4.6 HISTOLOGIC SECTIONS

Half of the 24 test specimens were preserved after testing in formalin solution; each of these specimens was sliced in half, in a direction perpendicular to the cartilage surface, before being submerged in the fluid. Each specimen was then sliced in a direction perpendicular to the direction of sliding, and stained using hemotoxylin and eosin (H&E), alcian blue, or safranin O fast green stains, each of which highlights different features of the sectioned specimen. The histologic sections were then observed and photographed under a photomacroscope. All photographs in this section were taken at a magnification of 80X unless otherwise specified. Several examples of each stain are included to demonstrate the variety of information available from this technique.

Figure 4.40 shows a histologic section, stained with alcian blue, of the specimen from test CS05, a high load, buffered saline test. Since the entire surface of the cartilage plug potentially contacts the surface of the stainless steel disk, all of the visible cartilage surface in this figure was a part of the contacting surface during testing. The locations of chondrocytes appear quite clearly as dark points in the image. The surface of the cartilage is rough, as a result of worn and compressed material. On the right side of the image, a region of darker material follows the curvature of the cartilage surface; this dark area indicates a high concentration of proteoglycans in this part of the material.

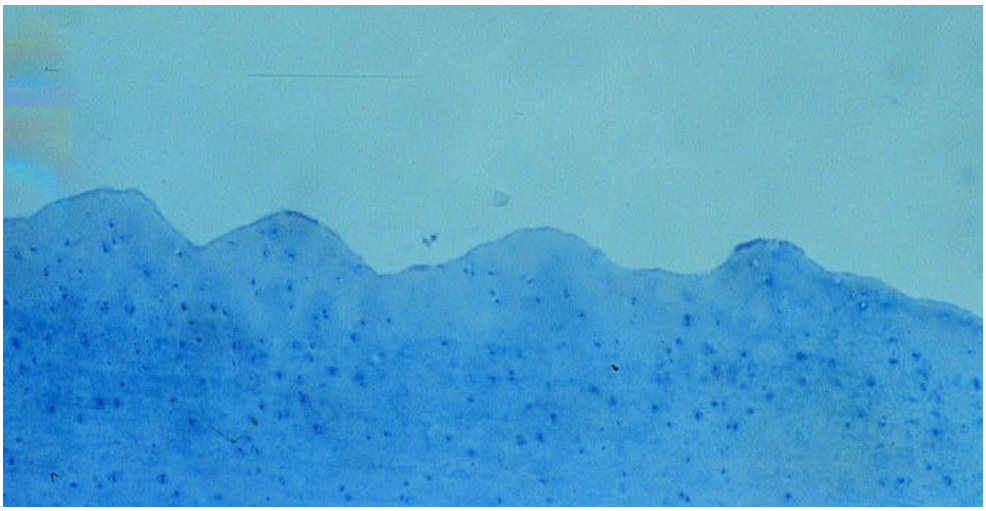

Figure 4.40: Histologic Section of Saline Test, High Load, Alcian Blue, 80X

Figure 4.41 shows another section from the same cartilage specimen, stained with safranin fast green. The lacunae, gaps surrounding the chondrocytes, are visible in this photograph. Several of the same surface features are visible in figures 4.40 and 4.41. The cartilage surface is rough, and the concentration of chondrocytes is higher near the surface than in the depths of the cartilage layer.

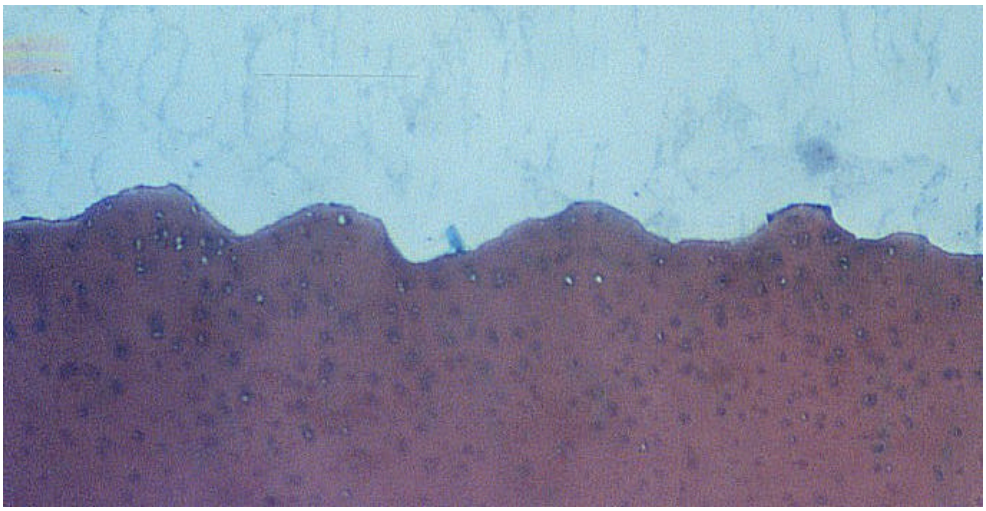

Figure 4.41: Histologic Section of Saline Test, High Load, Safranin Green, 80X

The next three figures show sections from the test specimen CS14, a high load, synovial fluid test. Figure 4.42 shows this specimen with H&E stain. Both the cell nuclei and lacunae are visible, and appear on observation to be evenly distributed throughout the material. The surface is smooth, with only small variations in topography.

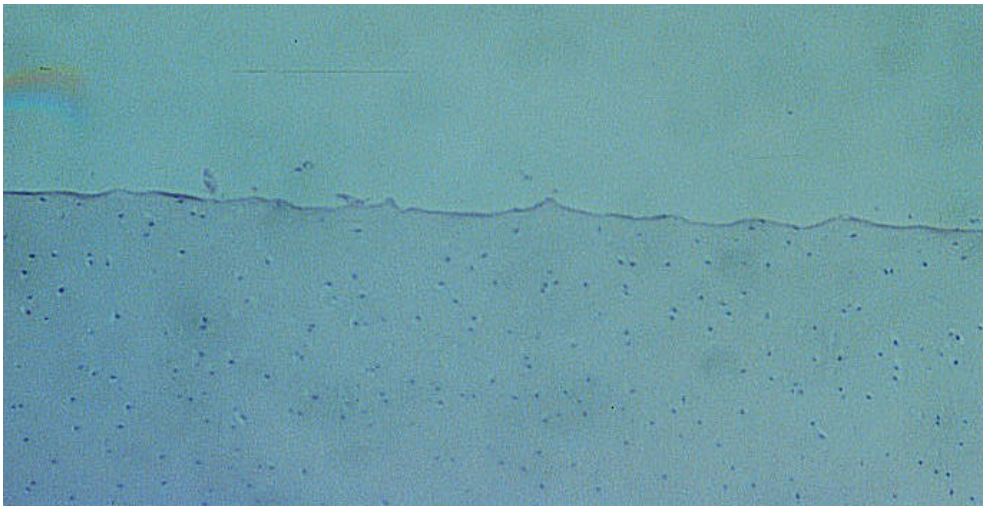

Figure 4.42: Histologic Section of Synovial Fluid Specimen, High Load, H&E, 80X

In Figure 4.43, the same specimen is shown using alcian blue as the stain. As in the previous figure, the cartilage surface is quite smooth, indicating a low level of cartilage wear. A light blue region can be seen near the surface; farther inside the material, the cartilage has stained a darker blue. This indicates an uneven distribution of proteoglycans in the material.

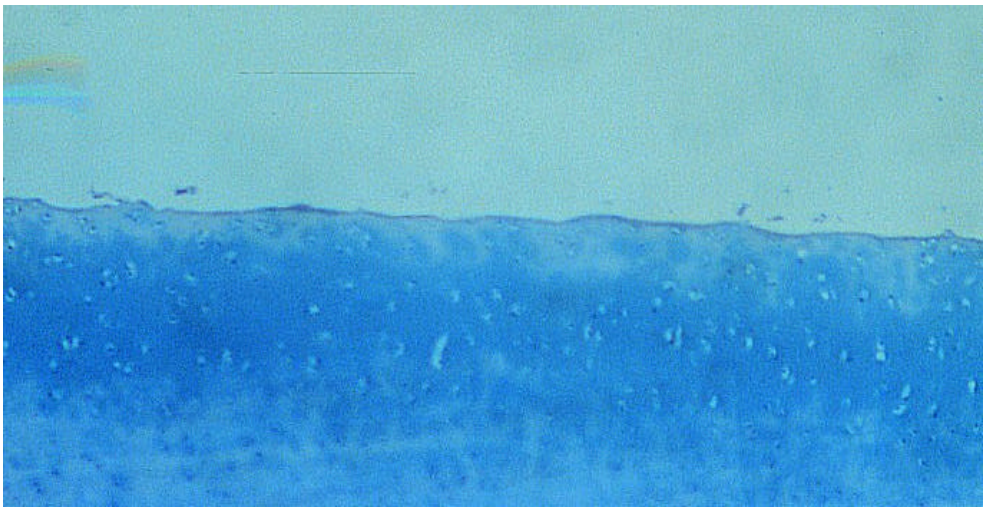

Figure 4.43: Histologic Section of Synovial Fluid Specimen, High Load, Alcian Blue, 80X

Figure 4.44 shows this specimen stained with safranin fast green stain. As in the previous figures, the surface is relatively smooth. The shapes of the lacunae can easily be seen with this stain; several of the voids nearest the surface are slightly elongated parallel to the surface.

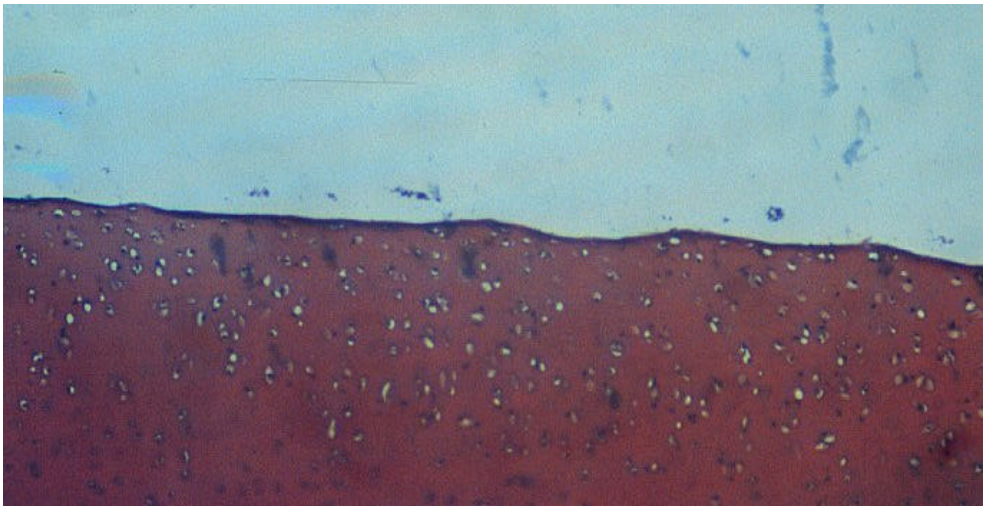

Figure 4.44: Histologic Section of Synovial Fluid Specimen, High Load, Safranin Green, 80X

Figure 4.45 shows a section from the specimen CS06, a high load hyaluronic acid test. The surface appears rough, though not as remarkably mountainous as the saline specimen shown in Figures 4.40 and 4.41. As in earlier figures, the material has stained light blue near the surface, but darker blue farther from the surface.

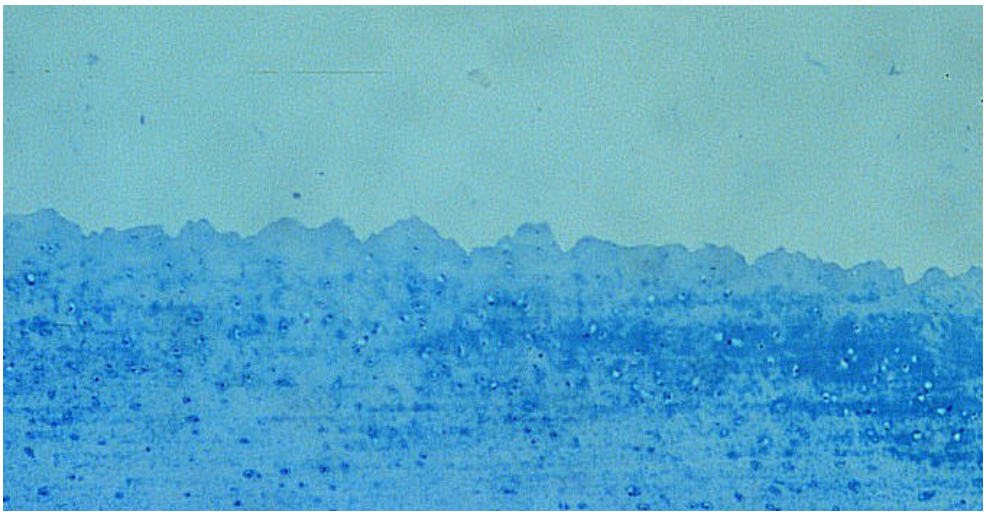

Figure 4.45: Histologic Section of Hyaluronic Acid Specimen, High Load, Alcian Blue, 80X

The same specimen is shown in Figure 4.46, using safranin fast green as the stain. The lacunae are visible, and appear to be more closely spaced nearest the surface of the cartilage. The worn surface shows features similar to those in the previous image.

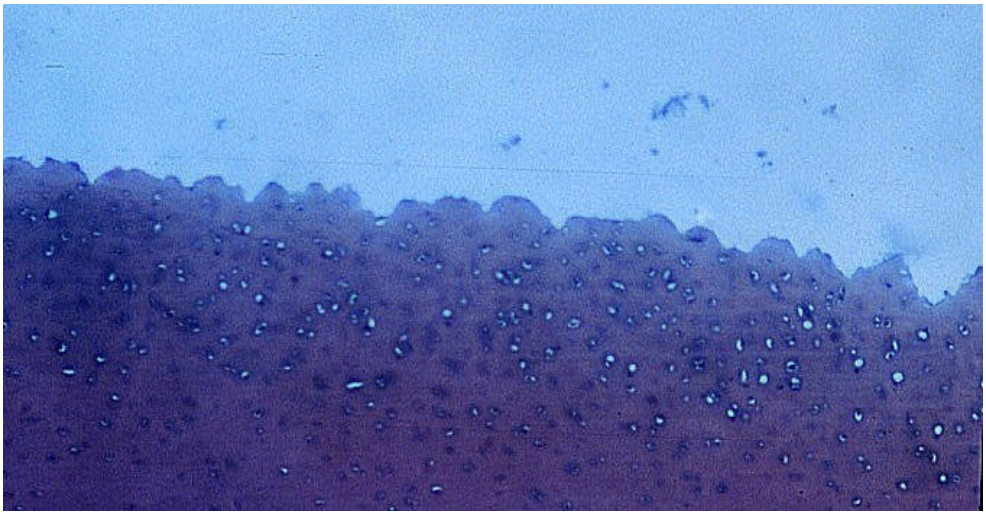

Figure 4.46: Histologic Section of Hyaluronic Acid Specimen, High Load, Safranin Green, 80X

Several of the histologic sections, especially those of low-load specimens, show evidence of some elongation of the lacunae, which may be a condition which precedes delamination of the material. Figure 4.47 shows specimen CS11, which exhibited excessive elongated gaps in the interior of the cartilage after being tested. This test used hyaluronic acid as the lubricant, under low load. Several flaps have been lifted from the surface, which probably would have become large wear particles under continued sliding. These flaps were visible on all histologic sections from this specimen, indicating that they were probably not an artifact of the specimen preparation process.

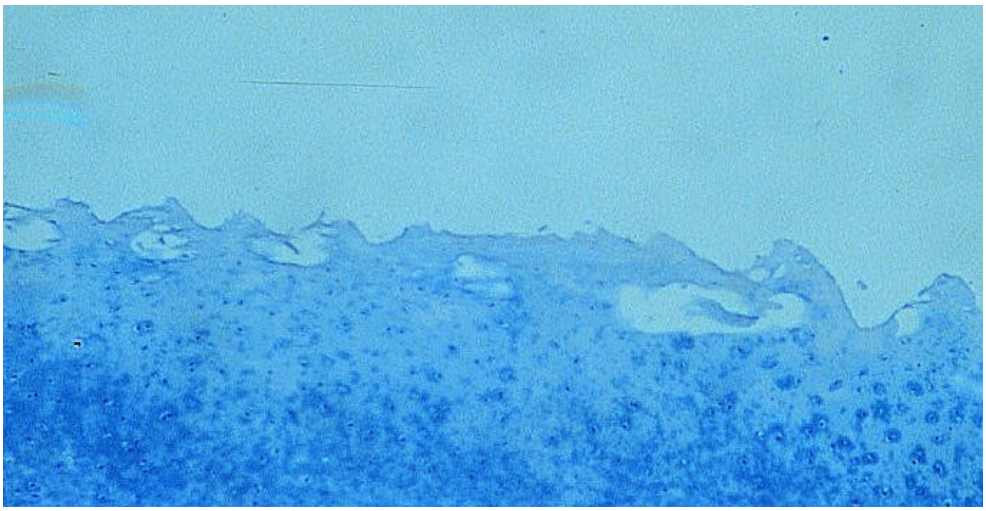

Figure 4.47: Histologic Section of Hyaluronic Acid Specimen, Low Load, Alcian Blue, 80X

On a few occasions, Schroeder [23] found similar large flaps, torn from the surface of several test specimens. These flaps are a sign of damage that was not measured in the hydroxyproline wear analysis, because they remain attached to the cartilage surface. Figure 4.48 shows one such flap that was found in the present study, on the specimen from test CS08. It appears similar to those found by Schroeder, but very few such features were observed on other specimens in this study. Furthermore, multiple sections were taken from adjacent locations on the cartilage specimen. If a feature fails to appear on more than one of the adjacent sections, it is likely that the feature is an artifact of the sectioning process. The sections adjacent to that which is shown in Figure 4.48 failed to show any evidence of the large flap shown in this figure. This evidence suggests that this particular flap, unlike those observed by Schroeder, may be an artifact of the specimen preparation.

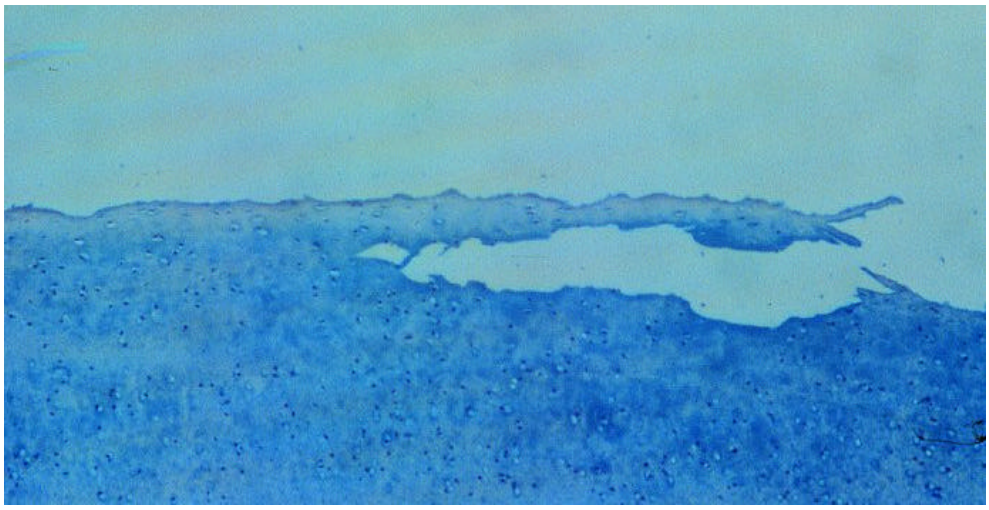

Figure 4.48: Histologic Section of Hyaluronic Acid Specimen, Low Load, Alcian Blue, 80X