Introduction
As early as 1913, Tournade propounded that mammalian spermatozoa undergo physiological ripening during their epididymal passage. Later, Bedford (1967) and Orgebin - Crist (1967, 1969) established the principle of epididymal maturation of the spermatozoa. Now it is generally accepted that spermatozoa arriving in the caput epididymidis neither have the capacity for progressive motility nor the capacity to fertilize the egg. A complex sequence of events such as sperm maturation in the epididymis and capacitation and acrosome reaction in the female tract (Austin 1951, Chang 1951, Barros 1974 Langlais and Roberts 1985, Bearer and Friend 1990) are essential prerequisites to ensure that the spermatozoa reach the site of fertilization in optimal fertilizing condition. The spermatozoa undergo structural transformations leading to the regionalization of its plasma membrane and appearance of morphologically distinct domains. Anatomically, major subdivisions of the mammalian spermatozoon comprise of acrosomal and post acrosomal domains of the head and middle-piece and principal-piece domains of the tail (Olson and Winfrey 1991). This morphological and functional regionalization is reflected in the reorganisation of plasma membrane components during sperm maturation.
A variety of techniques have been employed to monitor alterations in the macromolecular composition of the sperm plasma membrane. Sperm surface regional differences were demonstrated by their capacity to exclude eosin (Ortavant 1953, Amann and Almquist 1962). Immunological studies reveal distinct regional differences in the antigenicity of mammalian spermatozoa (Hunter and Hafs 1964, Baker and Amann 1970, Johnson and Hunter 1972). Sperm surface antigens are localized with the incorporation of monoclonal antibodies both at the light and electron microscope levels (Killian and Amann 1973, Schellpfeffer and Hunter 1976, Myles and Primakoff 1983, Primakoff and Myles 1983, Eddy et al., 1985).

Changes in the surface charges of the spermatozoa from different regions of the epididymis was determined by the binding of colloidal iron hydroxide and cationized ferritin (Yanagimachi et al., 1972, Bedford 1975, Courtens and Fournier-Delpech 1979, Lopez et al., 1987).

Sperm surface charges are determined by measuring cellular electrophoretic mobility (Bangham 1961, Bey 1963, Holt 1983), isoelectric focusing (Hammerstedt et al., 1979, Moore 1979) and by aqueous-two phase-partitioning (Geada et al., 1989).

Sperm membrane glycoconstituents were localized with a wide variety of lectins (Nicolson 1974, Koehler 1978, 1981). Lectins conjugated with fluorescein, ferritin, peroxidase and colloidal gold have been
fruitfully used to detect the exposed saccharides of the sperm surface (Holt 1984, Horrisberger 1984, Lis and Sharon 1986, Sinowatz et al., 1989). The agglutinability of the spermatozoa with lectins (Kashiwabara 1965, Olson and Danzo 1981, Talbot and Franklin 1978) and characterization of the sperm plasma membrane glycoproteins with lectin affinity columns (Fournier - Delpech and Courot 1980, Rankin et al., 1989) and lectin blotting technique (Sakamaki et al., 1989) have proved useful to analyse sperm surfaces.

Fluorescent lipid analogue (C16dil) permits to probe the lipid diffusibility and fluidity of the sperm plasma membrane (Wolf 1987). Treatment of spermatozoa with polymixin and filipin enables to study the distribution of anionic phospholipids and cholesterol in the sperm plasma membrane (Bearer and Friend 1980, Miller 1989).

Spectroscopic techniques exploit the preferential solubility of amphiphilic probes into the specific domains of the sperm plasma membrane (Klausner et al., 1980, Wolf and Voglmayr 1984). In electron spin resonance spectroscopy, the signals from surface directed spin labels reflect the physical environment in the phospholipid - water interface of the plasma membrane. Incorporation of water soluble spin labels determines the integrity of sperm plasma membranes (Lepock et al., 1975, Hammerstedt 1979). Nuclear magnetic resonance spectroscopy provides information of the metabolic status of the spermatozoa in
various phases of their passage through the epididymis (Smith et al., 1985, Robittaile et al., 1987).

Scanning electron microscopy has been extensively employed to study the three dimensional features of the spermatozoa. Transmission electron microscopy of ultrathin sections of chemically fixed and frozen cells has extended the scope of morphogenetic studies and studies on the chemical properties of sperm membranes. Examination of freeze fractured/etched sperm plasma membrane enables to follow the structural differentiation in their interior and also helps to visualize the cell surface region topochemistry at molecular resolution (Bozzola and Russell 1992). Striking evidence of sperm membrane regionality is obtained by freeze fracture methods. The split membrane faces are designated as P-face i.e. protoplasmic face and E-face i.e. exoplasmic face and these faces are studded with intramembranous particles (Branton 1966) and the sperm plasma membrane appears as a, "tapestry of different textural domains" (Bearer and Friend 1980). Pinto da Silva (1987) introduced fracture label and label fracture methods to gain further insight into the molecular organisation of the sperm plasma membrane.

In this study morphological approaches to identify the glyco-components and the intramembranous particle organisation of the plasma membrane of the spermatozoa in a number of mammalian and avian species viz., goat (Capra indicus), buffalo-bull (Bubalus bubalis), human (Homo sapiens), squirrel (Funambulus pennantii), mongoose
(Herpestes auropunctualus), cat (Felis catus), dog (Canis domesticus), parrot (Psittacula krameri) and myna (Acridotheres tristis) is presented. Furthermore, integrated biophysical studies employing magnetic resonance spectroscopy on the goat, buffalo-bull and human spermatozoa are incorporated.

The regional heterogeneity of the plasma membrane domains of the acrosome, equatorial segment, and post acrosome of the head, middle-piece and principal-piece of the sperm tail were analyzed in an effort to identify features pertinent to their specific functions.

Lectins - class of oligomeric proteins - showing specific affinity to bind with mono or oligosaccharides have been used to examine the disposition of exposed carbohydrates on the sperm plasma membrane of the above mentioned mammalian and avian species. A number of fluorescein conjugated lectins viz., Bauhinia purpurea; BPA, Canavalia ensiformis or concanavalin A; Con A, Dolichos biflorus DBA, Griffonia simplicifolia I; GS I; Griffonia simplicifolia II; GS II, Maclura pomifera MPA, Arachis hypogaea or peanut agglutinin PNA, Glycine max or soybean agglutinin SBA, Ulex europaeus UEA and Triticum vulgaris or wheat germ agglutinin WGA were used. Quantitative information of lectin binding on the sperm surface has been supplemented with quantitative data obtained flow cytometrically. Colloidal gold conjugated lectins have been used at ultrastructural level to identify the lectin receptors on the epididymal spermatozoa of buffalo-bull, squirrel and human ejaculates. With fracture
label, WGA receptor sites have been localized on the fractured membrane halves of the plasma membrane in the buffalo-bull spermatozoa.

Transmission and scanning electron microscopy have been fruitfully utilized to assess the fine structure organisation of the maturing epididymal spermatozoa. Changes in the plasma membrane architecture of the maturing spermatozoa of goat, buffalo-bull, squirrel and mongoose were studied in freeze-fracture replicas. Plasma membrane alterations accompanying \textit{in vitro} capacitation and acrosome reaction of goat spermatozoa have been documented by using lectin labeling, scanning electron microscopy and freeze-fracture methods.