of the boundary, giving rise to an artificial sharpness which over-emphasized the effect of the shearing.

In summary, it has been shown that deoxyribonucleic acid of unusually high sedimentation coefficient can be prepared. If these results can be extended to deoxyribonucleic acid from somatic tissues, it appears to me that at present no limit can be set to the length of the molecule of deoxyribonucleic acid *in vivo*. Protein bridges may exist along these 'molecules', but, until some evidence for them is forthcoming, it is simpler to imagine that the double helix persists uninterruptedly—perhaps for the length of a chromosome[9].

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Lubrication of Mammalian Joints

THE experiments and arguments of McCutchen[1] and Lewis and McCutchen[2] appear to confirm the theory of lubrication of mammalian joints first put forward twenty-seven years ago with particular reference to the intra-articular fibrocartilages and later developed in connexion with particular problems of articular structure, general and special[3]. The essence of that theory is that there is a sensibly thick film of synovial fluid between articular surfaces while the joint is in motion, and that this fluid is not only maintained between the surfaces but also flows between them in the direction of motion in accordance with the laws of viscous hydrodynamics. The question of the origin of the fluid was left in abeyance, being a physiological rather than a mechanical problem.

It is an axiom, too often unstated, that the flow of lubricant film while it is acting requires that the fluid shall adhere to the fixed and the moving surfaces; this is tantamount to saying that these surfaces shall be thoroughly soaked with fluid. Movement of one of the surfaces will then necessarily produce a laminar flow if the fluid be viscous, as is easily demonstrated by simple physical models at speeds commensurate with those found in our joints. The structural basis for the sponge-like character of articular cartilage has already been shown by myself[4]. This structure differs markedly from that described by Benninghoff, referred to in the communication from Lewis and McCutchen. The late Prof. Benninghoff told me verbally that he had not examined articular cartilage by the methods given in the preceding reference. Lewis and McCutchen have shown that the articular sponge not only soaks up fluid, thus ensuring its adhesion to the bearing surfaces, but also permits it to be squeezed out, thus ensuring an instantaneous formation of a lubricant film which can then itself be moved as stated above. Such a rapid formation of lubricant fluid is essential in the joints where the range of movement is small by engineering standards and also alternates rapidly in direction. It should be stressed, however, that any theory of articular lubrication must cover all the phenomena of structure within the joint cavity, and should account for the presence, shape and disposition of soft structures (for example, fatty pads) and ancillary deformable structures (for example, articular disks) found in certain joints where the general theory of viscous lubrication indicates a need for their presence. The 'weeping lubrication' spoken of by Lewis and McCutchen appears to complete the existing theory rather than to supplant it, and is a valuable addition to our knowledge of biomechanics.

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WHILE we agree with Prof. MacConaill that there is a thick layer of fluid over most of the area between the articulating surfaces of a joint, we none the less insist that how it gets there is a mechanical rather than a physiological problem. When a joint is loaded, the fluid between the surfaces will be at high pressure, and this must be overcome by whatever process supplies the fluid. Weeping lubrication solves the problem by automatically pressurizing the reservoir from which the fluid is supplied. This is accomplished at the expense of gentle contact at a few high spots in order to press the sponge-like cartilages back into the fluid they are soaked with.

Hydrodynamic lubrication can, in principle, drag fluid into the high-pressure region, but the amount is very small. A simple calculation[1,2] for the knee joint of a sheep shows that, even were the shapes and motion of the joint surfaces ideal, the amount of fluid which can be brought between the articulating surfaces in one swing of the leg at walking speed is equivalent to a layer no greater than half a micron thick. We have shown that the weeping process can provide 30–70 times this amount of fluid; so it seems unlikely that the hydrodynamic contribution is very important. At lower speeds, hydrodynamic lubrication seems even less likely, because the amount of fluid supplied per swing follows the half-power of the sliding speed. If one follows the hydrodynamic theory down to extremely low sliding velocities in the hope of being helped by the unusual properties of synovial fluid[2], one finds that there is no appreciable increase in viscosity of the lubricant until the sheep walks at less than 10^{-7} m.p.h., at which speed the