Microstructure of Mammalian Spermatozoa*

ARTHUR S. H. WU
Department of Animal Science
Oregon State University, Corvallis

The mammalian spermatozoon (sperm) is, indeed, a unique type of cell. Despite its microscopic size, the sperm accomplishes the formidable tasks of fertilization and of transmitting the genetic information of the male parent to his offspring. It can survive, either in the presence or in the absence of air, for a considerable period of time. Also, it possesses an active motility and an array of cellular components to carry on its functions. The structural and functional interrelationships of the sperm has, however, puzzled biologists for years largely because the fine structure of the sperm cell cannot be clearly observed with conventional optical instruments. With the advent of techniques in electron microscopy, it is possible to study the microstructure of spermatozoon by electron microscope when single sperms are cut into sections of ¼-½ millionth of an inch in thickness. This communication will briefly review the present concept of sperm morphology according to electron microscopic studies at Oregon State University as well as some other institutions[4 6 8 10 14 16 17 20 23] and others.

In gross appearance the mammalian spermatozoon somewhat resembles a tadpole. However, as a single cell the sperm has a rather complex structure (Figure 1). The head, which may vary in shape depending on the species, is fully occupied with the nucleus where one finds the chromosomes carrying genes that determine the individual traits. The anterior surface of the head is covered by the acrosome and the posterior portion by the postnuclear cap. The tail of the sperm originates from the structure known as the proximal centriole at the posterior pole of the sperm head. Our electron micrographs clearly demonstrate that the proximal centriole in bovine spermatozoa appears as a cylindrical structure and contains, in its wall, 9 sets of triplet tubules arranged in a "pin wheel" fashion.

The sperm tail is conventionally subdivided into three parts, i.e., the midpiece, main piece and end piece. In addition to the outer cellular coverings, the tail has a central axial filament core. The latter consists of a pair of central fibrils surrounded by a ring of 9 doublets. These 11 fibrils persist into the end piece of the tail. In the midpiece and the main piece, an additional outer ring of 9 coarser fibrils is found to encase the axial core. These fibrils, the central pair and the 2 rings of 9 each, are embedded in a homogeneous matrix and enclosed

Continued on page 17

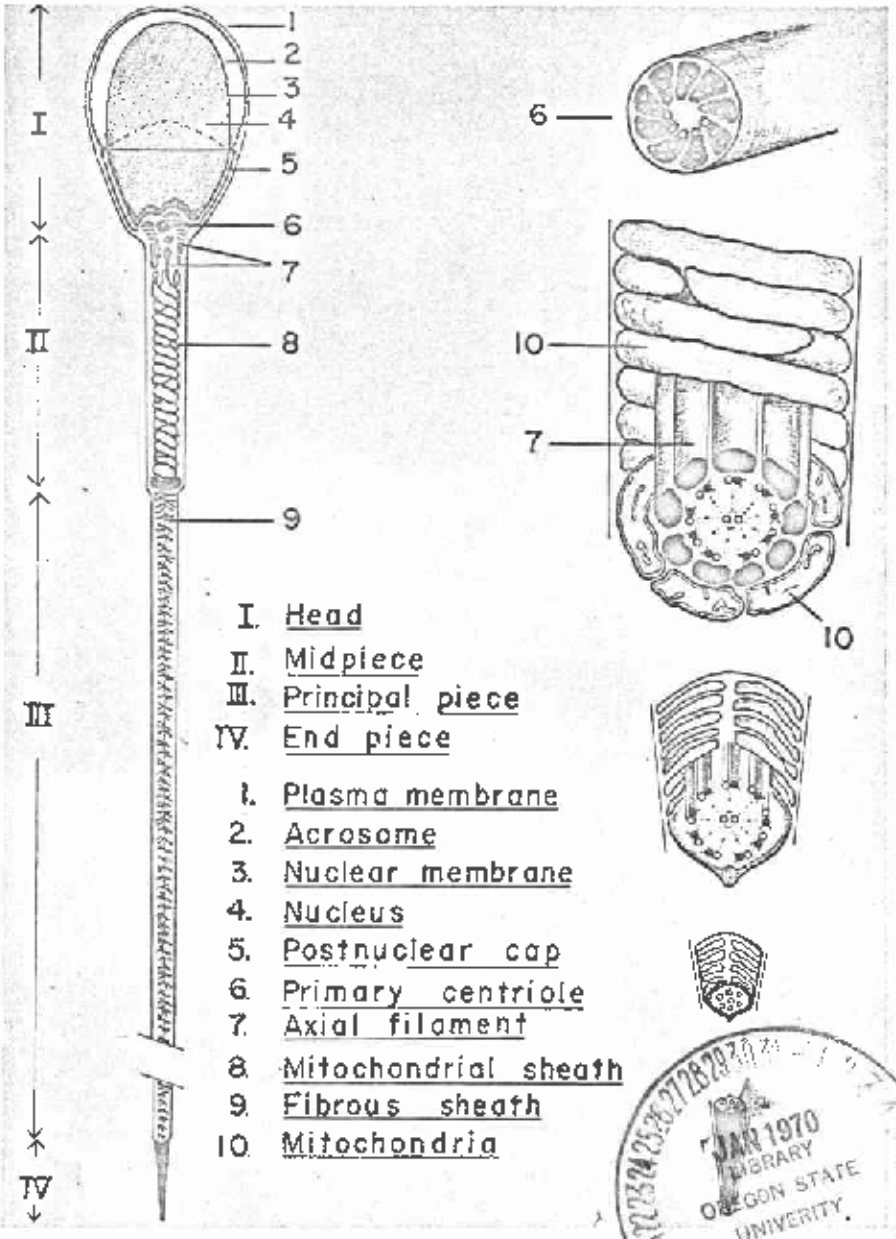

FIG. 1. Diagrammatic representation of the recent concept of the fine structure of a bovine spermatozoon. (Complied from literature and work at Oregon State University; Wu, 1966)

*Special Report No. 214, Oregon Agricultural Experiment Station. Research on sperm morphology at O.S.U. is partly supported by the National Association of Animal Breeders and Curtiss Breeding Service.

Hogsdon Named President Of World-Wide Group

Ralph E. Hodgson

Dr. R. E. Hodgson, Director of Animal Husbandry Research Division of the U.S.D.A.'s Argicultural Research Service, has been elected president of the World Association for Animal Production. He will serve this post until the next World Conference on Animal Production in 1968 at Washington, D.C.

Organized in Rome, Italy in 1963, the W.A.A.P. is an organization of animal production societies from over the world. Conferences are held periodically to exchange technical information on animal production. Eight animal production societies in some 30 countries are charter members. The American Dairy Science Association and the American Society of Animal Science represent the United States.

For outstanding research in dairy production, Dr. Hodgson received the Borden Award in 1939, and the Superior Service Award from the U.S. Department of Agriculture in 1947.

Washing house plants with soapy water and a soft brush or cloth may be all that's needed to remove aphids, mealybugs, and scale insects from broad-leaved plants, according to the U.S. Department of Agriculture.

SPERMATOZOA
STRUCTURE continued

either by the mitochondrial sheath in the midpiece or by the fibrous sheath in the principal piece. This rather complex architecture of the sperm tail is essential for its active motility and has a major role in facilitating the sperm transport and fertilization in the female reproductive tract.

Another interesting structure of sperm is the mitochondrial sheath which consists of many mitochondria arranged in an end-to-end fashion and wound around the axial core of the midpiece. The function of the mitochondria depends upon the varieties of enzymes they carry for generating, transforming and utilization of energy. Thus, the midpiece is often considered as the powerhouse of the sperm cell, and midpiece abnormalities have been reported[9] in some cases of bovine sterility.

Besides the enzymes related to cellular metabolism, the sperm cell also carries enzymes for other biological processes. The acrosome, for instance, is believed to carry enzymes such as hyaluronidase, which may aid the sperm to pass through the large number of cells surrounding the freshly ovulated egg and thus facilitate fertilization. Abnormalities in sperm acrosome and nucleus have been described in mice with hereditary sterility[12 15] and in many cases of bovine infertility.[1 5 7 11 18] Acrosome abnormalities have also been reported in boars with breeding difficulties.[2 13 19] More recently an uncontrolled growth of the acrosome system during the formation of spermatozoa has been revealed with electron microscopy in a sterile boar.[3]

This brief review illustrates the close relationship between sperm structure and sperm function on one hand and the morphological abnormalities in sperm structure and the deterioration of fertility on the other. The great contribution made by A.I. to animal breeding emphasizes the continuing need for progress by research. More accurate and precise methods for semen evaluation are needed, as are more economic and convenient techniques to preserve the fertilizing capacity of sperm from various species.

Research in the microstructure of spermatozoa with continued emphasis on determining the relationship between sperm structure and sperm physiology and pathology may provided needed answers to many of the present problems in animal reproduction.

LITERATURE CITED

[1] Aamdahl, J. 1951. Nord. Vet. Med., 3, 102.
[2] Bane, A. 1961. Proc. IVth Int. Cong. Ani. Reprod., p. 810.
[3] Bane, A. and L. Nicander. 1966. J. Reprod. and Fert., 11, 133.
[4] Baylor, M. R. B., A. Nalbandov and G. A. Clark, 1943. Proc. Soc. Exp. Biol. Med., 5, 229.
[5] Blom, E. 1948. Medl. danke Dyrl., 31, 446.
[6] Blom, E. and A. Birch-Andersen. 1960. Nord. Vet. Med., 12, 261.
[7] Bonadonna, T. 1955. Riv. Biol., 47, 297.
[8] Bretschneider, L. H. 1950. Proc. Kon. Ned. Akad. v. Wettenschappen, 52, 526.
[9] Coubrough, R. I. and C. A. V. Barker. 1964. Proc., Vth Int. Cong. Ani. Reprod. Art. Insem., Vol. 5, p. 219.
[10] Fawcett, D. W. 1958. Intern. Rev. Cytol., 7, 195.
[11] Hancock, J. L. 1949, Vet. Rec., 61, 308.
[12] Hollander, W. F., J. H. D. Bryan and J. W. Gowen, 1960, Fert. Steril. 11, 316.
[13] Liess, J. and D. Krause. 1958. Dt. tierarztl. wschrft. 65, 677.
[14] Rahlmann, D. F. 1961. J. Dairy Sci., 44, 915.
[15] Rajasekarasetty, M. R. 1954. Fert. Sterility 5, 68.
[16] Reed, C. I. and B. P. Reed. 1948. Anat. Rec. 100, 1.
[17] Saacke, R. G. and J. O. Almquist. 1963. J. Dairy Sci., 46, 635.
[18] Teunissen, G. H. P. 1946. Tijdschr. Diergeneesk, 71, 292.
[19] Wohlfart, E. 1961. Fortpfl. Stor. Besam. Haustiere, 5, 268.
[20] Wu, S. H. and F. F. McKenzie. 1954. Sci., 119, 212.
[21] Wu, S. H. and F. F. McKenzie. 1955. J. Ani. Sci., 14, 1151.
[22] Wu, S. H. and J. E. Newstead. 1963. J. Ani. Sci., 22, 867.
[23] Wu, S. H. 1965. J. Ani. Sci., 24, 232.

Meat Consumption Down

Per capita consumption of all meats in 1965 was down somewhat from that consumed in 1964 according to the National Live Stock and Meat Board. Today's meat consumption per capita annually amounts to nearly 100 lbs. of beef, about 60 lbs. of pork, and about 9 lbs. of veal and lamb.

The 1965 decrease was due primarily to an 8 percent decrease in pork production, according to the report. Per capita pork supplies are expected to increase late in 1966.