SEWALL WRIGHT TAUGHT ME

3. PHYSIOLOGICAL GENETICS

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EUSTON GROVE PRESS

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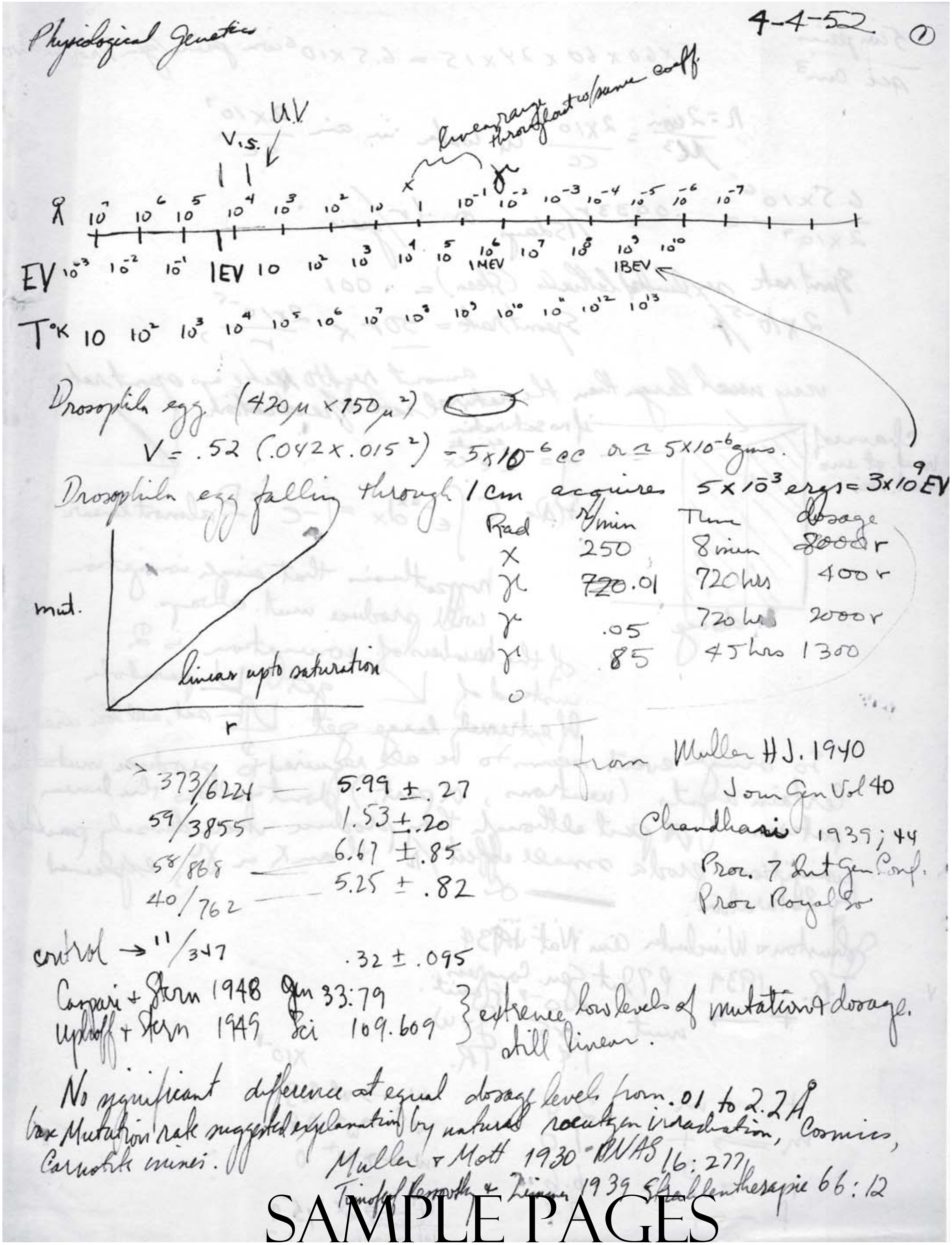

Physiological Genetics

4-4-52 ①

V.S. U.V

linear range throughout w/same coeff.

x γ

λ 10^7 10^6 10^5 10^4 10^3 10^2 10 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7}

EV 10^{-3} 10^{-2} 10^{-1} 1EV 10 10^2 10^3 10^4 10^5 10^6 1MEV 10^7 10^8 10^9 1BEV 10^{10}

T°K 10 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9 10^{10} 10^{11} 10^{12} 10^{13}

Drosophila egg ($420\mu \times 150\mu^2$)

$V = .52\ (.042 \times .015^2) = 5 \times 10^{-6}$ cc or $\simeq 5 \times 10^{-6}$ gms.

Drosophila egg falling through 1 cm acquires 5×10^{-3} ergs $= 3 \times 10^9$ EV

mut.

linear upto saturation

r

Rad	r/min	Time	dosage
x	250	8 min	~~8000~~ r
γ	~~720~~ .01	720 hrs	400 r
γ	.05	720 hrs	2000 r
γ	.85	45 hrs	1300
o			

373/6224 — 5.99 ± .27
59/3855 — 1.53 ± .20
58/868 — 6.67 ± .85
40/762 — 5.25 ± .82

from Muller H.J. 1940 Journ Gen Vol 40
Chandhari 1939; 44
Proc. 7 Int Gen Conf.
Proc Royal Soc

control → 11/347 .32 ± .095

Caspari + Stern 1948 Gen 33:79
Uphoff + Stern 1949 Sci 109.609
} extreme low levels of mutation + dosage. still linear.

No significant difference at equal dosage levels from .01 to 2.2 Å

Low Mutation rate suggested explanation by natural roentgen irradiation, Cosmics, Carnotite mines.

Muller + Mott 1930 PNAS 16:277

Timofeeff Ressovsky + Zimmer 1939 Strahlentherapie 66:12

$\frac{5 \text{ ion pairs}}{\text{sec cm}^3}$ $5 \times 60 \times 60 \times 24 \times 15 = 6.5 \times 10^6$ ion pairs/gen Pros. in air

$\frac{R = 2 \text{ ion}}{\mu^3} = \frac{2 \times 10^{12}}{cc}$ in water in air $\frac{2 \times 10^9}{cc}$

$\frac{6.5 \times 10^6}{2 \times 10^9} = .0033r/15$ days or $.1r$/year.

Spont rate sex linked lethals (Stern) = .001
$2 \times 10^{-5}/r$ Spont rate $= 50r \times \frac{2 \times 10^{-5}}{r}$,

very much larger than the ~~natural rate of radiation~~ amount need to make up spont rate.

if no saturation exists
$y = Ce^{-cx}$

$P(d) = C\int e^{-ax}dx = 1 - e^{-cD}$ almost linear

hypothesis that single ionization would produce mut. always.

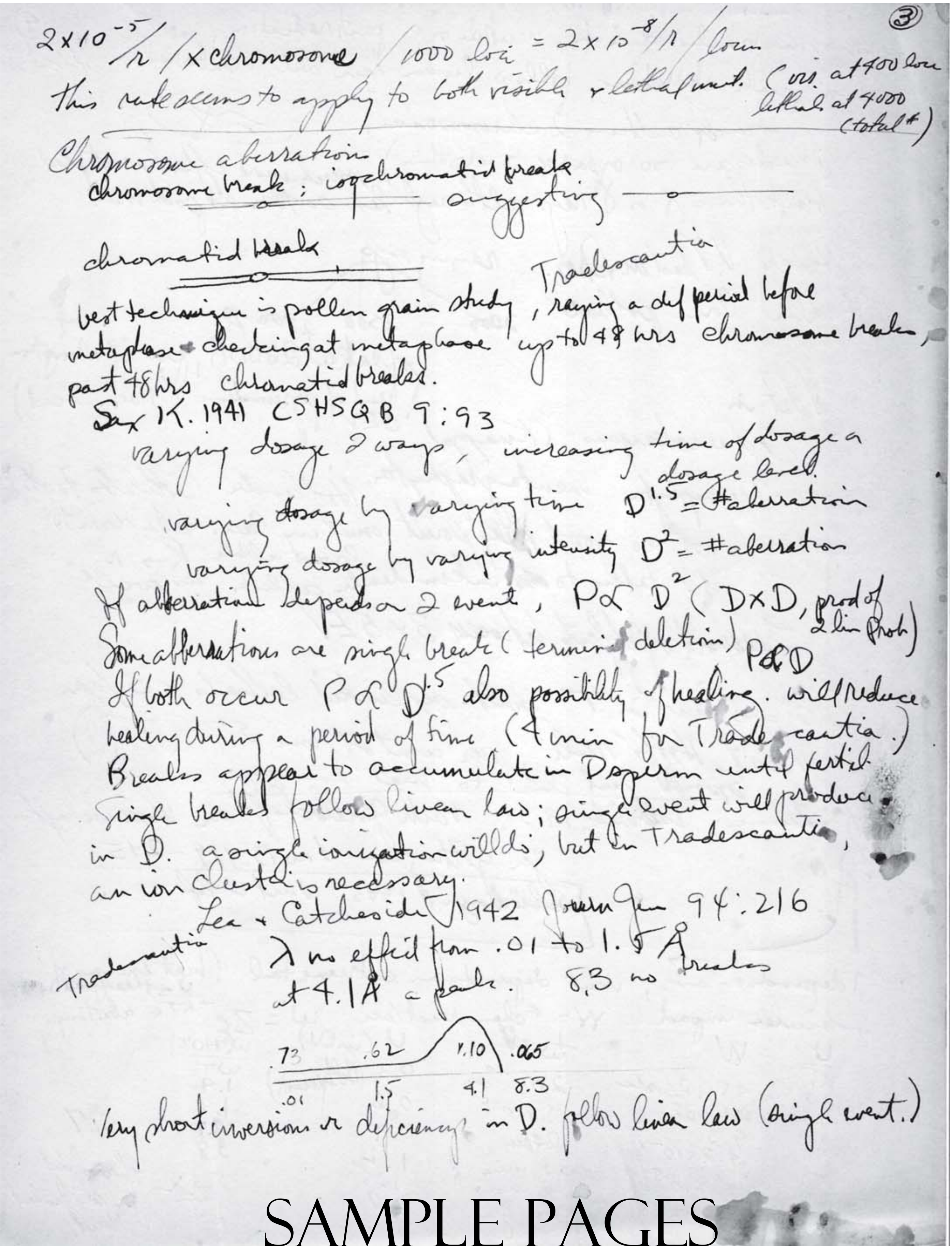
If the numbers of ionization is 2 instead of ⌞ get ⌞ parabola
If extremely large get ⌞ sat, all loci used up

So single event seems to be all required to produce mutation. Certain agents (neutrons, α part.) don't follow the linear pattern. α part although they produce more densely packed ionization prod a smaller effect/r than X or γ, explained by Saturation. ——— α

Johnston & Winchester Am Nat 1934
T.R. 1939 P 7 Int. Gen. Congress.

		$\times 10^{-8}$/r/unit.
+ → mut	.85	} + W
	1.4	T.R.

			$\times 10^{-8}$
+ → m	2.4	$w \to w^e$	0.3
m → +	1.0	$w^e \to w^+$	0.8
+ → f	6.6	$w \to w^+$	0
f → +	[illegible]	$w^+ \to w^x$	5.[illegible]
		$w \to w^x$	1.2



③

2×10^{-5}/r / X chromosome / 1000 loci $= 2\times10^{-8}$/r / locus

this rate seems to apply to both visible & lethal mut. (vis. at 400 loci, lethal at 4000 (total #))

Chromosome aberration

chromosome break; isochromatid breaks

suggesting

chromatid breaks

Tradescantia

best technique is pollen grain study, raying a dif period before metaphase & checking at metaphase up to 48 hrs chromosome breaks, past 48 hrs chromatid breaks.

Sax K. 1941 CSHSQB 9:93

varying dosage 2 ways, increasing time of dosage & dosage level.

varying dosage by varying time $D^{1.5}$ = #aberration

varying dosage by varying intensity D^2 = #aberration

If aberration depends on 2 event, $P \propto D^2$ ($D\times D$, prod of 2 lin prob)

Some aberrations are single break (terminal deletion) $P \propto D$

If both occur $P \propto D^{1.5}$ also possibility of healing. will reduce healing during a period of time (4 min for Tradescantia.)

Breaks appear to accumulate in D sperm until fertil.

Single breaks follow linear law; single event will produce in D. a single ionization will do, but in Tradescantia, an ion cluster is necessary.

Lea & Catcheside 1942 Journ Gen 94:216

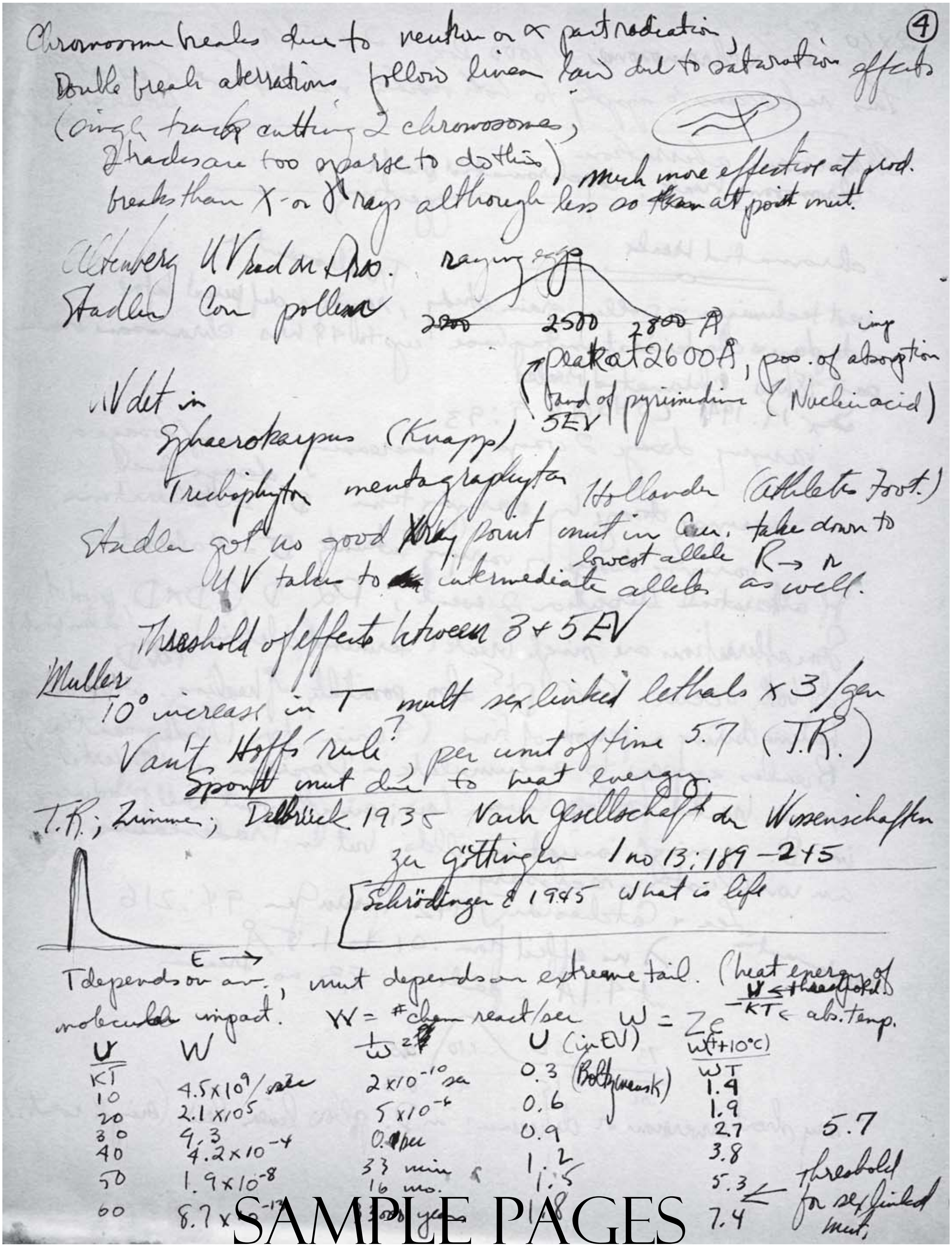
Tradescantia λ no effect from .01 to 1.5 Å

at 4.1 Å a peak. 8.3 no breaks

.73 .62 1.10 .065

.01 1.5 4.1 8.3

Very short inversions or deficiency in D. follow linear law (single event.)



(4)

Chromosome breaks due to neutron or α part radiation,
Double break aberrations follow linear law due to saturation effects
(single track cutting 2 chromosomes,
γ tracks are too sparse to do this) much more effective at prod.
breaks than X- or γ rays although less so than at point mut.

Altenberg UV had on Dros. raying eggs
Stadler Corn pollen

2200 2500 2800 Å

peak at 2600 Å, pos. of absorption band of pyrimidine (Nucleic acid)
5EV

UV det in
Sphaerocarpus (Knapp)
Trichophyton mentagrophytes Hollander (Athlete Foot.)
Stadler got no good X-ray point mut in Corn, take down to lowest allele R → r
UV takes to intermediate allele as well.
Threshold of effects between 3 + 5 EV

Muller
10° increase in T mult sex linked lethals × 3/gen
Van't Hoff's rule? per unit of time 5.7 (T.R.)
Spont mut due to heat energy.
T.R.; Zimmer; Delbrück 1935 Nach Gesellschaft der Wissenschaften zu Göttingen 1 no 13: 189–245
Schrödinger 1945 What is life

E →

T depends on av., mut depends on extreme tail. (heat energy of molecular impact. W = # chem react/sec $W = Ze^{-U/KT}$ U ← threshold, T ← abs. temp.

U/KT	W	1/ω 2πf	U (in EV) (Boltzmann K)	W(T+10°C)/WT	
10	4.5×10⁹/sec	2×10⁻¹⁰ sec	0.3	1.4	
20	2.1×10⁵	5×10⁻⁶	0.6	1.9	
30	9.3	0.1 sec	0.9	2.7	5.7
40	4.2×10⁻⁴	33 min	1.2	3.8	
50	1.9×10⁻⁸	16 mo.	1.5	5.3	← threshold for sex linked mut.
60	8.7×10⁻¹³	33000 yrs	1.8	7.4	

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