CORRECTION

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An error was made in the order of Authors. The correct title page is as follows and should be read and cited as such.

FLOW PERMEATION ANALYSIS OF BOVINE CERVICAL MUCUS

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ABSTRACT Geometrical properties of the microstructure of whole bovine cervical mucus were studied. An experimental technique was developed for measuring the flow of fluid through the mucus microstructure in response to application of a prescribed external pressure gradient. The data obtained were analyzed in conjunction with a mathematical model of the hydrodynamics of the flow-permeation process. The sizes of typical interstices within the microstructure were calculated to be of the order of 1 μm, with typical macromolecular filament diameters being of the order of 100 Å. These dimensions were interpreted as representative of an equivalent network giving rise to measured flow permeability. The values of filament size showed a strong experimental correlation with the solids content of the mucus.

INTRODUCTION

The uterine cervix is an anatomical juncture situated at the posterior end of the vagina. In many mammals insemination occurs within the vagina; the cervix thus functions as the initial passageway through which spermatozoa migrate, en route to the site of fertilization in the oviduct. In a number of these species, including primates and ruminants, the cervical canal is filled with mucus that is generally similar to that of the respiratory tract. The cervical mucus can be regarded as consisting of a solid phase (mucin) and a liquid phase (plasma). The liquid phase consists of soluble proteins, low molecular weight carbohydrates and electrolytes, and comprises 95–99% or more of the whole mucus (Blandau and Moghissi, 1973). The solid phase is a polydisperse system of fibrous glycoprotein macromolecules (Gibbons and Mattner, 1966; 1971).

The whole mucus possesses a remarkable set of rheological and other biophysical properties that are intimately associated with its physiological function. This function involves the admission of morphologically normal, vigorous spermatozoa into the cervix, and their subsequent distribution and upward migration (Davajan et al., 1970; Blandau and Moghissi, 1973; Elstein et al., 1973; Overstreet and Katz, 1977). Viscoelastic and other rheological properties of human and bovine cervical mucus have been described and related to cervical function (e.g. Nakamura et al., 1973; Eliezer, 1974; Wolf et al., 1977; Tam et al., 1980). These studies have characterized the mucus on a scale that is large compared with the size of a swimming spermatozoon. Certain inferences, primarily qualitative, can be drawn between the macroviscoelastic behavior of the mucus and the local properties of the microstructure (e.g. Lutz et al., 1973). However, relatively little attention has been devoted to the specific microarchitectural properties of the mucus that modulate the movements of spermatozoa within it. In this regard, the geometry of the mucin network, i.e., the sizes of the filaments and of the interstices between them, is of paramount importance (Katz and Berger, 1980). Using scanning and transmission electron microscopy, the mucus microstructure has been made visible (Singer and Reid, 1970; van Bruggen and Kremer, 1970; Chretien et al., 1973; Zaneveld et al., 1975). The conflicting pictures of the microstructure resulting from these studies seem to be associated with different methods of specimen dehydration and fixation (Chretien, 1977). Mucus contracts during these processes, and is not sheared uniformly because of its adherence to solid surfaces. The loss of soluble electrolyte may also change the dimensional organization of the microstructure. Consequently, the quantitative and even qualitative relationships between the photomicrographs of electron microscopy and the nature of the microstructure of whole mucus are not established.

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