CLEAVAGE OF ARTIFICIALLY CONSTRICTED SAND DOLLAR EGGS

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In certain cells, at certain times in the cell cycle, the centers of the asters of the mitotic apparatus are closer to the poles than they are to the equatorial surface. This observation has been incorporated as an essential component of several hypothetical explanations of the way in which the mitotic apparatus establishes the division mechanism in the cell surface of all animal cells. The purpose of this investigation was to determine whether that geometrical relationship is necessary for sand dollar egg cleavage.

Sand dollar (Echinarachnius parma) gametes were obtained by 0.5 M KCl injection. Eggs were mechanically denuded 4 min. after fertilization. About 30 min. before cleavage, the spherical 142 μm diameter cells were inserted into glass loops (78 μm i.d.) so that they were partly constricted into equal parts, and the mitotic apparatus was maneuvered so that it straddled the constriction. In this circumstance, the length of the mitotic apparatus is not significantly affected, but the cell is reshaped into an elongate dumbbell in which the long axes of the cell and the mitotic apparatus are coincident. Artificial constriction increases the distance from the astral center to the pole and decreases the distance from the astral center to the equatorial surface. In this case, the normal relationship is reversed, because the polar surface is located farther from the astral center than the equatorial surface. These cells divide normally.

The geometrical relationship between the mitotic apparatus and the surface can also be changed by treatment with 0.06 M ethyl urethane, which reduces the size of the mitotic apparatus by about one third and blocks cleavage. When the mitotic apparatus of urethance-treated eggs is pushed closer to the surface, furrows develop, suggesting that in spherical cells the reduced mitotic apparatus is unable to establish furrows because its influence does not reach the surface. In order to determine where the critical geometrical deficiency lies, different surface regions were moved closer to parts of the mitotic apparatus. When treated cells are confined in short pieces of 80 μm i.d. glass capillary, the mitotic apparatus orients parrallel to the capillary axis, and the cell divides, even though the polar surfaces are displaced farther than normal from the asters. When similar cells are confined in 115 μm i.d. capillaries, they do not divide, and pushing the polar surfaces inward toward the asters has no effect. Insertion of urethane-treated eggs into 78 μm i.d. glass loops results in cleavage if the plane of artificial constriction lies in the equatorial region between the asters. There is no cleavage if the mitotic apparatus is located elsewhere.

Cells were doubly constricted by partially aspirating them into the reduced orifices (80 μm i.d.) of opposed micropipets. Simultaneous constriction of the sub-polar and sub-equatorial surfaces did not reverse the effect of urethane, although untreated controls cleaved. The results indicate that establishment of the division mechanism is not dependent upon a special geometrical relationship between the mitotic apparatus and the polar surface, and that deficiencies arising from reduction in the size of the mitotic apparatus can be remedied only by shortening the distance from it to the equatorial surface. This investigation was supported by NSF Grant PCM 7902624.

PRIMARY ROLE OF VOLUME EXPANSION IN THE STIMULATION OF RECTAL GLAND FUNCTION

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Previous studies have indicated that expansion of intravascular volume in the shark is the major physiologic stimulus of rectal gland chloride secretion (Amer. J. Physiol., 1984). These studies demonstrated that comparable stimulation of chloride secretion occurred despite the tonicity or chloride concentration of the volume load and regardless of the effect of the volume stimulus on plasma chloride concentration. To further define the role of intravascular volume expansion in this physiologic response, measurements of plasma volume were performed before, during,