trait itself, which is not a very specific entity but involves essentially increases or aberrations in structures which are normally present, might be regarded as rather favoring this explanation. Before this hypothesis, which would bring these cases of mammalian teratology into line with many roughly similar phenomena in the field of botany, can be regarded as more than a suggestion, a great deal of critical data must be accumulated. If it should be substantiated one of the main causes of the observed aberrant ratios would be the frequent failure of cells which receive the extra chromatin element to develop into functioning gametes.

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Microelectrodes and micromagnets.[1]

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Two kinds of microelectrodes and one micromagnet have been perfected and used with very good results.[2] First, it was found that a platinum wire (No. 35, C.P.) inserted into a close-fitting quartz capillary can be drawn over a minute oxy-acetylene flame to a perfectly insulated needle-point less than one micron in diameter. Indeed, the platinum core in this exceedingly fine point may closely approximate the limits of microscopic vision.

The platinum wire at the opposite (undrawn) end extends a few mm. beyond the quartz capillary in order that the former may be annealed to an insulated copper wire of about the same diameter as that of the platinum wire and 2 feet in length. The drawing of the electrodes (see Fig. A, 1 and 2) and the annealing is readily done over the oxy-acetylene microburner (m.b.). About 3 mm. of the needle-tip of the electrode is bent over the flame, at right angles (Fig. A, 3) and the opposite end is sealed with deKhotinsky cement into a glass shank 5 mm. in

[1] Funds for these investigations were generously provided by President Campbell and the Research Board of the University of California.

[2] Taylor, Cataphoresis of Ultramicroscopic Particles in Protoplasm, PROC. SOC. EXP. BIOL. AND MED., 1925, xxii, 533.

diameter and 35 mm. long (Fig. A, 3, sh). This shank fits into the instrument-holder of a recently designed micro-manipulator.[3] By means of the latter the electrodes are operated with finest precision in a moist chamber on the stage of the microscope.

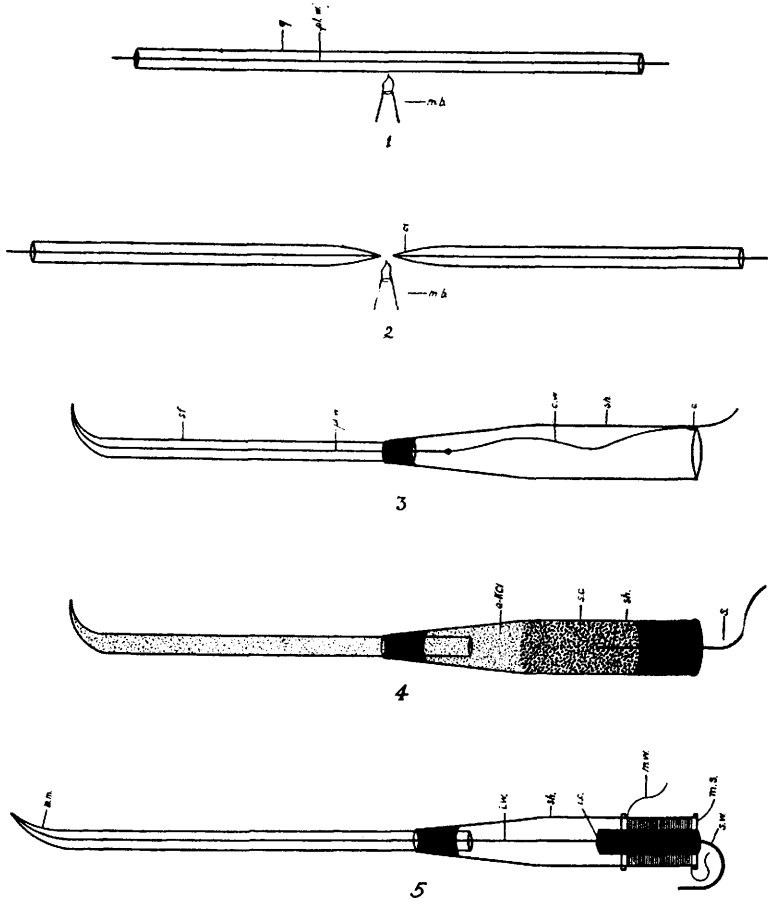

FIGURE A.

Showing construction of Micro-electrodes and Micro-magnets.

a-KCl, 0.5 per cent solution of potassium chloride in dialyzed agar; *c.*, cement; *c.w.*, copper wire; *el.*, electrode; *i.c.*, iron core; *i.w.*, iron wire; *m.b.*, micro-burner; *m.m.*, micro-magnet; *m.s.*, magnet spool; *m.w.*, magnet wire; *pl.w.*, platinum wire; *q.*, quartz capillary; *s.c.*, silver chloride; *s.*, silver wire; *sh.*, shank; *sf.*, shaft; *s.w.*, "shorting" wire.

[3] Taylor, Improved Micromanipulation Apparatus, *Univ. Calif. Pub. in Zool.*, 1925, xxvi, 443.

The second type of microelectrode is non-polarizable. For many purposes the platinum electrode would appear to be entirely satisfactory, but certain experiments make necessary the use of this second type. Peterfi[4] has recently described a microelectrode very similar to this one which has been in use for several months, so that his and mine were designed quite independently. Our methods of constructing these non-polarizable microelectrodes are somewhat different, hence I offer the following procedure:

A micropipette, made preferably from a quartz capillary of about 1 mm. in outside diameter and 50 cm. long, is filled by means of a good Luer syringe with a melted 0.5 per cent KCl solution of carefully dialyzed agar. When the agar solution has thoroughly hardened, the micropipette is sealed with White's dental cement (of low melting point) into a glass shank (Fig. A, sh.) similar to that described above for platinum electrodes. The inner end of the pipette, which should extend only a few mm. into the "bowl" of the shank, is now well covered with a few drops of the melted agar solution. When the agar has thoroughly cooled, the bowl of the shank is almost filled with slightly moist, well pulverized AgCl (C.P.). Into the silver chloride is inserted a No. 20 silver wire of convenient length (about 1 ft.). The end of the "bowl" is then filled and completely sealed with deKhotinsky cement which thereby firmly holds in place the silver wire. It is advisable to insulate the exposed portion of the silver wire by coating it with the deKhotinsky cement or by means of glass beads which can be quickly made by cutting a capillary tube into lengths of 1 cm. each.

After mounting the two electrodes of this type in the micromanipulator they are "shorted" for some time previous to use, in order to obviate any difference of potential.

The E. M. F. is provided by a dry cell of about 1.5 volts (the voltage being precisely determined by means of a Weston Standard Cell). Included in the circuit are two resistance boxes totalling 12,000 ohms and one of 40 ohms, a nitrogen-mercury key and a specially designed Leeds and Northrup galvanometer having a sensitivity of 35,714 megohms.

The micromagnets, consisting of quartz with a soft iron core, are drawn in the same manner and quite as fine as the platinum

[4] Peterfi, *Pflüger's Archiv. Physiol.*, 1925, ccviii, 454.

electrodes described above. Into a close-fitting quartz capillary 30 cm. long is inserted a No. 30 soft iron wire with free ends extending 20 cm. beyond either end of the capillary tube. The magnets are then drawn over the microburner as illustrated in Fig. A. The very tip of the iron core is completely enclosed by the quartz. After slightly curving the drawn ends (Fig. A, 5) each magnet is thereupon mounted and temporarily cemented into the glass shank such that the free end of the iron wire projects 3 or 4 cm. beyond the base of the shank. This permits the soldering of the wire onto one end of the soft iron core (*i. e.*, Fig. A., 5) of the magnet spool (m.s.). This spool, made of wood, is 2.5 cm. long and 1.5 cm. in diameter—a size sufficient to accommodate the winding on of 1500 ft. of No. 36 triple insulated copper magnet wire (m.w.) One end of the soft iron core (4 mm. in diameter) should extend about 3 mm. beyond the spool in order to provide support for the glass shank. Having soldered the iron wire to the projecting core, the glass shank, now unsealed from the micromagnet, is slid over the free end of the iron core whereon it is firmly cemented by means of the deKhotinsky wax. In turn, the micromagnet is permanently cemented in the shank (Fig. A, 5).

The micromagnets, like the microelectrodes, are supported and operated in the moist chamber by means of the micromanipulator.

It is evident that these electrodes and magnets afford a means for the study of the electric and magnetic properties of protoplasm in the interior of a living cell, thus eliminating an unknown factor—the cell-membrane. But they also provide means for an independent study of this unknown factor. It is believed that other uses also may be made of these microinstruments.