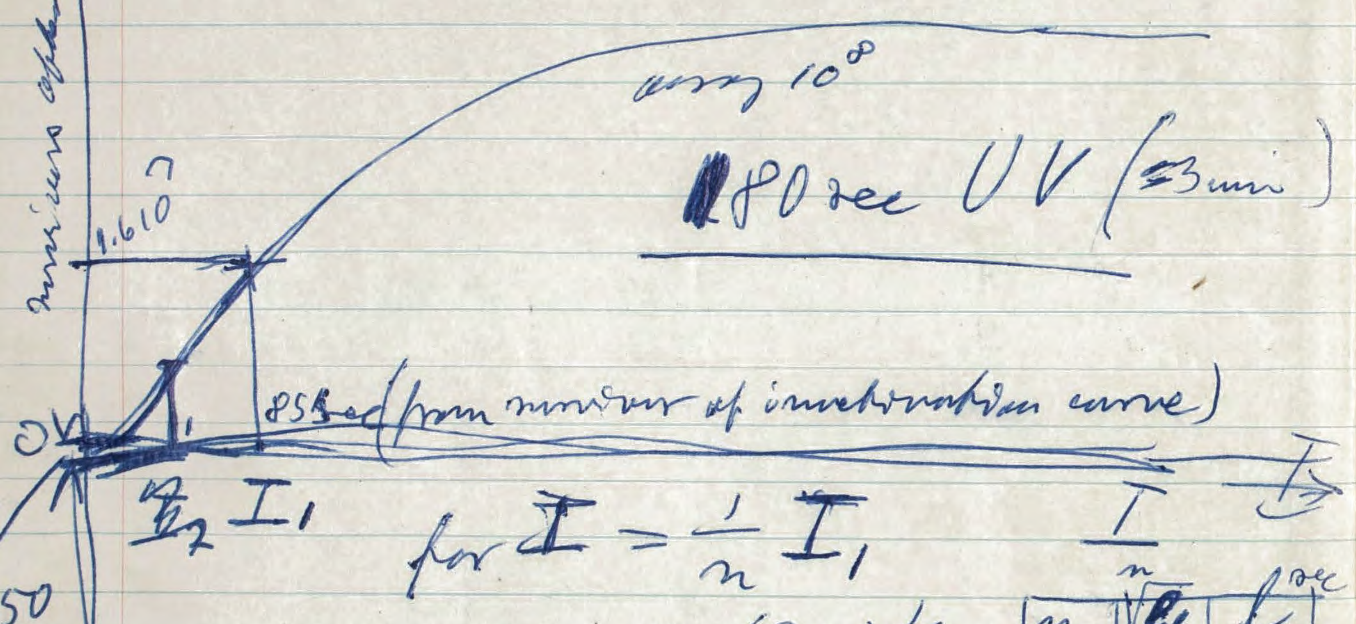
A certain amount of chemical [illegible] is produced by the UV irradiation
When we shine light of increasing
I ~~[illegible]~~ for 1 hour we have
(writing $c_0 = d$)

$$-\frac{dc}{dt} = kIc$$

or

$$c = d\,e^{-kI}$$

$c_0 = d$ for $I = 0$
$c = c_I$ for I



for $I = \frac{1}{n} I_1$

$$c = c_0 \left(\frac{c_1}{c_0}\right)^{\frac{1}{n}}$$

or

$$\ell = d \left(\frac{\ell_1}{d}\right)^{\frac{1}{n}}$$

ℓ

n	$\sqrt[n]{\frac{\ell_1}{d}}$	ℓ sec
1.5		109
2	0.69	123
3	0.78	140
4	0.83	150
5	0.86	155
6	0.885	159
8	0.915	164
1/2		40
1	[illegible]	85

$$Ik = \ln \frac{d}{\ell}$$

$$k = \frac{1}{I} \ln \frac{d}{\ell}$$

for $\begin{cases} n = \infty \\ \ell = d \end{cases}$

Theoretical (programme)

We measure

0.) Vary UV dose, no light: survivors
called UV series / up to 2.5 × 3.5 min

1.) Vary UV dose, ~~[illegible]~~ no light, regrow; mutants

0. and 1.) give us dose² law for mutants go to ~~[illegible]~~ 160 sec. should ~~[illegible]~~ and go further

2.) Vary UV dose → 1 hr light regrow; a) survivors (b) b) numbers

~~[illegible]~~ 1, 2a) enable us to

a1) determine ratio of mutants for dark to light for any given U.V. dose this may be const. Q

a2) determine ~~[illegible]~~ whether resulting killing after light gives as many mutants as UV, no light for same killing

c.) determine if number of mutants after a varying dose of U.V + 1 hr light is the same as for dose $\sqrt{Q}$ and no light

3.) Vary light intensity for fixed UV dose and determine: survivors and mutants:

Survivors and mutants ~~[illegible]~~ should again vary parallel and moreover we expect the following:

~~220~~ ~~270~~ UV	Assay	after light	Repeat dilution	Repeat assay	Multiple	$T1/10^8$	$T6/10^8$	$T4/10^8$	l	$T1/10^8$ for l	$T6/10^8$ for l	$T4/10^8$ for l
0	1.3×10^8											
220												
270	—	1.3×10^6	1:15	5.36×10^7	600	15,400	10,500	68,500	126 sec	16,000	1600	110,000
						Exp			Theory			

This experiment to show that mottling after light reactivation also determines mutants correctly. Mutants interpolated or extrapolated with „square of dose" law to get theoretical values. —
For interpolation see graph (B/r) 6

4.) Use a fixed UV say 3 min and 1½ min and give for 1 hr light at varied intensities
measure: survivors
measure: mutants

a.) see if mutants correspond to original dose l (for 3 min U.V)
b.) see if both mutants and survivors vary with same factor of light intensity for the two chosen UV doses (3 min 1½ min); of this the mutants will be a more sensitive test for ~~strong~~ strong lights and the survivors will be a more sensitive test for small reactivations, particularly for small reactivations in 3 min U.V. case

5.) Control Death by light alone (full strength)
6.) How does reactivation depend on duration (full strength)
If light only for 270 sec U.V
7.) Take 30 sec UV, regrow, use as starting material: give it 160 sec UV regrow test for mutants
up to 3 hours light (test for mutants)

Theoretical remarks. — 4

0.) UV series, No light, measure: survivors, go ~~[illegible]~~ 500 sec [as a function of dose d(sec)
Use points 30 sec, 80 sec, 120 sec 160 sec

1) UV, (no light), regrow, measure: (80 sec 120 160 180 200 ~~230~~ 220)
mutants [to establish square of dose law]
go to 160 sec UV, any further?

2) UV + 1 hr light, ~~[illegible]~~ measure:
survivors, to determine whether ~~[illegible]~~ virtual [dose l^{sec} ~~[illegible]~~ defined by survivors from curve established under 0.) is equal to Q (about 2.5) ~~×~~ d(sec)
Go out to 3½ × 2.5 min
230 sec × 2.5 ~~[illegible]~~ = 570 sec

3.) UV + 1 hr light regrow measure!
mutants, — go out to 270 sec UV and beyond?
~~[illegible]~~ 400 sec (T1) to give 10 m/sec
450 sec (T4) " "
From 1.) and 3) get ratio Q^2 of "$\frac{\text{Dark}}{\text{light}}$"
This should be done now for 30, 80, 160 sec UV! " "
From 2 and 3 one would see whether mutants correspond to dose l calculated from survivors

8.) Delayed appearance of [illegible] in [illegible]

9.) Check [illegible] [illegible]

Theory of light reactivation at varied light intensity : / Question
What about experiments of this type :
A UV dose is given and non recoverable death is measured as a function of time between UxV x dose and light application a.) how does this depend on the U.V. dose? b.) if some light is given immediately after UV and then we incubate for varying periods of time before we give.)
Theory: assume there is a deathrate which is some function of the concentration f(c) of the poison c
Question: ~~what determines~~ If light leaves $\frac{1}{4}$ of mutants, or $\frac{1}{10}$ of mutants (at higher UV dose) it means it leaves $\frac{1}{2}$ of or $\frac{1}{3.3}$ rd of poison
Why should it remove a larger fraction of the poison at higher U.V. doses ??
Perhaps because the latter are in a ~~dif~~ deeper lag ?!

Effect of filter 738 on reactivation

160 sec UV inactivated from [1.34 10^8] down to [72,400] or drop from 10^8 to 54,000.

1 hr light Uragne 1000 watt at 8 inches with Cell filter (see before) reactivated without filter 5.94×10^7

with filter [molded] 5.61×10^7

or 5% loss within exp error.

See book III May 10/49

Kolldrug by light 41
B/r in saline for 2½ days
with Mogul 1000 Watt lamp at
8 inches [with $\frac{5}{100}$ normal cells in
anodish pyrex flasks]

gives no kolldrug in 37° room
with fans on [temp rise estimated
of 2°C]

see Book III May 10 /49

Light calibrations

~~[illegible]~~
8 inches from 1000 Watt lamp
(120 Volt Mazda) to photocell line
gave with hole I on Photocell No 2
with filter 9883 59.5 divisions
" " B580 50 - divisions

~~Hg~~ Hg lamp goes up (close by) to 200
divisions with 9883
and with 9883 + 738 it goes to 70. -
738 cuts to 1/3 ord

To get ~~[illegible]~~ dark to light
ratio at ~~[illegible]~~ say 76 second
extrapolate back from light
from light 180 second with square law

	T1/108	T6/108	T4/108
D 76 sec dark	6700	6000	25000
L 76 sec extrap.	1600	1140	5000
	4.2	5.25	5
$\sqrt{\ }$	2.1	2.3	2.24

These figures have to be compared to 2.51

If we extrapolate ~~[illegible]~~ the T6 case from
180 sec 7100 with square law
to 175 sec ~~[illegible]~~ 6000

$\frac{175 \text{ sec}}{76 \text{ sec}} = 2.3 = q$

similarly:

for T1 case $q = 2.05$
for T6 case $q = 2.3$
for T7 case $q = 2.24$

See graph 12

this is excellent agreement with above values (2.1, 2.3, 2.24) which uses square law very essentially

UV	Assay	Regrow Dil	Assay after Regrow	Mult.	Con $T1/10^8$	Con $T6/10^8$	Con $T4/10^8$	Size Sample T1	$\frac{T4}{T1}$	$\frac{T4}{T6}$
0	8.1×10^7	100	9.7×10^8	1200	53	29	210		4	7.2
30	$5.4_5\times10^7$	80	10^9	1480	766	506	2550	400	3.3	5.0
76	2.17×10^7	20	1.4×10^9	1290	6700	6000	25000	670	3.7	4.2
76	"	200	—							
114	3.06×10^6	20	2.1×10^8	1370	11,900	14,600	66000	400	5.5	4.5
152	5.72×10^4	10	5.2×10^6	920	35000	16000	110000	200	3.2	6.9
170	6.34×10^3	No Regrow								
190	2.35×10^7	40	6.4×10^8	900	9900	7100	31000	990	3.1	4.4
285	3.2×10^6	20	2.71×10^8	1400	11,700	10,700	44,300	300	3.8	4.1
380	8.56×10^4	10	9.3×10^6	1000	14,900	5800	41,000	120	2.75	7
425	8.26×10^3	10	8.3×10^5	1000	23,500	18,000	97,500	20	4.2	5.4
475	613	No Regrow								
551	20	"	"							

suspect because it falls off curve

no light

FIRST Measurement

~~190~~			~~5.06×10^8~~	~~860~~	~~10800~~	~~8500~~	~~36800~~
~~285~~			~~2.45×10^8~~	~~1520~~	~~9600~~	~~7000~~	~~40700~~
~~380~~			~~7.15×10^6~~	~~835~~	~~1270~~	~~7700~~	~~47000~~
~~425~~			~~5.2×10^5~~	~~600~~		~~28000~~	

B/r ~~[illegible]~~ May 13th/49, May 11th/49

for square law see graph No 7

This is in graph No 10 No 11 gives Q = 2.51

$$\frac{L}{D} = \frac{1}{q} + \left(1-\frac{1}{q}\right)\left(\frac{\frac{L_0}{D} - \frac{1}{q}}{1-1/q}\right)^n$$

q can be determined by measuring for a given D the value of L_0 and another value L, —

Theory of intensity variation effect

For infinite intensity and by 2 theories
we find dose L (after light) $= \frac{D}{Q}$

we may then write

$$L = \frac{D}{Q} + \left(1 - \frac{1}{Q}\right) D e^{-\alpha I t}$$

For instance if we give a dose of 180 sec
and if $Q = 2.5$

$$L = \frac{180}{2.5} + \left(1 - \frac{1}{2.5}\right) 180 e^{-\alpha I t}$$

we now determine ~~the~~ ~~[illegible]~~ L for various values of I. – If we find
$L = L_0$ for $I = I_0$

$$L_0 = \frac{180}{2.5} + \left(1 - \frac{1}{2.5}\right) 180 e^{-\alpha I_0 t}$$

$$\frac{L_0 - \frac{180}{2.5}}{180\left(1 - \frac{1}{2.5}\right)} = e^{-\alpha I_0 t} = \frac{L_0 - \frac{D}{q}}{1 - 1/q} = e^{-\alpha I_0 t}$$

For example for $I_0 = 22.5$ $L_0 = 120$ sec

$$e^{-\alpha I_0 t} = 0.445$$

for $I = 2 I_0 = 45$ $L = 72 + 108 (0.445)^2 = 93.4$

for $I = 4 I_0 = 90$ $L = 72 + 108 (0.445)^4 = 72 + 108 \times 0.04$

$$\cancel{L = \frac{D}{q} + \left(1 - \frac{1}{q}\right) D e^{-\alpha I_0 t}}$$

for $I = n I_0$

rework

~~q_1~~ Q relates ~~to~~ to no delay

q_1 relates to one hour delay

q_t relates to n hour delay

~~$q_n - 1$~~ q_n meant q_t for $t = n$ hours

$n = 3$

$$\frac{q_n - 1}{q_n} \Big/ \frac{Q-1}{Q} = \left(\frac{q_1 - 1}{q_1} \Big/ \frac{Q-1}{Q} \right)^n$$

$$\frac{Q-1}{Q} \left(\frac{q_n - 1}{q_n} \Big/ \frac{Q-1}{Q} \right)^{\frac{1}{n}} = \frac{q_1 - 1}{q_1} = \cancel{\;}$$

0.455

$\frac{0.9}{1.9} = 0.475$

$$\frac{q_{n-1} - 1}{q_{n-1}} \times \frac{Q-1}{Q} = \left(\frac{q_n - 1}{q_n} \Big/ \frac{Q-1}{Q} \right)^{\frac{n-1}{n}} \frac{Q-1}{Q}$$

$2/3$

0.412

(2) (2)

Cap of May 18th /13

$Q_3 = 1.53$

$q_2 = 1.90$

$q_1 = 1.90$

$Q = 2.14$

Noorch equation. 0.396 m

$$\frac{q_m - 1}{q_m} = \left(\frac{q_3 - 1}{q_3} \Big/ \frac{Q-1}{Q} \right)^{\frac{m}{3}} \frac{Q-1}{Q}$$

for instance $m = 6$

$$\frac{q_6 - 1}{q_6} = \left(\frac{0.53 \times 2.14}{1.53 \times 1.14} \right)^2 \frac{1.14}{2.14}$$

H

Theory of time delay effect:

We assume that reactivable portion $D(1-\frac{1}{q})$ decays exponentially with time. Then after delay of t hours we have a dose L

$$\cancel{L = \frac{D}{q} + \left\{\left(1-\frac{1}{q}\right)D - \left(1-\frac{1}{q}\right)D\, e^{-\lambda t_{delay}}\right\}}$$

$$L_t = D - \left(1-\frac{1}{q}\right)D\, e^{-\lambda t_{delay}}$$

$$\left\{\begin{array}{l} \dfrac{L_t}{D} = 1 - \left(1-\dfrac{1}{q}\right)e^{-\lambda t_{delay}} \\[2ex] \dfrac{L_t^*}{D} = \dfrac{1}{q_t^*} \end{array}\right.$$

$$\frac{1}{q^*} = 1-\left(1-\frac{1}{q}\right)e^{-\lambda t^*}$$

$$\frac{1-\frac{1}{q^*}}{1-\frac{1}{q}} = e^{-\lambda t} = \frac{q^*-1}{q^*} \Big/ \frac{q-1}{q}$$

If number of hours is n t_0 apply and q_0^* is value of q^* for t_0 hours

2.26
.774

1.29 1.14 = A
3.04 2.14

1.135
1.745

A = 0.226

$$\frac{q^*-1}{q^*} \Big/ \frac{q-1}{q} = \left(\frac{q_0^*-1}{q_0^*} \Big/ \frac{q-1}{q}\right)^n$$

say 1 hour

$qbA = qb-1$ or $qb(A-1) = -1$ ~~$qb = 1$~~ $\frac{1}{1-A} = 1.29$

Because we assume

$X_0 = a$ Dose

$y_0 = b$ Dose   where $a + b = 1$

$$\frac{L}{\text{Dose}} = a + b\underbrace{\left\{\frac{\lambda}{\alpha I+\lambda} + \frac{\alpha I}{\alpha I+\lambda}\, e^{-(\alpha I+\lambda)t}\right\}}_{\text{bracket}}$$

This is ~~[illegible]~~ obviously independent of Dose — $a = \frac{1}{Q}$ $b = \left(1 - \frac{1}{Q}\right)$

Value of λ could be taken from 3 hour delay experiment

$Q = 2.14$

$\left(\frac{L}{D}\right)_{3\text{ hours}} = \frac{1}{1.5} = 0.654$

$e^{-\lambda 3} = \frac{0.346}{0.533} = 0.650$

0.467
.533

$3\lambda = 0.430$

$\lambda = 0.143$

$L = D - \left(1 - \frac{1}{Q}\right) D e^{-\lambda t}$

or

$\left(\frac{L}{D}\right)_{\text{for 3 hours exp}} = 1 - \left(1 - \frac{1}{Q}\right) e^{-\lambda 3}$

$e^{-\lambda 3} = \frac{1 - \left(\frac{L}{D}\right)_{3\text{ hours}}}{1 - \frac{1}{Q}}$

1 hr delay gives 0.113

2 hr delay gives 0.146

For calculating ~~[illegible]~~ I from measured point of value of Bracket

$$\frac{\frac{L}{D} - \text{Bracket}}{1 - \text{Bracket}} = \frac{1}{Q}$$

Combined theory of intensity I & time delay effects.

Let y_0 be the value of the y at time 0 when we start light irradiation and let us assume that reactionally amount of poison y changes

$$\frac{dy}{dt} = -y(\alpha I + \lambda)$$

$$\text{or } y = y_0 e^{-(\alpha I + \lambda)t}$$

remaining poison

$$\frac{dx}{dt} = \lambda y$$

$$L = x_0 + \underbrace{\int_0^t \lambda y \, dt}_{y_0 \frac{\lambda}{\alpha I + \lambda}\left(1 - e^{-(\alpha I + \lambda)t}\right)} + y_0 e^{-(\alpha I + \lambda)t}$$

$$\cancel{\boxed{L = x_0 + y_0 \frac{\alpha I}{\alpha I + \lambda} e^{-(\alpha I + \lambda)t}}}$$

$$L = x_0 + y_0 \left\{ \frac{\lambda}{\alpha I + \lambda} + \frac{\alpha I}{\alpha I + \lambda} e^{-(\alpha I + \lambda)t} \right\}$$

To calculate λ from a 3 hr delay (with high intensity) $I = 2 I_0$

$$L_{\text{no delay}} = x_0 + y_0 \frac{\lambda}{\alpha I + \lambda}$$

$$L_{\text{3 hours delay}} = x_0 + y_0 + y_0 e^{-\lambda 3}\left(\frac{\lambda}{\alpha I + \lambda} - 1\right)$$

$$= x_0 + y_0 - y_0 \frac{\alpha I}{\alpha I + \lambda} e^{-\lambda 3}$$

$$\cancel{= x_0 + y_0\left(1 - \frac{\alpha I}{\alpha I + \lambda} e^{-\lambda 3}\right)}$$

$$= x_0 + y_0 \left(\frac{\lambda + \alpha I(1 - e^{-\lambda 3})}{\alpha I + \lambda} \right)$$

$$= x_0 + y_0 \frac{\lambda}{\alpha I + \lambda} + y_0 \frac{\alpha I}{\alpha I + \lambda}\left[\lambda 3 - \frac{(\lambda 3)^2}{2}\right]$$

$$L_{\text{3 hours delay}} - L_{\text{no delay}} =$$

$$= y_0 \frac{\alpha I}{\alpha I + \lambda}\left[\lambda 3 - \frac{(\lambda 3)^2}{2!} \ldots\right]$$

and

$$y_0 = f(L_{\text{no delay}})$$

$$L_{\text{no dl.}} = x_0 + (1 - x_0)\frac{\lambda}{\alpha I + \lambda}$$

$$L_{nd} - \frac{\lambda}{\alpha I + \lambda} = x_0 \left(\frac{\alpha I}{\alpha I + \lambda}\right)$$

$$x_0 = \frac{L_{nd} - \frac{\lambda}{\alpha I + \lambda}}{\frac{\alpha I}{\alpha I + \lambda}} \quad \Bigg| \quad 1 - x_0 = 1 - \frac{L - \frac{\lambda}{\alpha I + \lambda}}{\frac{\alpha I}{\alpha I + \lambda}}$$

Pre-sponsor experiment: M.

comparing two days. Bugs 13/? taken
from same saline suspension
On first day bugs were in saline
at 3.30 overnight. —

Exp. start on May 10 (Plates read May 11)
Bugs in saline since evening of May 6th.
in ~~ice~~ ice box, —
UV inactivation curve
and reactivation by those light
at 0'' given in graph 13
this shows L/D straight line slope 2.51

$$L = x_0 + \int_0^t \lambda y \, dt + y_0 e^{-(\alpha I+\lambda)t}$$

$$\frac{dx}{dt} = \lambda y$$

dark for 3 hours ~~[illegible]~~

$t=0$ to $t=3$ $\quad y = y_0 e^{-\lambda t}$

$$L = x_0 + \cancel{y_0}\left[1 - e^{-\lambda 3}\right] + y_0 e^{-\lambda 3} \left\{ \frac{\lambda}{\alpha I+\lambda} + \frac{\alpha I}{\alpha I+\lambda} e^{-(\alpha I+\lambda)(t-3)} \right\}$$

$L_{\text{no delay}} = x_0 + y_0 - y_0 \frac{\lambda I}{\lambda I + \lambda}$

from this

$$e^{-\lambda 3} = \frac{1 - \frac{L_{\text{3h delay}}}{D}}{1 - \frac{L_{\text{no delay}}}{D}}$$

Assuming that $e^{-(\lambda I + \lambda)t}$ can be neglected which is true for $I = 2 I_0 (\theta^q)$

H

$y_0 = 1 - x_0 =$

$$= \frac{\frac{\alpha I}{\alpha I+\lambda} - L + \frac{\lambda}{\alpha I+\lambda}}{\alpha I} (\alpha I + \lambda)$$

$$\frac{\alpha I + \lambda}{\alpha I} - \frac{L_{\text{no del}}}{\alpha I} = y_0$$

$L_{\text{3 hours d}} - L_{\text{no del}} =$

$$= \left[1 - \frac{L_{\text{no delay}}}{\alpha I + \lambda}\right]\left[\lambda 3 - \frac{(\lambda 3)^2}{2!} + \dots\right]$$

Repeat

$$L_{\text{3 hours delay}} = x_0 + y_0 - y_0 \frac{\alpha I}{\alpha I+\lambda} e^{-\lambda 3}$$

$$= D - y_0 \frac{\alpha I}{\alpha I + \lambda} e^{-\lambda 3}$$

$$L_{\text{no delay}} = x_0 + y_0 \frac{\lambda}{\alpha I + \lambda}$$

$$e^{-\lambda n} = \frac{1 - \frac{L_{\text{delay}}}{D}}{1 - \frac{L_{\text{no delay}}}{D}} \qquad \frac{1 - \left[1 - \frac{y_0}{D}\frac{\alpha I}{\alpha I + \lambda} e^{-\lambda 3}\right]}{1 - \left[\frac{x_0}{D} + \frac{y_0}{D}\frac{\lambda}{\alpha I + \lambda}\right]}$$

$\ln(L - L_\infty)$ for $I = 1$ and $I = 2$
$\overset{\wedge}{I \neq 2}$

~~Figure 23 for $I = 1$ UV 150 and 250~~

June 13 $I = 1$ and $I = \frac{100}{42} = 2.4$
temp $40°C$ in $I = 2.4$ pos.
half lives 9 min and 15.8 mins
looks like some saturation
$UV = 175$

June 9
at $I = 2.4$
gives 8.5 min half life

Room 35°

June 23 $I = 1$ and $I = 2$ (~~[illegible]~~

$I = 1$ 15.8 min (half life) $\tau = 3$ min
$I = 2$ 9.5 min $\tau = 1$ m
at $UV = 250$
and
$I = 1$ for $UV = 150$
gives half life 15.8 mins

For write up (M)

1.) $S_2(D) = S_1\left(\frac{D}{Q}\right)$

May 11
June 19, 21, 23, 25 ($L_{\frac{1}{2}}$ 20 to 180)

mishaps in June 16 and 18 lost before hunt

$\ln(L - L_S)$ for $I = 1$ and $I = 2$

June 23 UV ~~250,~~150 $I=1$ | June 13 $I = 1$ and $2{+}0$ half life 9 min for $I = 2{+}0$ and 16 min | not so good June 17 UV $I=1$

Indep of L from UV Dose

better expressed as straight line giving Q^* for short say 25 min reactivation

June 23/49

different sensitivity: say N_a genes
~~have r_a~~ form part of the chromo-
some which has r_a hits
N_b genes form rest of chromosome
which has r_b hits   Then

$$\frac{B}{B_0} = \left[1-\left(1-e^{-\frac{r_a}{N_a}}\right)^2\right]^{N_a}\left[1-\left(1-e^{-\frac{r_b}{N_b}}\right)^2\right]^{N_b}$$

for large r_a and r_b

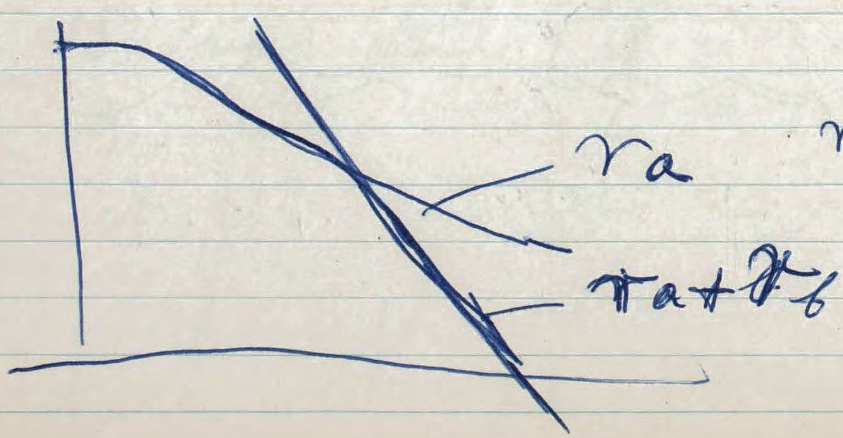
$$\frac{B}{B_0} = \left[2e^{-r_a/N_a}\right]^{N_a}\left[2e^{-r_b/N_b}\right]^{N_b}$$

and

$$\ln\frac{B}{B_0} = N_a \ln 2 - r_a + N_b \ln 2 - r_b$$

$$= \underbrace{(N_a+N_b)}_{N}\ln 2 - \underbrace{r_a+r_b}_{r}$$

where r is number of hits on chromosome
N total number of genes



$r_b \ll r_a$

Delbrück – Bauer U

Shape of survivor curves

B Diploid case (equal sensitivity of all genes, and both chromosomes)

~~probability of both being~~

Number of hits per chromosome r

Number of genes N

probab of survival of one gene $e^{-\frac{r}{n}}$

" " killed one gene $1-e^{-\frac{r}{n}}$

" " " both genes $(1-e^{-\frac{r}{n}})^2$

" " viable escape $1-(1-e^{-\frac{r}{n}})^2$

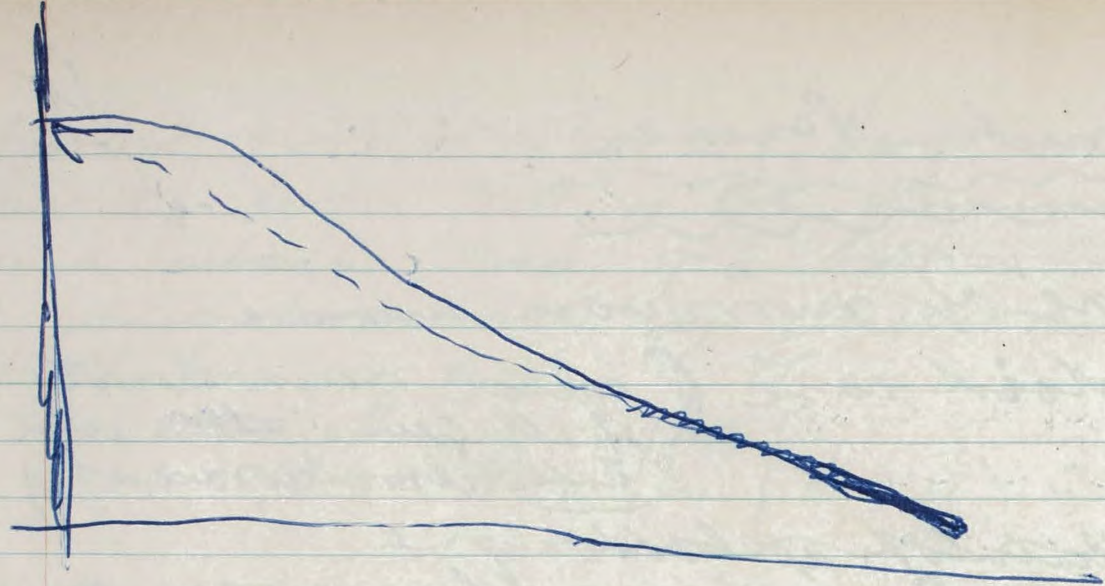
for N genes probability of viable escape

$$\frac{B}{B_0} = \left[1-(1-e^{-\frac{r}{n}})^2\right]^n$$

~~for large r~~ and $\frac{B}{B_0} = \sim \left[2e^{-r/n}\right]^n = 2^n e^{-r}$

$$\log \frac{B}{B_0} = n \log 2 - r$$

extrapolates for $r=0$ to $n \log 2$



[illegible] If N_2 genes require two chromosomes but and N_3 genes require three chromosomes hit. — r_2 hits on that part of chromosome which contains the N_2 genes; r_3 hits on that part of the chromosome that ~~requires~~ contain the N_3 genes:

$$\cancel{\frac{B}{B_0} = \left[1-\left(1-e^{-r_1/N_1}\right)\right]^{N_1}\left[1-\left(1-e^{r_2/N_2}\right)^2\right]^{N_2}}$$

$$= \left[1-\left(1-e^{-r_1/N_1}\right)^2\right]^{N_1}\left[1-\left(1-e^{-r_2/N_2}\right)^3\right]^{N_2}$$

For large r_1/N_1 ; r_2/N_2

$$B/B_0 \simeq 2^{N_1} e^{-r_1} \times 3^{N_2} e^{-r_2}$$

equal sensitivity of all genes, but different sensitivity of the two chromosomes — I and II 4

survival of a gene I of chromosome
has r hits

probab of ~~survival~~ survival of I $\quad e^{-\frac{r}{N}}$

probability that
I is hit $\quad 1-e^{-\frac{r}{N}}$

probability that
two survive of one is hit $(1-e^{-\frac{r}{N}})\,e^{-\beta\frac{r}{N}}$
{where βr are hits on chromosome II}

viable if either I survives

or if ~~one~~ is hit but II survives

so $$\frac{B}{B_0} = \left[e^{-\frac{r}{N}} + (1-e^{-\frac{r}{N}})\,e^{-\frac{\beta r}{N}}\right]^N$$

$$= \left[e^{-\frac{r}{N}} + e^{-\frac{\beta r}{N}} - e^{-(1+\beta)\frac{r}{N}}\right]^N$$

for large r and $\beta < 1$

$$\frac{B}{B_0} \approx \left[e^{-\beta\frac{r}{N}}\right]^N \approx e^{-\beta r}$$

$$\ln\frac{B}{B_0} \approx -\beta r$$

or

$$\frac{\beta}{\beta_0} = \underbrace{\cancel{1} - (1-e^{-r/N})^2}_{\text{probab for viable doublett}} + \underbrace{(1-e^{-\frac{r}{N}})^2 e^{-\frac{\beta r}{N}}}_{\text{prob for dead doublet but surviving singlet}}$$

for $\beta = 1$

$$(e^{-\frac{r}{N}} - 1)(1 - e^{-r/N})^2 + 1$$

O.K.

for larger r and βr

$$\frac{B}{B_0} \approx 2e^{-r/N} + e^{-\frac{\beta r}{N}}$$

if $\beta < 1$

$$\ln B/B_0 = -\frac{\beta r}{N}$$

if $\beta > 1$

$$\ln \frac{B}{B_0} = \ln 2 - \frac{r}{N}$$

$N_1 + N_2 = N$

$$\ln B/B_0 \approx \underbrace{N_1 \ln 2 + N_2 \ln 3}_{} - \underbrace{(r_1 + r_2)}_{r}$$

~~[illegible]~~

hits on chromosome

~~[illegible]~~

three chromosomes

I and II equal III different

~~probabl~~ hits on I and II $\frac{r}{N}$

hits on III $\beta \frac{r}{N}$

Probab. that III survives is $e^{-\beta \frac{r}{N}}$

Probab that III ~~[illegible]~~ is hit $(1 - e^{-\beta\frac{r}{N}})$

Probab that III is hit but (I+II) are viable

is $(1 - e^{-\beta \frac{r}{N}})\left[1 - (1 - e^{-\frac{r}{N}})^2\right]$

Probab that (I + II + III) ~~[illegible]~~ is viable

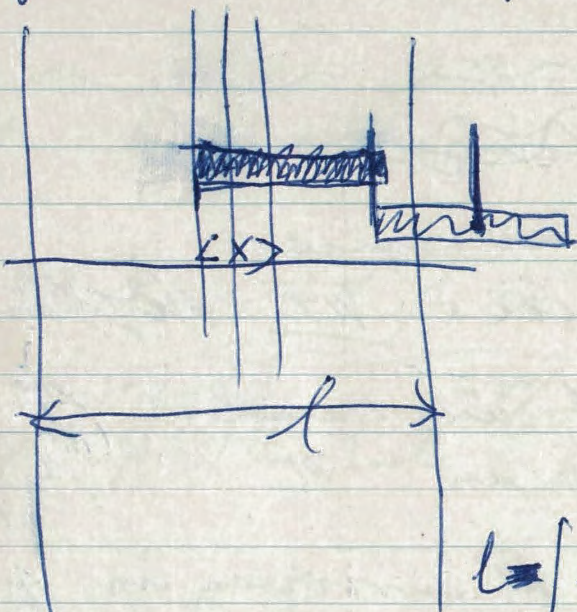
$$\frac{B}{B_0} = e^{-\beta \frac{r}{N}} + (1 - e^{-\beta \frac{r}{N}})\left[1 - (1 - e^{-\frac{r}{N}})^2\right]$$

$$= 1 - (1 - e^{-r/N})^2 + (1 - e^{-\frac{r}{N}})^2 e^{-\frac{\beta r}{N}}$$

inside strip becomes 0 at

$$\frac{d}{2} = 2a$$
$$d = 4a \;;$$

lets strips make equal



$$l - \left[\frac{l}{2} - \frac{d}{2} + \frac{x}{2}\right] =$$

$$= x$$

$$\frac{l}{2} + \frac{d}{2} - \frac{x}{2} = x$$

$$\frac{3}{2}x = \frac{l+d}{2}$$

$$x = \frac{l+d}{3}$$

$$\frac{x}{2} = \frac{l+d}{6}$$

$\frac{x}{2} = \frac{d}{2} - a$ means:

$$\frac{l+d}{6} = \frac{d}{2} - a$$

$$= \frac{d}{2} - \left[d - \frac{l}{2}\right]$$

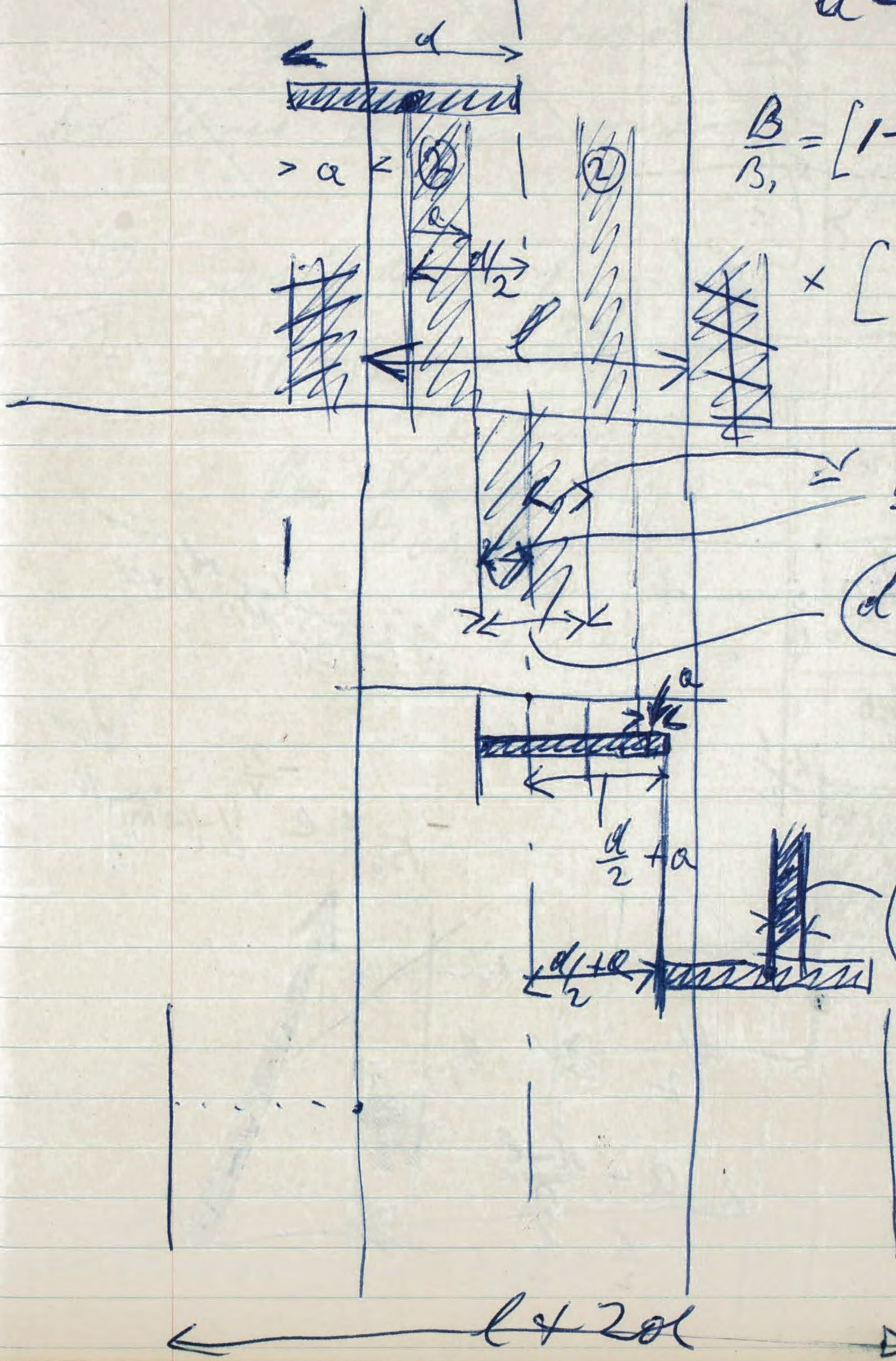
$$\frac{l+d}{6} = \frac{l}{2} - \frac{d}{2}$$

$$\frac{l+d}{3} = l - d$$

$$l+d = 3l - 3d$$

$$0 = 2l - 4d \quad d = l/2$$

for band case (2 and 3 tubes)



$d - \frac{l}{2} = a$

$\frac{B}{B_1} = \left[1 - (1 - e^{-\nu_a/N})^2\right]^N \times$

$\times \left[\quad\right]^N$

$\simeq \frac{d}{2} - a$

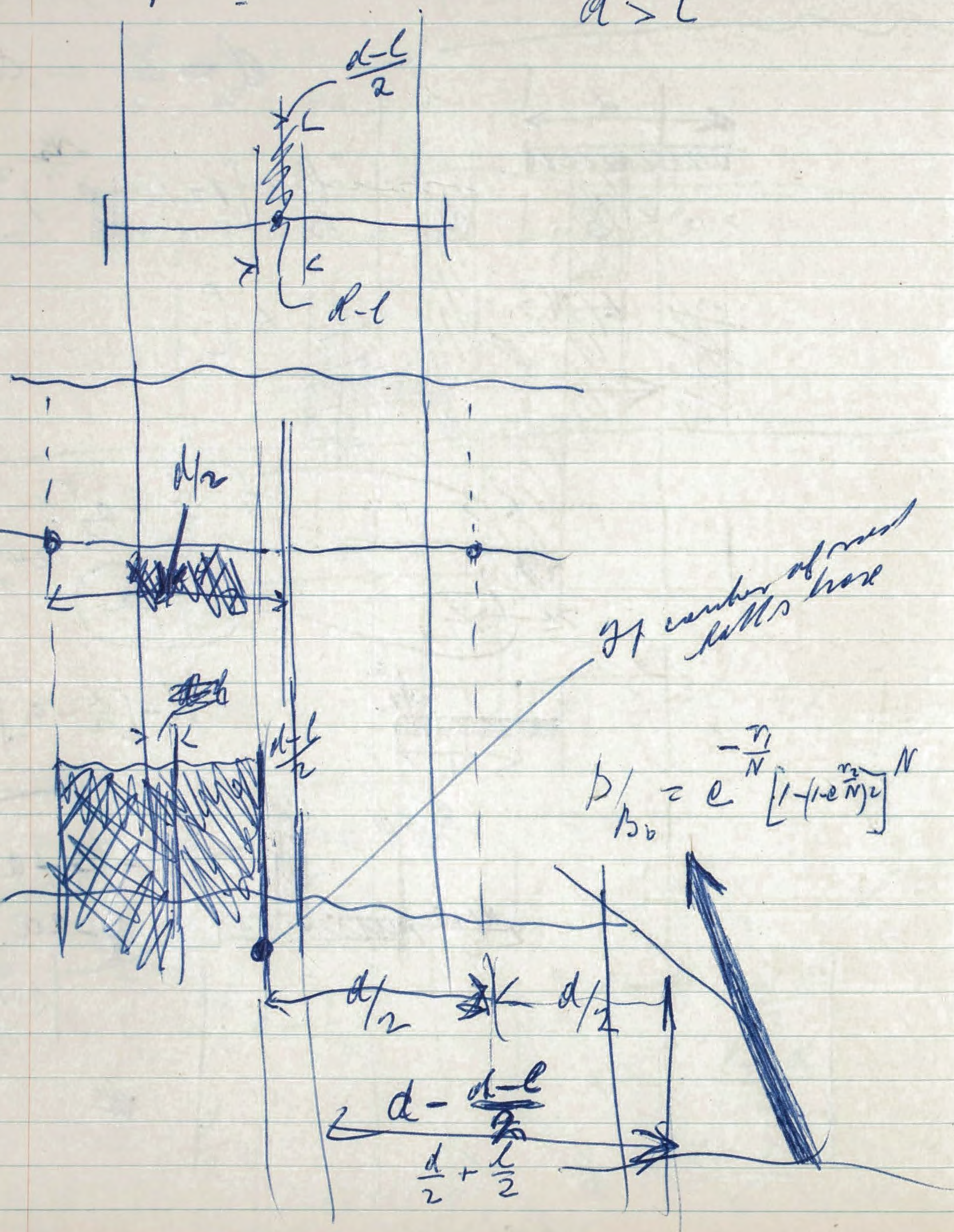
$d - 2a$ center strip

$d - \left[\frac{d}{2} - a\right]$

$\frac{l}{2} - \left(\frac{d}{2} + a\right) = \frac{d}{2} - 2a$ side strip

Case of one and two hits

$d > l$



$$B/B_0 = e^{-\frac{r_1}{N}}\left[1-(1-e^{-\frac{r_2}{N}})^2\right]^N$$

44

~~and~~

$$\cancel{2d - l + 3 \times l + d =}$$

~~$3d$ is label of strips for three dimensional case~~

label of strips

$\frac{B}{B_1}$ will have form

$$\frac{B}{B_1} = \left[1-\left(1-e^{-\frac{r_2}{N}}\right)^2\right]^N \left[1-\left(1-e^{-\frac{r_3}{N}}\right)^3\right]^N \cdots$$

for large r

$$\ln \frac{B}{B_0} \sim N \log 2 - r_2 + N \log 3 - r_3$$

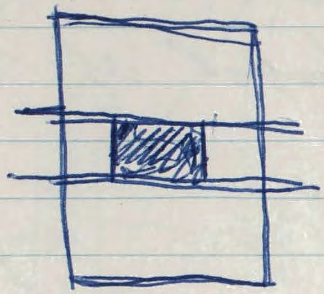
$$d - \frac{l}{2} + \frac{l+d}{3} = \frac{6d - 3l + 2l + 2d}{6}$$

$$\frac{8d - 2l}{6} > \frac{1}{3} l$$

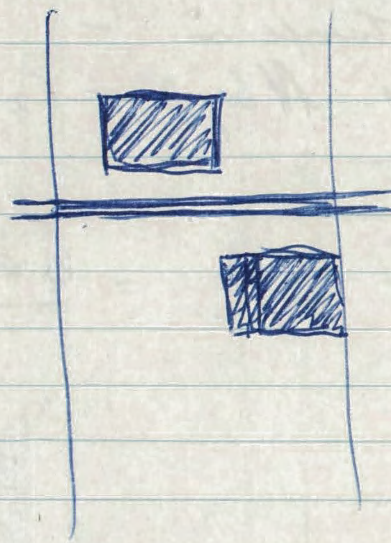
$$< l$$

Maschine

light flashes
at irregular
intervals



producing



counting

~~for~~ Ultimate slope in hotland case. —

~~for~~ number of lots by center of ~~Diff~~ "road" per acre be ρ

then ultimately everything may be block except a small spot

number of lots increasing by one more than $d\rho$ lots

Now take rudimentary case of 1 and two lots —

center strip $\frac{d-l}{\cancel{2}}$

side strip $\frac{d}{2} - \frac{d-l}{2} + d - l$

$\cancel{d-\frac{l}{2}}$ $= \frac{d}{2} + \frac{d}{2} - \frac{l}{2} = d - \frac{l}{2}$

~~[illegible]~~ one ~~&~~ two lot centered:

~~d~~ wrong because certain other combinations of two lots will also hold. —

mutations improved

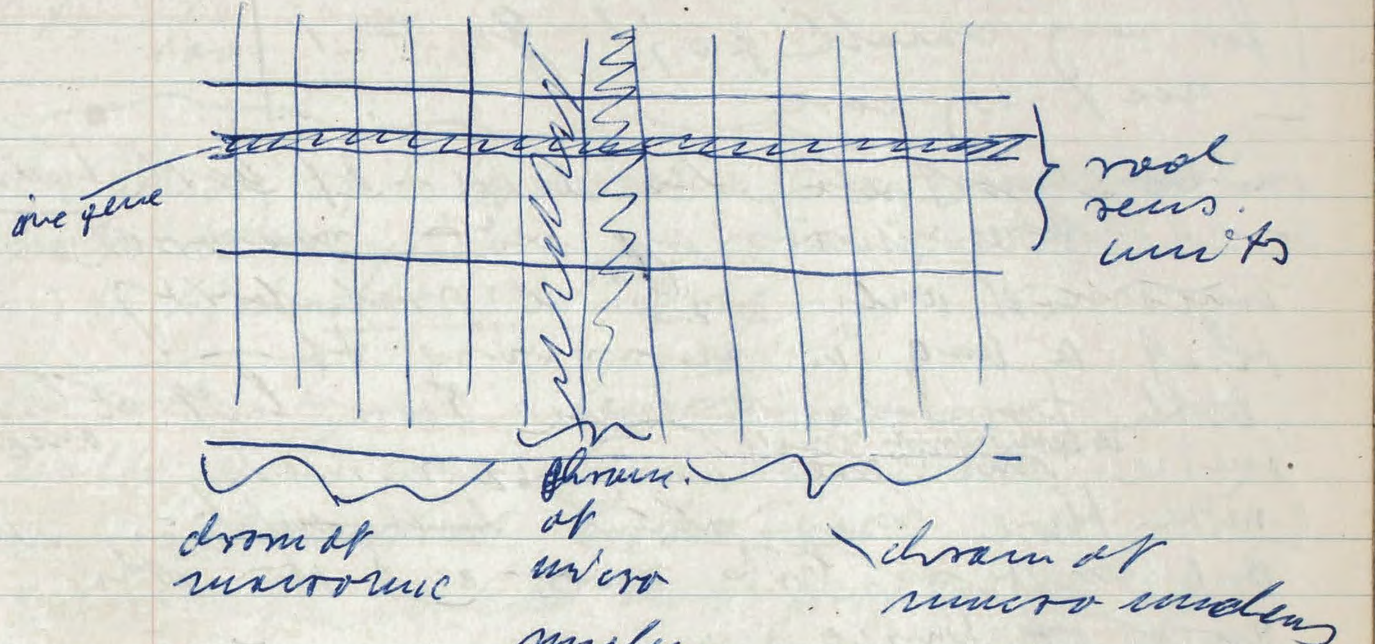
~~[illegible]~~ assumption: within a sphere of ~~ra~~ hit with high probability everything destroyed both the part of the gene that lies within the sphere and neighbouring genes. However rarely, say e.g. once in 20 hits, only the part of the gene ~~is~~ ~~the~~ which is lying within the sphere is destroyed but not the neighbouring genes. Let us assume here ~~that~~ the next neighbouring genes are vital for survival. If we now assume "diploid" case and

~~one now~~ have $\frac{r}{n} = 1$, one of the radiation units ~~will~~ ~~be~~ ~~[illegible]~~, containing the gene, will be destroyed with high probability.

Zero point mutations II

Assumptions à la Delbrück Brues:—

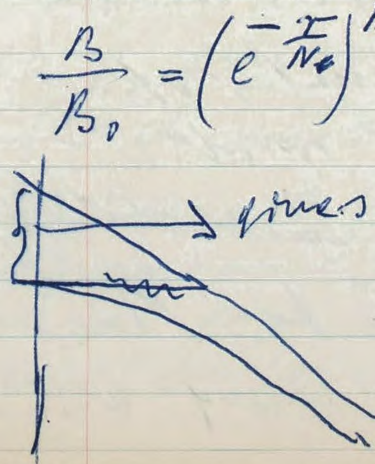
number of hits on 1 strand r



number of hits per radiation sensitive unit $\frac{r}{N}$

Delbrück Brues formula for survivors

$$\frac{B}{B_0} = \left(e^{-\frac{r}{N_1}}\right)^{N_1}\left(1-(1-e^{-r/N_2})^2\right)^{N_2}\left(1-(1-e^{-r/N_3})^3\right)^{N_3}$$



gives: $N_2 \log 2 + N_3 \log 3$

$N_1 + N_2 + N_3 = N$

let the probability that
we find a mutation for a
given dose be:

$$\left(1-g_0\right)^2 \times 10 g \quad \text{per survivor}$$

[for very small g_0; $1-g_0 = 1$
see X-ray case]

~~since almost all are dead of both twin~~
~~radiation units are hit we are~~
~~concerned only~~ Since probability
that a bug is surviving ~~if~~
~~both twin units have been hit at least~~
~~twice is exceedingly small we are only concerned~~ ~~once~~
~~with those cases where both units~~
~~one unit is hit once and the other either~~
~~once or twice~~

becomes exceedingly small if
both radiation unit have been
hit once and one of them
is hit a second time we
shall find that the number of
mutants per survivor will
increase ~~with the dose according~~
~~to D^2~~ proportional to the
square of the dose as long as

Facts from Demerec:

50 new point mutants / 10^8
5000 and point mutants / 10^8
for 4000 R which kills B/r down to $\frac{1}{100}$

The theory of U.V and X ray induced mutations

1.) UV; in diploid case

In order to get a specific mutation both twin radiation sensitive units must be hit. —
Each such unit has $p+1$ genes.
Probability that a gene ~~is killed~~ survives is α ~~for all genes except~~ for all genes except the one in which we are interested. [If radiation unit is hit!]
In order to get a mutation all p genes must survive in both "chromosomes" but the one special gene must be killed in both chromosomes; probability that the special gene ~~is killed~~ survives in one chromosome be g_0

$$\frac{\cancel{\frac{A}{B}}}{B_0} = \frac{(1-p_0)^2\left[1-(1-\alpha)^2\right]^p\left(1-e^{-\frac{r}{N}}\right)^2}{\left[1-\left(1-e^{-\frac{r}{N}}\right)^2\right]^2}$$

~~or~~ for ~~[illegible]~~ large $\frac{r}{N}$ denominator

$$\left[2\, e^{-\frac{r}{N}}\right]^2 = 4\, e^{-\frac{r}{2N}}$$

this does not go with second power of dose!

Argue differently: What is the

probability ~~[illegible] to find~~ that a survivor has ~~[illegible]~~ one ~~[illegible]~~ "surviving special hit" on one chromosome and one surviving special hit on ~~the~~ its twin chromosome?

The survivors fall into the following classes 1.) no hit on left special chrom. 2.) no hit on right special chromosome 3.) no hit on either, ~~[illegible]~~

4. special hit on the left and special hit on the right

$$\frac{4}{1.+2} = \frac{\cancel{[illegible]}\ [\text{small const}]\left(1-e^{-\frac{r}{N}}\right)^2 \left[\begin{smallmatrix}\text{prob. that}\\ \text{hit only once}\end{smallmatrix}\right]}{2\, e^{-r/N}} \quad (\text{each}$$

The probability of a bit or radiation unit that (or) an appreciable fraction of the genes — survives is small.
Let us see if this is true?

In order to get survival of the bug one must have all p genes survive in at least one of the two chromosome;

i.e. à la Brown

probability that both genes die
$$(1-\alpha)^2$$
probability that bug survives
$$\left[1-(1-\alpha)^2\right]^p$$

so if both radiation units are hit once

then probability of (alive) mutation
$$(1-g_0)^2\left[1-(1-\alpha)^2\right]^p = M$$

~~and number of mutations per survivor~~

$$\frac{M}{B} \approx (1-g_0)^2 \cancel{\left[1-(1-\alpha)^2\right]^p} (1-e^{-\frac{r}{N}})^2 \left(1-(1-e^{-\frac{r}{N}})^{N-2}\right)$$
$$\frac{B}{B_0} \quad \cancel{1-\left[1-(1-e^{-\frac{r}{N}})^2\right]^{N+1}}$$

Now let ~~for~~ a ~~system~~ close for which $R(\frac{r}{N}) = 1$ be: mutation/survivor =

$$= (1-g_0)^2 \, 10^{-y}$$

so we have (for large $\frac{r}{N}$)

$$(1-g_0)^2 \left[1-(1-\alpha)^2\right]^p = (1-g_0)^2 \cdot 10^{-y}$$

or $$\left[1-(1-\alpha)^2\right]^p = \frac{1}{10^y}$$

or $$1-(1-\alpha)^2 = \frac{1}{10^{y/p}} = A$$

~~[illegible]~~ or $\alpha = 1-\sqrt{1-A}$

or ~~[illegible]~~ for $\frac{y}{p} \ll 1$; $A \approx 1 - \frac{2.3\,y}{p}$

and ~~[illegible]~~ $\alpha = 1-\sqrt{\frac{2.3\,y}{p}}$

for $p = 100$; $y = 6$ $\quad \alpha \approx 1-\frac{1}{3} = 2/3$

probab that each hit only once.

~~product of hits $(1-e^{-\frac{r}{N}})$~~

$$\frac{(1-f_0)^2\left[1-(1-\alpha)^2\right]^p \left[\frac{r}{N}\, e^{-\frac{r}{N}}\right]^2 \left[1-(1-e^{-\frac{r}{N}})^2\right]^{N-1}}{\left[1-\ \right]^{N-1} \text{factor} + \left[1-(1-e^{-\frac{r}{N}})^2\right]^N}$$

~~for large~~ $\frac{r}{N}$ ~~for small~~ $\frac{r}{N}$ $\left(\frac{r}{N}\right)$

$$= \frac{(1-g_0)^2\left[1-(1-\alpha)^2\right]^p \left(\frac{r}{N}\right)^2 \left(e^{-\frac{r}{N}}\right)^2}{\left[1-(1-e^{-\frac{r}{N}})^2\right]^{k}}$$

for large $\frac{r}{N}$

$$\cong \frac{(1-f_0)^2\left[1-(1-\alpha)^2\right]^p \left(\frac{r}{N}\right)^2 \cancel{\left(e^{-\frac{r}{N}}\right)} e^{-\frac{r}{N}}}{2\, \cancel{\left[e^{-\frac{r}{N}}\right]}}$$

We ~~ca~~ can neglect some mutations (more than once) of one or both at the same radiation intensity ~~at~~ both

$$(1-g_0)^{k}\left[1-(1-\alpha)^{k}\right]^{p}\left(\frac{x}{N}\right)^{k}$$

$p = 100$

$\alpha = 2/3$

2 Standard doses

$$\left(1-\frac{2}{3}\right)^{k} \cancel{\left(\quad\right)} \left(1-\left(\frac{1}{3}\right)^{k}\right)^{p} 2^{k}$$

$h = 1$ $\qquad \left(\frac{2}{3}\right)^{n}$

$h = 2$ $\qquad \left(\frac{8}{9}\right)^{100}$ $\qquad \boxed{1000}$

10^{-5}

α

$$\left[1-\frac{1}{9}\right]^{\frac{100}{8}9}$$

e^{-11} $\qquad 3\cdot 10^{-5}$

$3000/10^{00}$

$[1-\frac{1}{27}]$

e^{-10} | $10^{-\frac{.80}{2.3}}$

e

e^{-1}

post start on U. V. mutants

assume $^{\alpha}/_N$ large $\frac{r_0}{N}$ number of

mutants M_0, we now increase

r by Δr what is $\frac{d}{dr}\frac{M}{S} = \frac{M'S - MS'}{S^2}$

$$S = S_0 e^{-r}$$

$$S' = -S_0 e^{-r}$$

$$\Delta M = 2(\text{factor})^2 \frac{r}{N} e^{-r/N} \quad \frac{\Delta r}{N} S -$$

$$\frac{\Delta M}{\Delta N} = \frac{1}{N} S \times 2 \times (\text{factor})^2 \frac{r}{N} e^{-r/N} - M e^{-r}$$

$$\frac{d}{dr}\frac{M}{S} = \frac{1}{N} \times 2 \times (\text{factor})^2 \frac{r}{N} e^{-r/N} +$$

$$\frac{dy}{dx} =$$

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

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

$x^2 e^{-x}$. for large R $\quad dr = N\,dx$

$$2x e^{-x} - x^2 e^{-x}$$

4

Now for X-rays:

probability of mutant

$$\frac{\alpha^p (1-g_0) \frac{r}{N} e^{-r/N} \left(e^{-\frac{r}{N}}\right)^{N-1}}{\left(e^{-\frac{r}{N}}\right)^N}$$

U.V. case considered

Me^{-r} ~~$(1-g_0)$~~ let g_0 be very small $(1-g_0)=1$

then we have taking higher terms

$$\left(e^{-\frac{r}{N}}\right)^2 \left\{ \left(1-(1-\alpha)^2\right)^p \left[\frac{r}{N}\right]^2 + \right.$$

$$\overline{\qquad\qquad\qquad\qquad\qquad\qquad}$$

$$\left\{1-\left(1-e^{-\frac{r}{N}}\right)^2\right\}$$

$$+\left[1-(1-\alpha)(1-\alpha^2)\right]^p \frac{r}{N}\left(\frac{r}{N}\right)^2 \frac{2}{2!}+$$

$$+\left[1-(1-\alpha^2)(1-\alpha^2)\right]^p \left(\frac{r}{N}\right)^2\left(\frac{r}{N}\right)^2 \frac{1}{2!}\frac{1}{2!}+$$

$+ \ldots$

for Ordway in Traine

Multifocal diploid theory

Assumption + N sensitive unit, each 100 "genes" probability α of one gene dying in case of hit. —

$\frac{B}{B_0}$ = ~~[illegible]~~

probability of survival of one gene of $\frac{r}{N}$ hits $e^{-\frac{\alpha r}{N}}$

of death of one gene

$$1 - e^{-\frac{\alpha r}{N}}$$

of death of both genes

$$(1-e^{-\frac{\alpha r}{N}})^2$$

of ~~[illegible]~~ one remaining viable

$$1 - (1-e^{-\frac{\alpha r}{N}})^2$$

of all remaining viable

$$\left(1-\left[1-e^{-\frac{\alpha r}{N}}\right]^2\right)^{pN}$$

assumption of independence!!!

for very high r

α - rays H

$\frac{M}{S} = \alpha^p (1 - q_0) \frac{r}{N}$ ~~[illegible]~~

40000 Rounds gave 1/100 survivor

or $r = 4.5$ close

for $r = 1$ we have $\sim$ 8000 Rounds

$5 \, 10^{-5} = \alpha^p (1 - q_0) \frac{4.5}{N}$

10,000

2000

$2 \, 10^{-5}$

$10^{-5} \approx \alpha^p (1 - q_0) \frac{1}{N}$

for $N = 10$

$q_0 = 0$

$10^{-4} = \alpha^p$

$p = 100$

$\alpha^{100} = 10^{-4}$

$\alpha = 10^{-\frac{1}{25}}$

$10^{\frac{1}{100}}$

$e^{\frac{2.3}{100}} \quad 1 + \frac{2.3}{100}$

$= e^{-\frac{2.3}{25}} \approx e^{-\frac{1}{10}}$

$= 1 - \frac{1}{10}$

$\alpha = 0.9$

or ~~surviving~~ probab of death only 0.1

putting now $1 - q_0 = \frac{1}{10}$

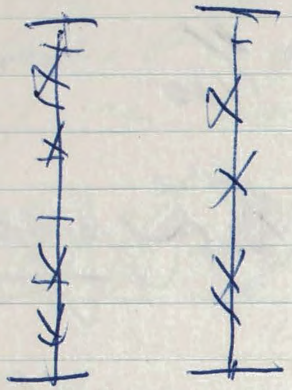
we get $10^{-3} = \alpha^p \quad | \quad e^{-\frac{2.3}{33}} = 1 - \frac{2.3}{33}$

$\frac{1}{14}$

Produkte at 1 link left — 1 link right

$P(1) \leq P(1) +$

$P_1(i)$



$P(k)$

Wieder Problem hell los!

B $\left[2e^{-\frac{\alpha\tau}{N}}\right]^{pN}$ H

$$2^{pN}e^{-p\alpha\tau}$$

$$\log\frac{B}{B_0} = pN\log 2 - p\alpha\tau$$

~~the~~ this does not help to get a larger N except that we made assumption of independence of hits ~~in same~~ on different genes in same radiation unit.

Try better:

~~is~~ viability in one section":

probability ~~of both de~~ in main section

Plastic 30 to 40 cents
per lbs Polyethylene
extruded
Marke 40 to 50 cents

Iron sheet per Ton
100 Dollars

Aluminum sheet 25 c/lb
$\frac{10}{1000}$ of inch

---

25 cents per 1000 cubic
CH_3 feet

and in California
40 cents per 1000 cubic feet

Buy Algae for humans $150/ton
for animal $60/ton

H

10000 foot candles Arizona desert at noon

Esquire 4i Quarterly last issue
The American Federalist

Remington Rand el.

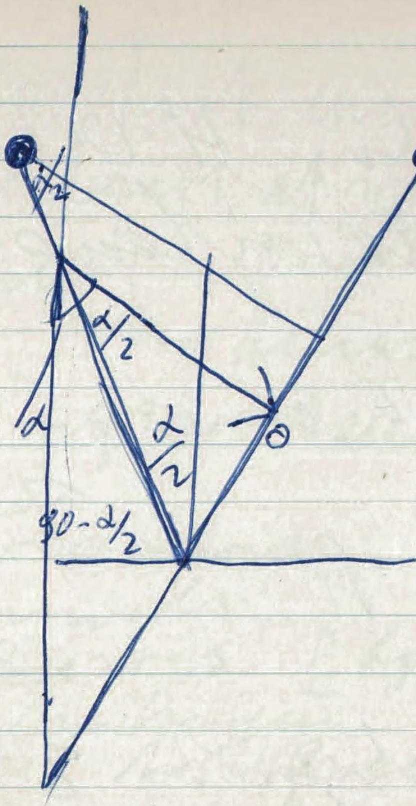
Wisconsin
vandals
Burris [Agric. Bioalum]
introgen [illegible] at
Blue green
and Calvin type work
[illegible]: Wolfe Scoog
[illegible] / [illegible]
of Blue green

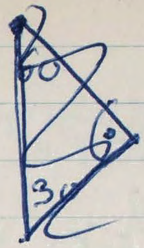
[illegible] $200 per acre

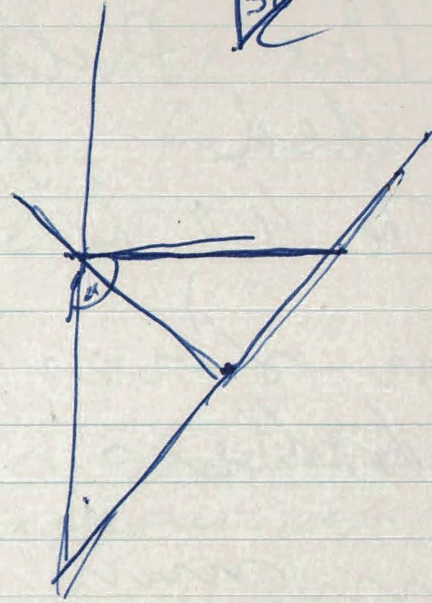
[illegible] land in California $500

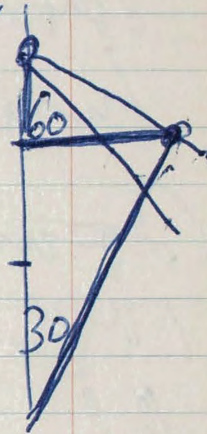
Chlorella with 40 – 50 tons dry weight
$5000 per Acres

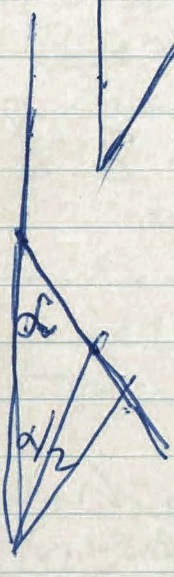
[illegible] 30% of cost
processing 10%











$\alpha + \alpha/2 = 90^\circ$

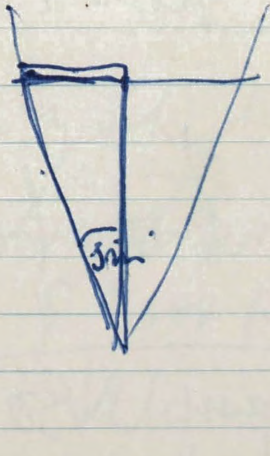
$\frac{3}{2}\alpha = \cancel{180}\ 90$

60

60°

$\sin\frac{\alpha}{2}$

$\sin 30$



$H_2CO_3 + Na_2CO_3 =$

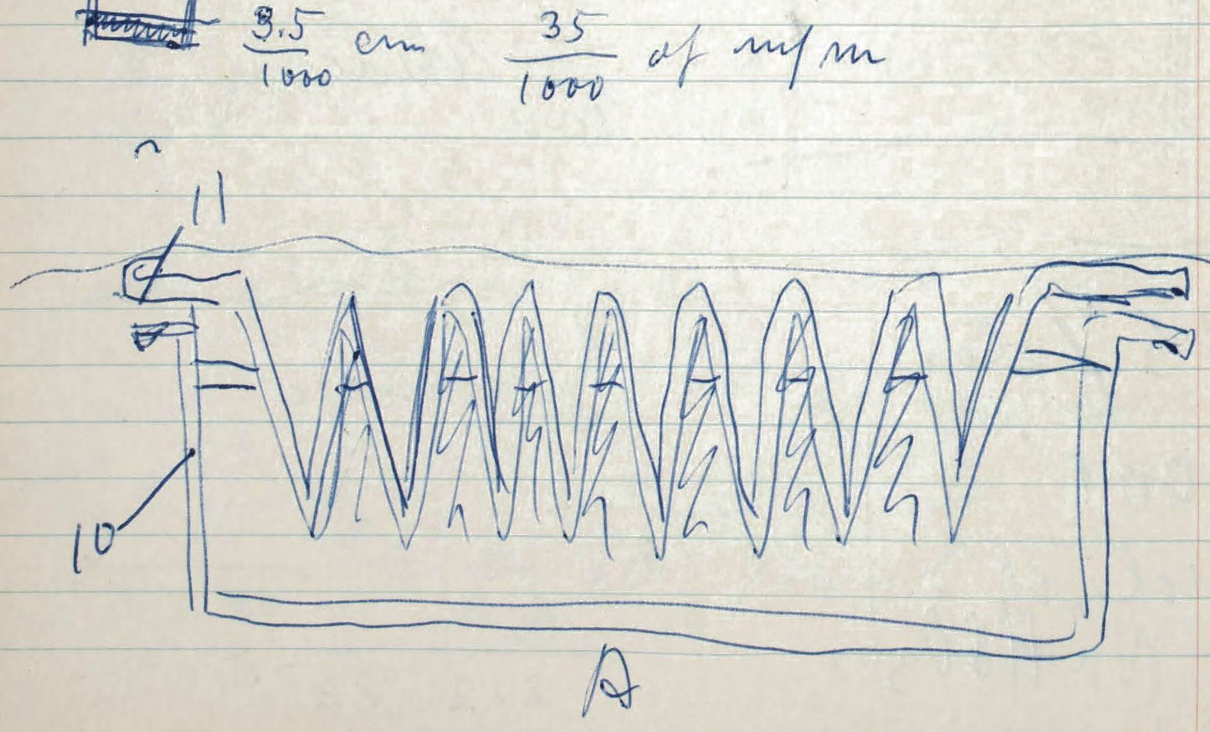
$2 NaHCO_3$

$C_1 \times C_2 = C_3^2$

Size ~~[illegible]~~ $\frac{c}{3}$

3.5 10^{-3} cc/cc

$\frac{3.5}{1000}$ cm $\frac{35}{1000}$ of mm



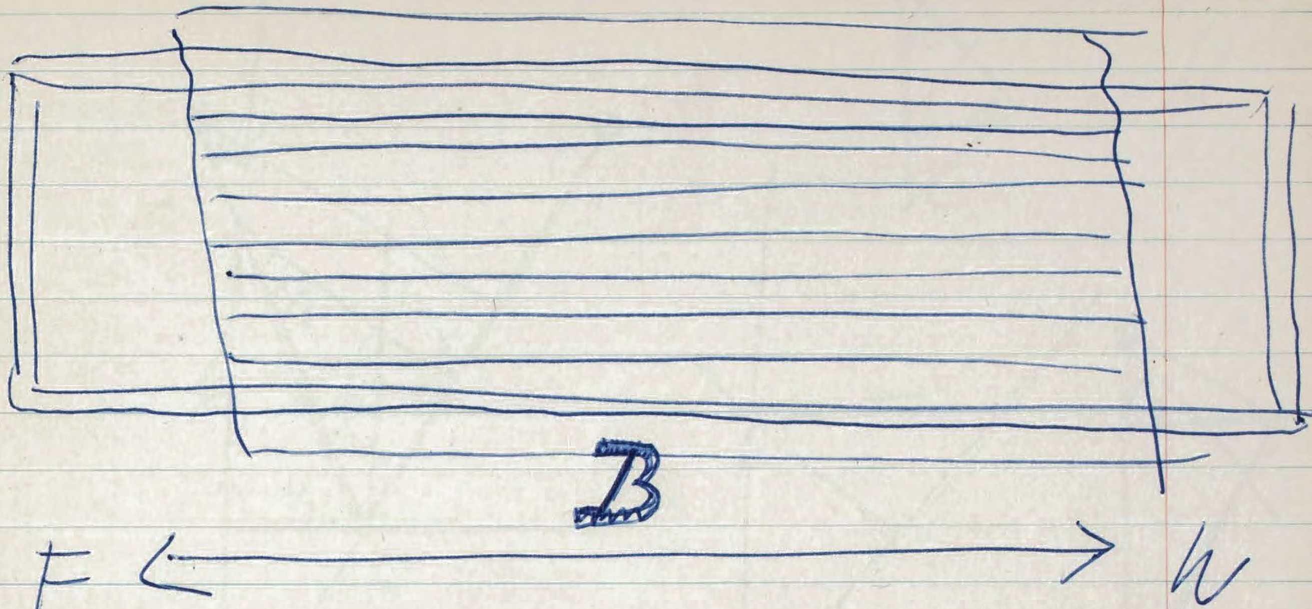
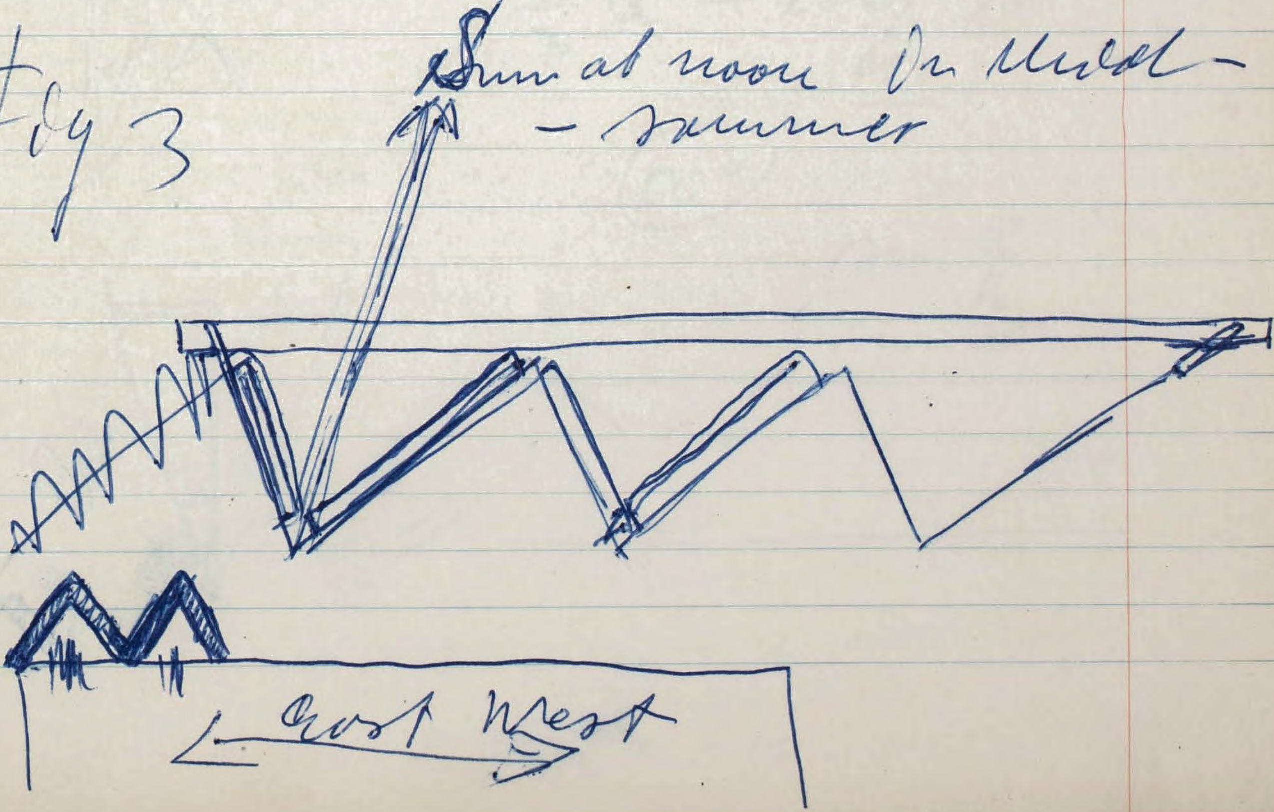
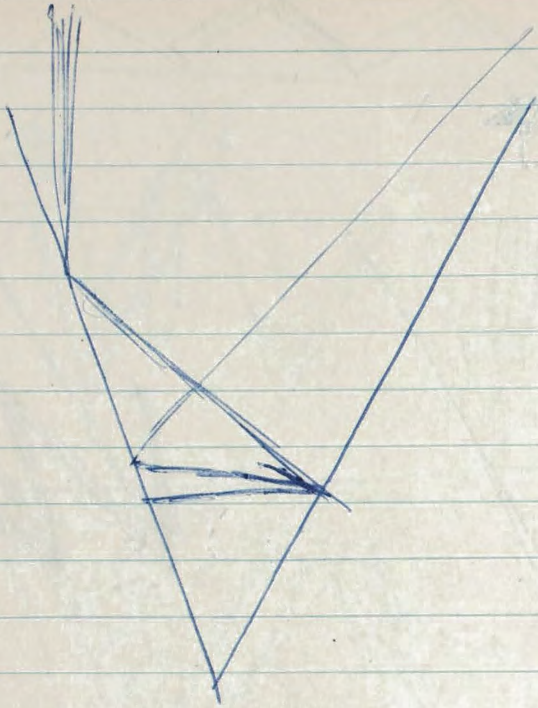


Fig 3





at 5% CO_2 $\frac{1}{1000}$ of $NaHCO_3$

at pH 6

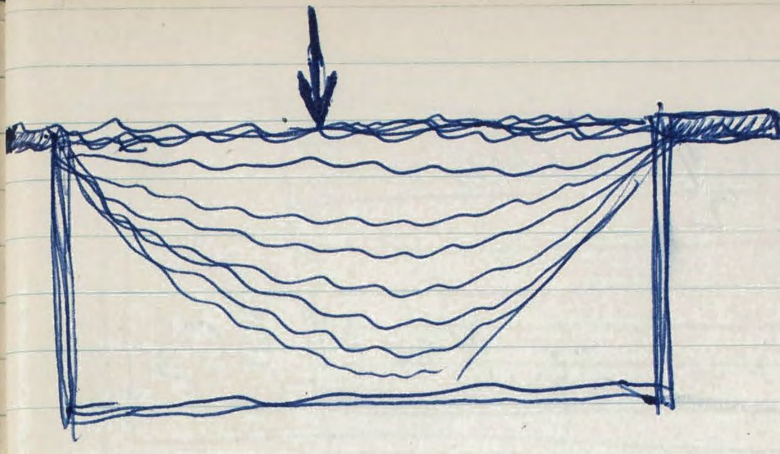
~~$\frac{1}{3} \times 10$~~

$\frac{3}{100}$ ~~per~~ % CO_2 $\frac{3}{10^5}$ Mol of $NaHCO_3$

1000 cc CO_2 gas / liter water

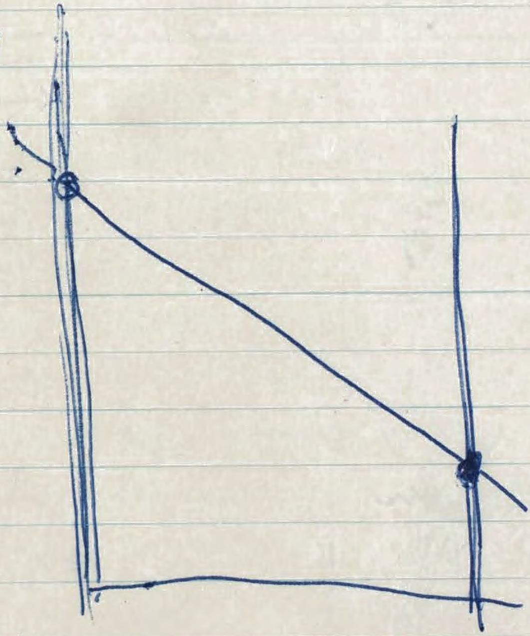
is $\frac{1}{22}$ of Mol at Atm pressure

$$\frac{3 \times 10^{-4}}{22} = \frac{3}{2.2} 10^{-5} \text{ Mol}$$



page 25
Manometric techniques
Umbreit
6

2567



1.) $NaHCO_3$

5 to 7

4.5 is best?

$\frac{3}{100}$ % CO_2 in air

$\frac{1}{200}$ Mol ?

at 5 % CO_2

0.001

Mol of

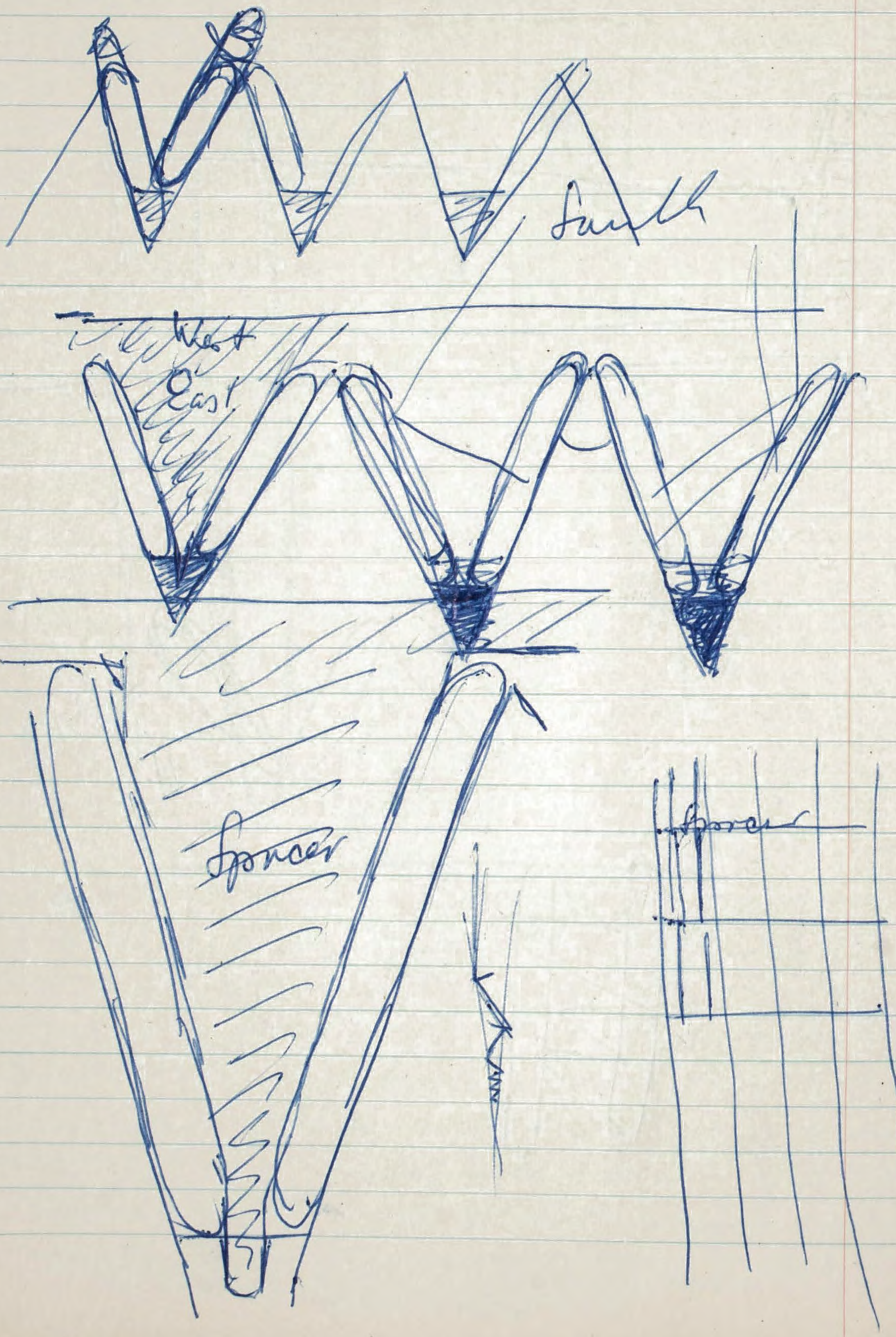
$NaHCO_3$

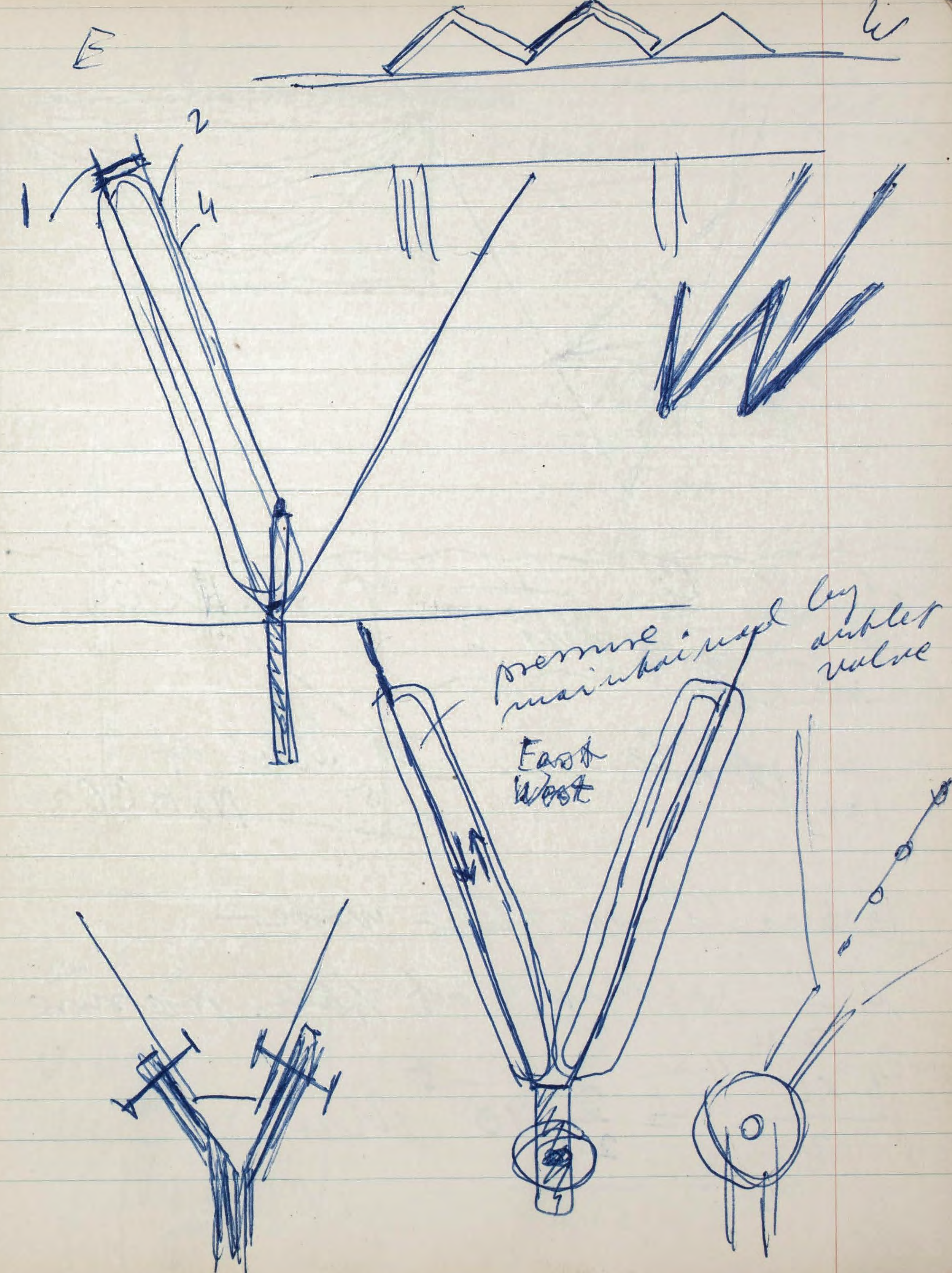
PH 6 //

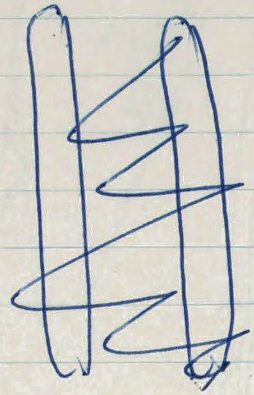
1000c

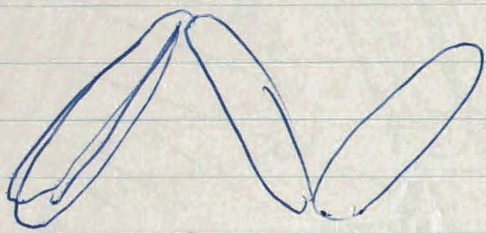
$\frac{3}{184}$ $\frac{1}{22}$ of a mol

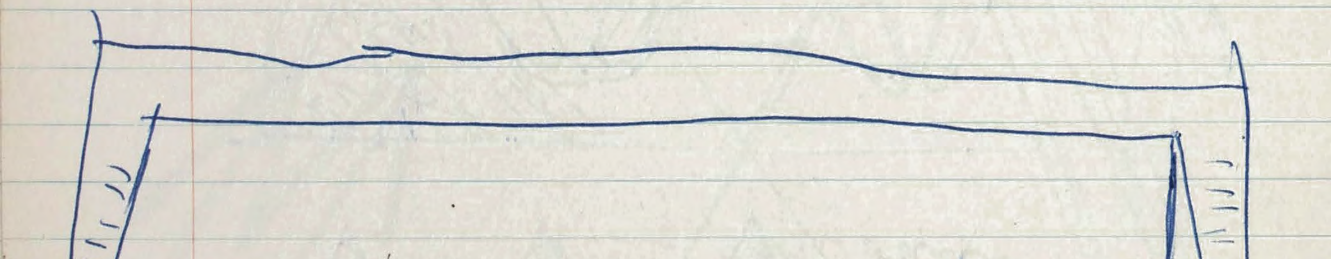
$\frac{3}{2.2}$ $\frac{1}{10^{-5}}$

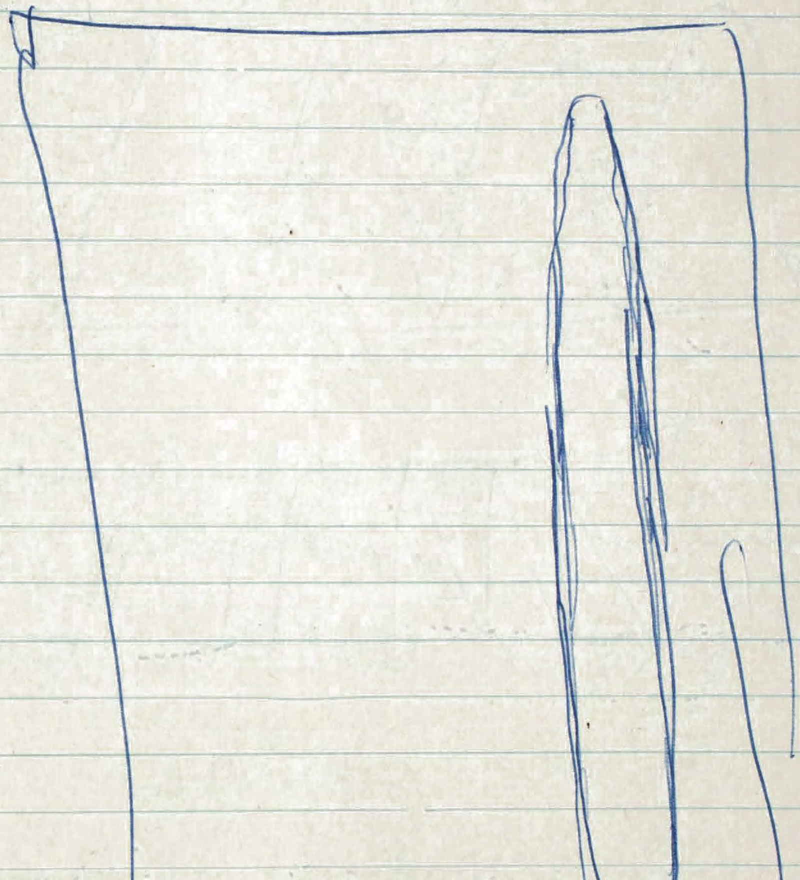

South
West
East
Spencer


E
W
1
2
4
pressure maintained by outlet valve
East
West









Sunlight Chlorella

Jack Myers Univ of Texas Austin Texas Algae.

1 sunlight degrees to saturate

10 use $\frac{1}{50}$ of sunlight

Brecke & Gaffron chopped light

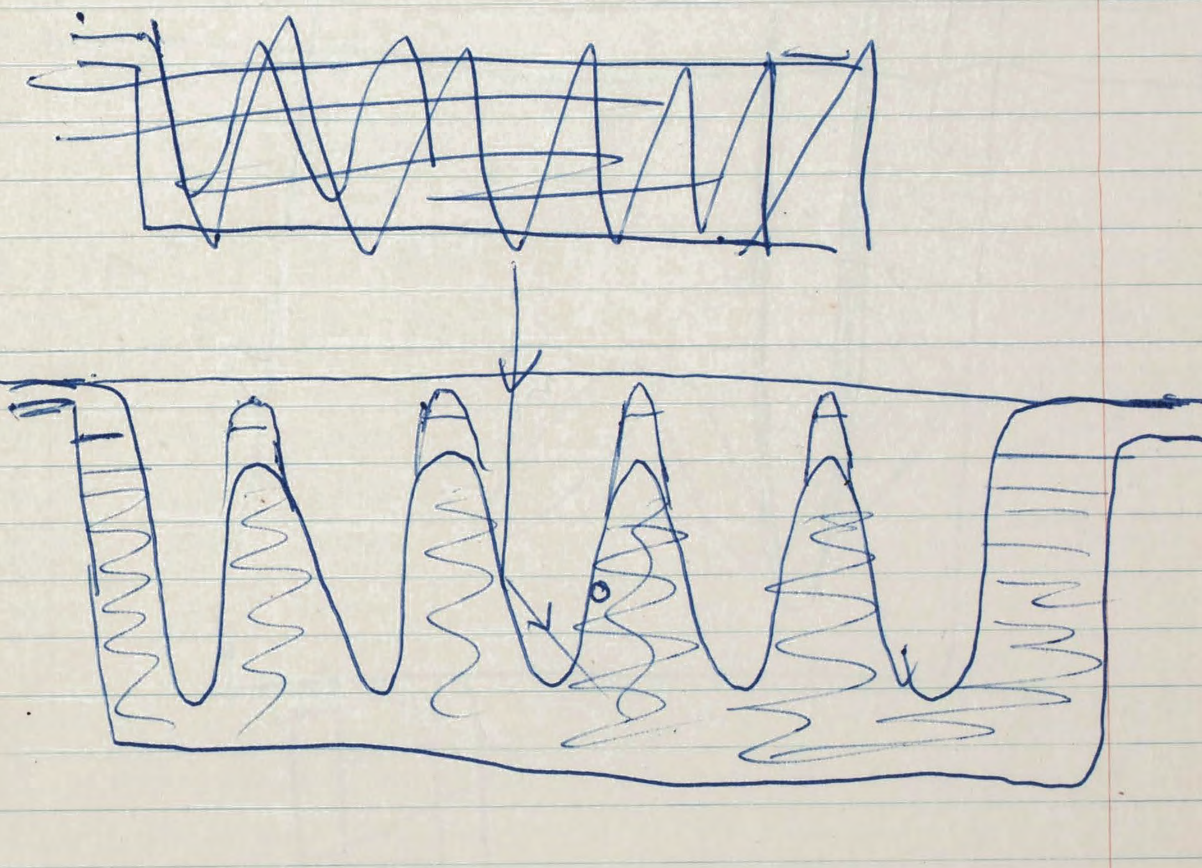
CO_2 tension over Na_2CO_3-NaHOH

Umbreit. ~~[illegible]~~ Manometric methods

Maximum 1 hr 2 cc pr[illegible] per liter
cell size 3 10^{-11} cc
1 cm 1/2 value for light

Trace elements

Nitrate (at pH 4) or glycine acid



Read Cowdry Problems of aging
1942.

Dobzhansky Genetics and the origin of Species

For transformation:
Ann. of Exp Medicine Apr/49
H. Taylor
Mutand and Austrian

Kelner A. 90. Duff Str.
~~Wa~~ Watertown Mass.

Landauer

E-2

Algae

1950