[17] Anfinsen, C. B., R. R. Redfield, W. L. Choate, J. Page, and W. R. Carroll, *J. Biol. Chem.*, **207**, 201 (1954).

[18] Although large numbers of ribosomes sediment with nuclei and mitochondria, most of these ribosomes are not actually bound to these structures. Indeed, if nuclei and over 95% of the mitochondria are removed by centrifuging at 8500 g_{max} for 10 min,[19] considerable quantities of ribosomes whose size distribution is nearly identical to that of those from Fractions I and II can be recovered in the pellet obtained by further centrifugation at the speed conventionally used to prepare the postmitochondrial supernatant fraction (20,000 g_{max} for 20 min).

[19] Schneider, W. C., and G. H. Hogeboom, *J. Biol. Chem.*, **183**, 123 (1950).

[20] Britten, R. J., and R. B. Roberts, *Science*, **131**, 32 (1960).

[21] Increasing the concentration of ribosomes layered onto the gradient did not substantially change the pattern of polyribosome size distribution but did result in some loss of resolution of the individual peaks.

[22] The amount of the lighter peak varied considerably.

[23] Tissières, A., J. D. Watson, D. Schlessinger, and B. R. Hollingworth, *J. Mol. Biol.*, **1**, 221 (1959).

[24] Ribosomes from Fractions I and II gave similar labeling patterns.

[25] Allen, D. W., and P. C. Zamecnik, *Biochim. Biophys. Acta*, **55**, 865 (1962).

[26] During this brief exposure to puromycin there was a striking breakdown of polyribosomes from all cell fractions to single ribosomes, far more extensive than that observed when the aggregates were simply warmed for an even longer period.

[27] Noll, H., T. Staehelin, and F. O. Wettstein, *Nature*, **198**, 632 (1963).

[28] Staehelin, T., F. O. Wettstein, H. Oura, and H. Noll, *Nature*, **201**, 264 (1964).

[29] Henshaw, E. C., T. B. Bojarski, and H. H. Hiatt, *J. Mol. Biol.*, **7**, 122 (1963).

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*MEIOTIC CONJUNCTIVE ELEMENTS NOT INVOLVING CHIASMATA**

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Chromosomes united as bivalents or multivalents at the first meiotic division may be said to be *conjoined*. The special term, and its noun and adjective, refer only to the union, implying nothing about the means. As conjunction is necessary for the coorientation of most chromosomes at meiosis, hence for segregation, conjunctive mechanisms become prime elements in the interpretation of meiosis. Fully a score of such mechanisms has been claimed or suggested by cytologists, including special forces, particular genic or chromosomal products, deviant coiling behavior and torsion, the cohesion of chromosomal organelles such as the kinetochore or nucleolus organizer, special properties of "heterochromatin," and so on. Nevertheless, but one means of conjunction has been proved, closely studied, and featured in the interpretation of meiosis, namely, chiasmata that arise from crossing over.[1]

The sort of conjunction examined here almost certainly occurs at meiosis in both sexes of *Drosophila melanogaster*,[2] but the rarity or absence of meiotic crossing over in the male, plus the ease with which chromosomes in spermatocytes may be studied microscopically, greatly simplify analysis. I therefore deal only with the formation of bivalents and multivalents by the sex chromosomes at spermatogenesis; a second paper will consider evidence for conjunction of this second type at meiosis in oogenesis.

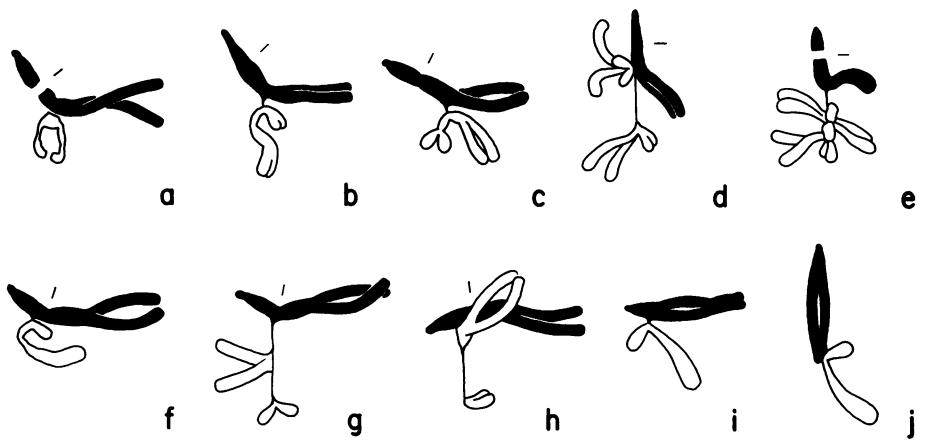

FIG. 1.—Conjunction at spermatogenesis of a normal X- (in solid black) with Y-chromosomes (in outline). Conjunctions *distal* (to genetic right) of nucleolus organizer: (*a*) with ring-Y (Y^{lc}); (*b*) in Y^S; (*c*) in Y^L; (*d*) with two Y's; (*e*) with three Y's (reversal of Fig. 24 in ref. 5). Conjunctions *proximal* to nucleolus organizer in: (*f*) Y^S; (*g*) Y^L; (*h*) Y^L. Expected conjunctions in $In(1)bb^{def}/Y$ *if* bb^{def} conjoins: (*i*) proximally; (*j*) distally. All are freehand sketches: X with kinetochore to left or above, and nucleolus organizer, or its approximate locus (*d*, *h*), indicated by a short bar above or to right of site.

XY-Conjunction at Spermatogenesis.—Though X- and Y-chromosomes of *Drosophila melanogaster* show a surprising degree of differentiation at prophase in giant larval neuroblasts, at late pro- and metaphase-1 of spermatogenesis they are isopycnotic, small (length of X $\approx 2^+ - 5^+ \mu$, length of Y $\approx 2 - 4\ \mu$), and compact, revealing few features that serve as reference points.[3] In acetic-orcein preparations these are the two arms of Y(Y^{Short}, length $\approx 0.8 - 1.5\ \mu$; Y^{Long}, length $\approx 1 - 2^+\ \mu$), the approximate locus of junction of the euchromatic right and heterochromatic left halves (*viz.*, Xe and Xh) of the rod-shaped X[4] and, rather rarely, the nucleolus organizer in Y^S or that in the mid-region of Xh. Attained resolution ($\approx 0.3 - 0.4\ \mu$) is therefore inadequate for demonstration of more than the large features of XY-conjunction which follow.

In XY-bivalents: (1) Y always conjoins somewhere within the proximal half of X, namely, within Xh, and never within the euchromatic half (Figs. 1*a–h*); (2) Xh conjoins with Y either in Y^S (most frequently), or in Y^L, but not simultaneously with both Y^S (Figs. 1*b*, *f*) and Y^L (Figs. 1*c*, *g*, *h*); (3) conjunction occurs to each side of the nucleolus organizer in Xh, but not in the distal third of Y^S nor in the distal half of Y^L (Figs. 1*a–h*); (4) a region to one side (or the other) of the nucleolus organizer in Xh may conjoin with either arm of Y (Figs. 1*b*, *c*; 1*f–h*); —it is as though each general region of conjunction in Xh and Y shares some common property; nevertheless, (5) conjunction does not involve a sizeable (or measurable) length in either Xh or Y; rather the visible region of actual union is always smaller than whatever segment of Xh, Y^S, or Y^L is involved, the connection between the chromosomes often appearing threadlike (Figs. 1*b–g*). Furthermore, it is remarkable that in X/2Y and X/3Y males: (6) all sex chromosomes conjoin nearly invariably to form a single multivalent (Figs. 1*d*, *e*), and (7) there appears to be but one region of conjunction within Xh in any given multivalent, all the Y-chromosomes customarily being associated to the same (but either) side of the nucleolus organizer in Xh, and sensibly at but one point (Figs. 1*d*, *e*).[5]

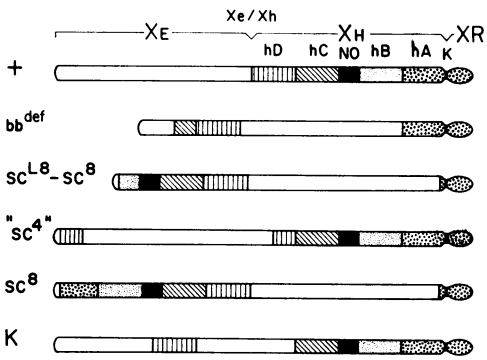

FIG. 2.—Diagram of main morphologic divisions of normal (+) and rearranged X-chromosomes (see text).

The question therefore arises: is the conjunctive capacity of Xh at spermatogenesis discontinuously expressed, perhaps being restricted to certain regions or organelles, or is it a general and uniform property throughout Xh, perhaps an aspect of "heterochromatin"?

If conjunction with Y at spermatogenesis involves a property *not* common to all regions of Xh, then any conjunctively incompetent portion must, at largest, be smaller than half of Xh. This is so because Xh is halved by the nucleolus organizer, and conjunction occurs interstitially within each half. Convincing demonstration of an incompetent region (if such exists) therefore requires a considerable improvement in resolution. Fortunately this can be brought about by cytogenetic means.

Is All of Xh Conjunctively Competent at Spermatogenesis?—Xh, at early prophase in giant neuroblasts of larvae, is broken into four main segments (hA through hD), two to each side of the nucleolus organizer (NO) (see + in Fig. 2). The region from the euchromatic-heterochromatic junction (Xe/Xh) to the right end of X may thus be represented:

Xe/Xh, hD, hC, NO, hB, hA, **k**, XR

with **k** and XR denoting the kinetochore and right arm, respectively. Certain deletions and rearrangements with breakpoints in Xh have been mapped in relation to these details (bb^{def} to K, Fig. 2).[4] As will become clear, they make it possible to circumvent the limitations of resolution and gain the microscopic demonstration at spermatogenesis that is sought.

Suppose that the conjunctive property is in fact *uniformly* distributed in Xh; then any sizeable part of Xh that remains structurally intact (whether displaced or not), following an induced rearrangement of the chromosome, would be expected to conjoin with Y in at least some first spermatocytes. The bobbed-deficient inversion, $In(l)bb^{def}$, may serve as a first test of the conjecture. This inversion rotates roughly the distal third of Xh (namely, the distal half of hC and all of hD) to near the distal tip of the X-chromosome, with almost the proximal quarter of Xh (namely, hA) remaining in position adjacent to the kinetochore. The deficiency encompasses approximately half of Xh, namely, most or all of hB (containing the bobbed locus), NO, and nearly half of hC (Fig. 2). Therefore, if conjunction is a generalized property of Xh at spermatogenesis, then both proximal and distal conjunctions of $In(l)bb^{def}$ with Y should occur (Figs. 1*i*, *j*).

Only one of the two configurations is, in fact, found at spermatogenesis. When $In(l)bb^{def}$ conjoins with Y, it does so solely with that portion of Xh now placed distally, the bivalent coorienting lengthwise along the axis of the first meiotic spindle (Figs. 3*a*, *b*). In the presence of two Y-chromosomes, $In(l)bb^{def}$ forms a trivalent, and here too conjunction is limited to the distal end of the chromosome

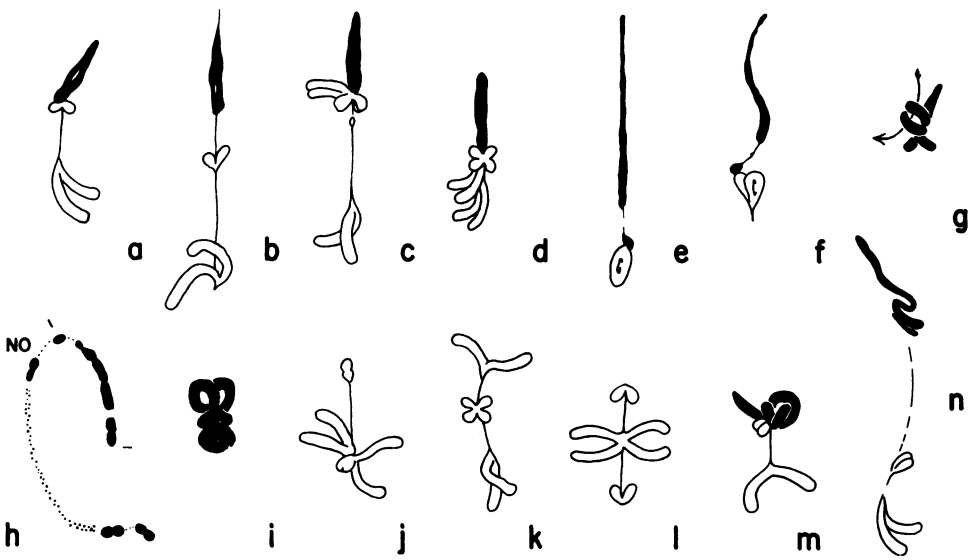

FIG. 3.—(*a*, *b*) In(1)bb^{def}/Y; (*c*, *d*), In(1)bb^{def}/2Y; (*e*, *f*), In(1)sc^{L8}-sc^{8}/Y^{lc} (a ring-shaped Y-chromosome); (*g*) In(1)K/O—arrow passes through loop (sister chromatids of Xe have separated); (*h*) Y^{S}X·Y^{L}-chromosome, neuroblast prophase: NO, nucleolus organizer; "Y^{S}" at distal (lower) end; Y^{L} set off by bars; (*i*) self-conjunction in Y^{S}X·Y^{L}; (*j*) YY-bivalent (Y^{L} conjoined with Y^{S}?); (*k*) YY-bivalent, Y^{S} conjunctions; (*l*) YY-bivalent, Y^{L} conjunctions; (*m*) In(1)K/Y; (*n*) separation of In(1)K from Y at anaphase-1. Except for (*i*), conventions as in Fig. 1.

(Figs. 3*c*, *d*). Taking these observations together with those on the structurally normal X-chromosome summarized above, it appears that (1) the piece of Xh which is inverted to a distal position in In(1)bb^{def} possesses a conjunctive capacity not present (or not expressed) in the large proximal piece that remains; (2) the kinetochore (as Gershenson concluded[6]) and XR are both without conjunctive capacity at spermatogenesis; and (3) the deficiency in this chromosome has eliminated at least one additional conjunctive region that lies close to the nucleolus organizer in the proximal half of Xh.

The three inferences can be tested. If (1) and (2) are valid, there must be a class of deleted X-chromosomes (ranging in size from greater than **k** + XR to less than hB + hA + **k** + XR) which fail to give regular segregation at spermatogenesis. Of 40 X-ray-produced, simple deletions of Xe, marked only by the wild-type genes from the left tip of Xe to the left of prune (viz., to left of map locus 0.8) but containing the kinetochore of X, XR, and varied lengths of Xh, ten give random segregation in Y^{S}X·Y^{L}/del males.[7] The same ten deletions do not increase nondisjunction of X- and Y-chromosomes in X/Y/del males above the very low control values of X/Y males. In these two sorts of test crosses, the remaining 30 deletions give 99–100 per cent segregation from the Y^{S}X·Y^{L}-chromosome, and 15–45 per cent induced XY-nondisjunction. All of the *segregating* deletions are greater than the fourth chromosome in length, whereas all ten of those behaving as random fragments are as small as chromosome-4, or smaller. It is the case, then, that XR, **k**, and at least most of hA are without conjunctive (hence segregative) competence so far as the Y-chromosome is concerned at spermatogenesis. It is unlikely, therefore, that the conjunctive behavior of the remainder of Xh can usefully be attributed to a

special property of "heterochromatin." That the distal portion of Y^S, and the distal half of Y^L are alike conjunctively inactive at spermatogenesis, yet classical examples of "heterochromatin," lends emphasis to this conclusion.

The third inference that there is at least one conjunctive region in Xh, lying between NO and **k**, may be tested by the bivalents formed by In(l)sc^{L8}-sc^8. This X-chromosome, derived by crossing over between Ins(1)sc^{L8} and sc^8, has its uninverted proximal portion of Xh represented by only an immeasurably small length of hA adjacent to the kinetochore, plus **k** and XR. The inverted portion of Xh includes the *bobbed* region to the immediate genetic right of NO (lying within a piece that is approximately half of hB), NO, and all of hC and hD. Most of hA and roughly the proximal half of hB have been deleted (Fig. 2). Now *if* conjunction occurs within the inverted distal fragment of hB, then at least some of the XY-bivalents displaying the nucleolus organizer in X must show this organelle lying *between* the conjoined Y-chromosome and the kinetochore of X. Such is the case.

In(l)sc^{L8}-sc^8, like bb^{def}, regularly forms a linear bivalent, Y conjoining exclusively at one or another of those parts of Xh that lie distally in this chromosome. These bivalents clearly include some in which the distal fragment of hB is the locus of conjunction (Figs. 3*e*, *f*). The structure of the 7 smallest of the 30 segregating deletions is also in agreement with the conclusions that there is indeed a conjunctive element in hB, and that the nucleolus organizer is not importantly involved in conjunction at spermatogenesis. These seven lack NO, are larger than chromosome-4, and consist of at least part of hB plus hA, **k**, and XR. However large, the fragment of hB in sc^{L8}-sc^8 which conjoins with Y is smaller than the inactive proximal piece of In(l)bb^{def}, and decidedly smaller than some of the ten incompetent deletions. It is likely, therefore, that something other than absolute size determines whether or not a section of Xh (i.e., "heterochromatin") can undergo conjunction with Y at spermatogenesis.

Can Parts of Xh Conjoin Intrachromosomally?—As regions to each side of the nucleolus organizer in Xh may be conjoined in different spermatocytes with sensibly the same site in Y, it may be wondered whether they would conjoin intrachromosomally were it mechanically feasible. Rearrangements such as Ins(l)sc^4, w^{m4}, rst^3 (collectively represented as "sc^4" in Fig. 2),[8] and K, and crossover products such as sc^8-sc^4, have a long length of Xe between elements of Xh (Fig. 2), and it is among inversions of this class at least that looped, foldback patterns would be anticipated if active sites of Xh can conjoin intrachromosomally. Such foldbacks do occur with all of the above chromosomes. Conversely, they are *not* found where all the conjunctive sites active at spermatogenesis lie to the same side of the inversion breakpoint (e.g., in Ins(l)bb^{def}, sc^{L8}, sc^8, sc^{S1}, sc^4-sc^8, w^{m4}-sc^8, rst^3-sc^8, sc^{L8}-sc^8, etc.). Though the presence of the multisited Y-chromosome makes ambiguous the interpretation of a bivalent or multivalent with an X-chromosome foldback, a foldback can be produced by the uncomplicated conjunction of two widely separated sites of Xh alone. Thus, conjoined foldbacks regularly occurred in an In(l)K/O cyst of first spermatocytes that came to being by gonial loss of the Y-chromosome within an otherwise normal In(l)K/Y testis (Fig. 3*g*).[9]

It is not clear whether there is a saturation effect on a conjunctive region, namely, an intrinsic limitation to the number of elements that can mutually be involved at a single point of association. Bivalents of In(l)K/Y males show Y conjoined at a

point not separable microscopically from that at which the loop in X is closed (Fig. 3*m*). Furthermore, disjoining anaphase-1 configurations in which the loop in X is opening are compatible with the notion that one region in Y and two regions in X were all involved in simultaneous conjunction (Fig. 3*n*). Appropriate In(l)X/2Y combinations also give associations of a looped X with two Y-chromosomes that suggest multiple conjunctions at a single region. But even if such multiple conjunctions do in fact occur at a single conjunctive site in Xh, no configuration that I have found would *require* for its interpretation the assumption that a single conjunctive element in Xh can unite with more than two others.

Nevertheless, it is likely that in the male a conjunctive region in Xh *can* conjoin with more than two other regions. In multivalents, whether formed in X/del/Y, X/2Y, or X/3Y spermatocytes, conjunction in Xh is almost invariably to one side of the nucleolus organizer or the other, and not to both sides (Figs. 1*d*, *e*).[5] Furthermore, no clear case has so far been recognized of a Y-chromosome as the middle member of a trivalent, namely, with an independent conjunction in each arm, despite search. It is as though only one in a set of potential conjunctive regions within each chromosome becomes activated in a given spermatocyte, and the first chromosome to be activated accumulates all practicable and competent partners at that region. If so, activation is probabilistic, with the inherent likelihood of activation in hD + hC and Y^S greater than in hB + hA and Y^L, respectively. The intercalation of Xe between potential conjunctive regions may be supposed to interrupt the implicit intrachromosomal control.

Can YY-Bivalents Form?—Gershenson[10, 6] concluded from his genetic studies that the rightmost end of the heterochromatic region of X is conjunctively inefficient as compared with a region in the genetically leftmost half, and that univalent Y-chromosomes and YY-bivalents must be frequent in In(l)sc^4-sc^8/Y and sc^4-sc^8/2Y spermatocytes. These inferences are borne out cytologically. When Xh is reduced to hD, or to a part of hD, as in Ins(l)sc^4-sc^8, sc^4-sc^{S1}, w^{m4}-sc^8 and rst^3-sc^8, a 30–40 per cent failure of conjunction may occur in spermatocytes having but one Y-chromosome, and up to 95 per cent YY-bivalents (with X univalent) are formed in X/2Y spermatocytes.

The univalent Y-chromosome shows no conjunction between its two arms at proto metaphase-1 and, like the univalent X-chromosome, it does not tend to be "lost" at spermatocytic meiosis. In general, each univalent is distributed to a pole at anaphase-1 and divides at anaphase-2, whether or not it earlier segregated in relation to its formal but independent partner. The YY-bivalents coorient and disjoin just as any other bivalent. The associations are in one or the other arm only (Figs. 3*j*, *k*, *l*); they may draw out to threadlike connections, and are predominantly conjunctions of Y^S with Y^S. In no case has it been necessary to conlude that greater than one region in either Y-chromosome was involved in an association. The regularities of behavior of the conjunctive regions in Xh and Y therefore seem closely similar.[11]

Discussion.—The union at the first meiotic division of spermatogenesis of normal or inverted X-chromosomes with one or more Y-chromosomes, of the In(l)K-chromosome with itself in the absence of a partner, and of two Y-chromosomes when their opposed X lacks certain parts of Xh, may all be accounted for by supposing that there are particular, localized, cohesive elements, or "collochores,"[12] in Xh and

Y. They may be conceived as chromosomal organelles analogous to a kinetochore or a nucleolus organizer, and, like them, perhaps divisible into functionable fractions.

The heterochromatic half of the X-chromosome of *Drosophila melanogaster* is thus conceived as differentiated with respect to its conjunctive capabilities just as it evidently is with respect to its other properties.[4] Conjunction of the sort dealt with here cannot be simply a general attribute of "heterochromatin," something *sui generis*. Gershenson[6] reached a somewhat similar conclusion, long ago, in a wonderful, pioneering study. His findings and mine, however, agree only partially, for the "blocks" to which he gave such interpretative emphasis have proved illusory.[15, 4]

Although collochores are hypothetic, for no characteristic morphologic features have been found that visibly differentiate their supposed sites in Xh or Y, they may prove akin to those proximal elements that are claimed to unite sister chromatids in the region of a divided kinetochore at mitotic metaphase,[13] exercising, perhaps, a cohesive role at mitosis as well as at meiosis. If so, they may serve as effective and ubiquitous meiotic conjunctive devices, quite generally supplementing or, in the absence of crossing over, supplanting the chiasma in its conjunctive role.[14]

Summary.—The large features of chiasmaless conjunction at spermatogenesis by X- and Y-chromosomes in normal sequence are specified [items (1)–(7), p. 1249]. It is shown that conjunctive competence at spermatogenesis is not a property uniformly distributed throughout the heterochromatic region of X, nor throughout the limbs of Y. At least the proximal fourth of the heterochromatic region of X, the right limb of X, the distal third of Y^S, the distal half of Y^L, the kinetochores, and very likely the nucleolus organizers, are conjunctively inert with respect to each other at spermatogenesis. The conjunctive properties are viewed as expressions of mappable, linear differentiations within the heterochromatic region, not as aspects of "heterochromatin."

Herrn Professor Dr. Hans Bauer, Max-Planck-Institut Tübingen, zu seinem sechzigsten Geburtstag mit den besten Wünschen in Verehrung gewidmet.

* Research supported in part by grants G–419 and G–19487 from the National Science Foundation.

[1] For discussion of chiasmata *not* arising from crossing over, see Kaufmann, B. P., *J. Morphol.*, **56**, 125–155 (1934) on mitotic chiasmata; and Cooper, K. W., *J. Morphol.*, **84**, 81–121 (1949) on mitotic and meiotic chiasmata.

[2] Cooper, K. W., *Genetics*, **30**, 472–484 (1945).

[3] Details of most rearrangements and genes may be found in Bridges, C. B., and K. S. Brehme, *Carnegie Inst. Wash. Publ.*, **552** (1944). Mitotic and meiotic chromosomes are described in *Biology of Drosophila*, ed. M. Demerec (New York, 1950), chap. 1.

[4] Cooper, K. W., *Chromosoma*, **10**, 535–588 (1959).

[5] Many figures of such XY-multivalents are to be found in: *J Morphol.*, **84**, 81–121 (1949).

[6] Gershenson, S. I., *Pub. Akad. Nauk U.R.S.R., Kiev*, **1939**, 1–117 (1940).

[7] The deletions were made by my colleague, Dr. Jakov Krivshenko of the University of Rochester. He determined their genic content; I determined their cytologic attributes. An account of some of their properties will be found in Grell, R. F., *Genetics*, **50**, 151–166 (1964).

[8] The inverted portion of hD, and the uninverted portion of Xe, are both shorter in $In(1)sc^4$ than in w^{m4} and rst^3 [see *Chromosoma*, **10**, 560 ff. (1959)].

[9] The tendency for sister chromatids to separate at pro- to metaphase-1 in Xe, but *not* in Xh, automatically produces ring configurations that may be scored mistakenly as foldbacks. When a terminal piece of Xe is microscopically definable, as in In(1)K, true foldbacks can be reliably discriminated.

[10] Gershenson, S. I., *J. Genet.*, **28**, 297–313 (1933).

[11] The $Y^{S}X \cdot Y^{L}$-chromosome does not permit a decision as to whether Y^{S} and Y^{L} can conjoin intrachromosomally, even though this chromosome regularly conjoins with itself in $Y^{S}X \cdot Y^{L}/0$ spermatocytes (Fig. 3*i*). Here "Y^{S}" denotes with certainty only the Y^{S}-fertility genes, for the "Y^{S}" element itself (Fig. 3*h*) is morphologically unlike the short arm of Y [cf. Figs. 10–25 and remarks, *Chromosoma*, **10**, 543 (1959)].

[12] Cooper, K. W., *Genetics*, **29**, 537–568 (1944).

[13] Lima-de-Faria, A., *Chromosoma*, **6**, 33–34 (1953); *Hereditas*, **41**, 238–240 (1955); *ibid.*, **42**, 85–160 (1956).

[14] See especially *Genetics*, **30**, 481–482 (1945).

[15] Kaufman, B. P., *Carnegie Inst. Wash. Publ.*, **43**, 115–120 (1944); also in *Radiation Biology*, ed. A. Hollaender (New York, 1954), vol. 1, pp. 627–711.

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*MALIC ENZYME AND LIPOGENESIS**

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The living cell employs NADPH in preference to NADH in many reductive synthetic processes. One case in point is the conversion of acetyl CoA to fatty acids where NADPH appears to be the reductant of choice.[1–3] A primary source of NADPH for such reactions has been considered to be the hexose monophosphate shunt. However, recent studies[4] in this laboratory have shown that in intact rat adipose tissue NADPH generated in the conversion of hexose monophosphate to pentose phosphate supplies only 50–60 per cent of the reducing equivalents used for fatty acid synthesis. The question was thus raised as to whether NADPH might be an obligatory reductant in only the first of the two reductive steps that occur in this process and whether reduced coenzymes other than NADPH might be employed in the second step. Alternatively, the possibility existed that NADPH was employed in both steps and that pathways other than the hexose monophosphate shunt existed for its generation. This later possibility appeared attractive in the light of data on the metabolism of pyruvate in adipose tissue. Work from the laboratory of Renold[5, 6] showed that synthesis of fatty acid from pyruvate can occur in adipose tissue incubated *in vitro* and under circumstances where generation of NADPH by the oxidation of hexose monophosphate seemed unlikely. Furthermore, it was shown that incorporation of labeled acetate into fatty acid in this tissue could be initiated by the addition of either glucose or pyruvate.[5] The work of Renold and co-workers thus suggested that the metabolism of pyruvate, at least in adipose tissue, can furnish reduced coenzymes utilizable for fatty acid synthesis. We have therefore explored some of the metabolic pathways open to pyruvate in rat adipose tissue. Our results show that the activity of the malic enzyme, first shown by Ochoa *et al.*[7] to catalyze the reaction

$$\text{Malate} + \text{NADP}^{+} \rightleftarrows \text{NADPH} + \text{pyruvate} + \text{CO}_2,$$

is much higher in rat adipose tissue on a nitrogen basis than in any other tissue from this animal that we have examined. Moreover, the activity of this enzyme in both rat adipose tissue and liver is altered in such a way by experimental conditions