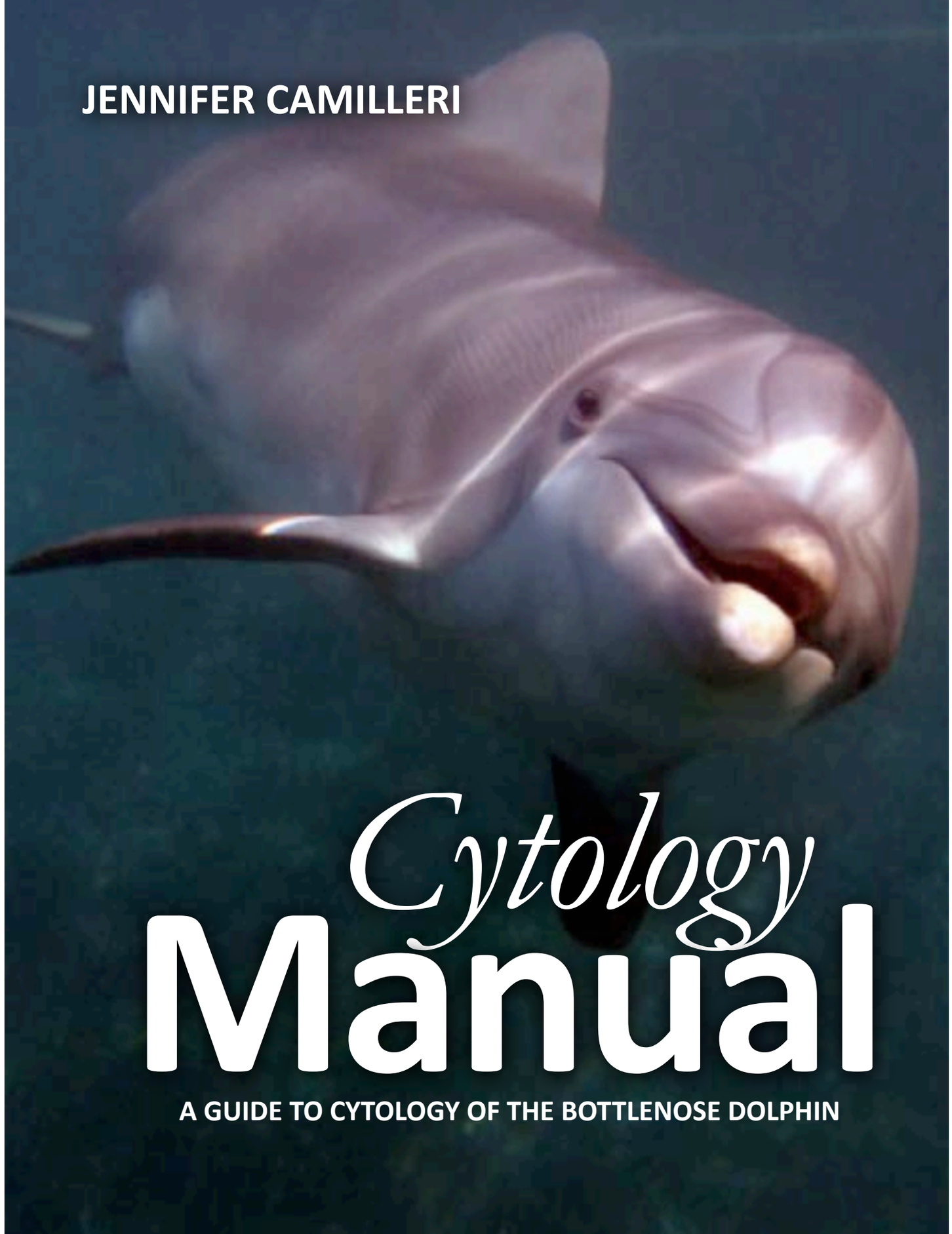

JENNIFER CAMILLERI
Cytology
Manual
A GUIDE TO CYTOLOGY OF THE BOTTLENOSE DOLPHIN

Cytology Manual

Written and illustrated by Jennifer Camilleri
Hard copy published February 2012 (Dolphin Quest)

Special thanks to Dr. Jay Sweeney, Michelle Campbell, and Dr. Gregg Levine for putting up with my constant emailing, and for providing helpful suggestions and information. To the entire Dolphin Quest crew: thank you for listening and supporting me along the way.

Cells and Organisms

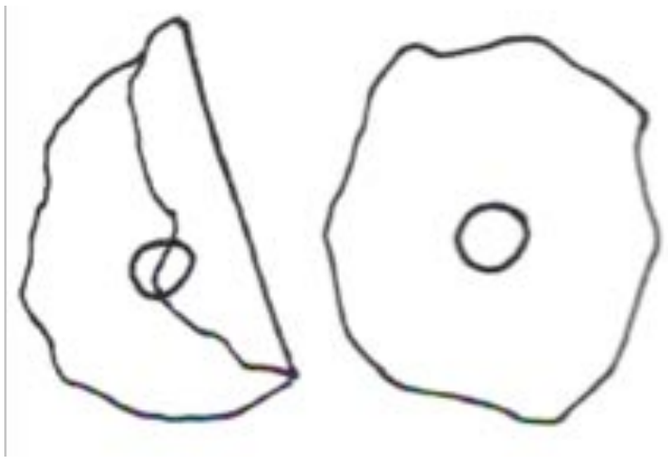
Epithelial Cells

Epithelial cells line surfaces of the body and organs for protection. They are commonly found in all samples and are not typically of concern if their numbers fall within normal ranges.

Squamous Epithelial Cells

DESCRIPTION

Squamous epithelial cells are the most commonly seen epithelial type. They have a flat, irregular shape. Stain readily adheres to cell nuclei, but the cell body is often only faintly stained. If stain is too dilute, epithelial cells are often quite difficult to see. Since squamous cells are flat, they may fold or roll up when placed on a slide. The diagram below depicts the typical shapes of squamous epithelial cells with their prominent nuclei.



The number of epithelial cells seen in a sample is used as an estimate of the concentration of that sample. These cells don't necessarily indicate a pathology if they are outside normal ranges, and although the average observation is around 5 cells per high power field, you might see anywhere from 0 to TNTC (too numerous to count) epithelial cells in a given sample.

Normal Concentrations

To estimate the concentration, the cells must first be counted from a total of ten high power fields (i.e. fields viewed with the 40x objective lens). The number of cells counted must then be divided by ten to give an average number observed per high power field (hpf). In *sputum* and *gastric samples*, the normal epithelial count is less than five cells per field (i.e. <5/hpf). In *fecal samples*, it is normal to see anywhere from 0-TNTC epithelial cells. In *urine samples* it is normal to observe 2 – 10 epithelial cells in your high power fields.

Recording Your Findings

If you saw 80 epithelial cells in ten fields, then your findings should read '8/hpf' as an average of epithelial cells per field. If you saw 25 epithelial cells, instead of writing, '2.5/hpf,' it is better to give a range (i.e. 2-3/hpf). This finding can be recorded in the 'epithelial cells' section of the individual animal's lab spreadsheet.

Figure 1A

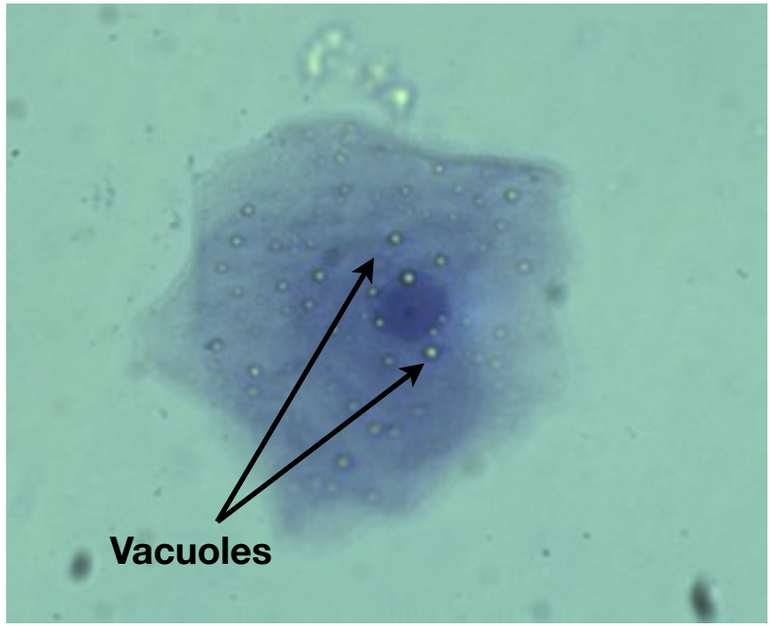


Figure 1B

Figure 1A: An epithelial cell with cocci bacteria adhered to the cell body. This cell is seen here using the 10x objective lens.

Figure 1B: Prominent vacuoles seen in the cell.

Figure 1C: A slide is a three dimensional environment, therefore epithelial cells are often seen at different angles. The cell here is seen in cross section.

Figure 1D: The distinct nuclei shown in this image (made visible with New Methylene Blue stain) can aid the cell count. There are 20 cells in this image.

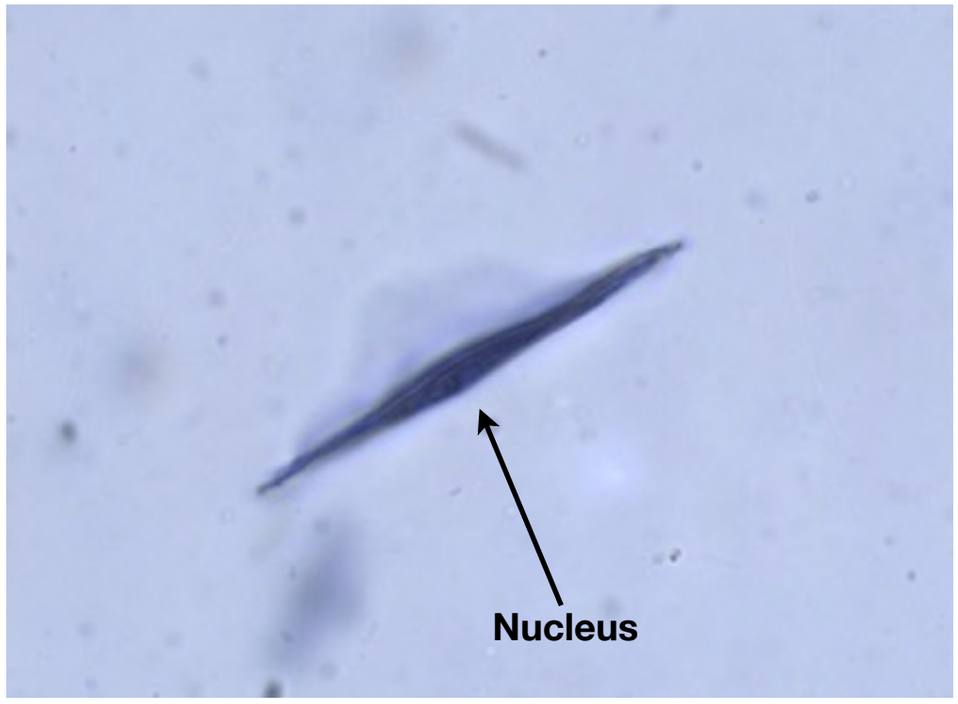


Figure 1C

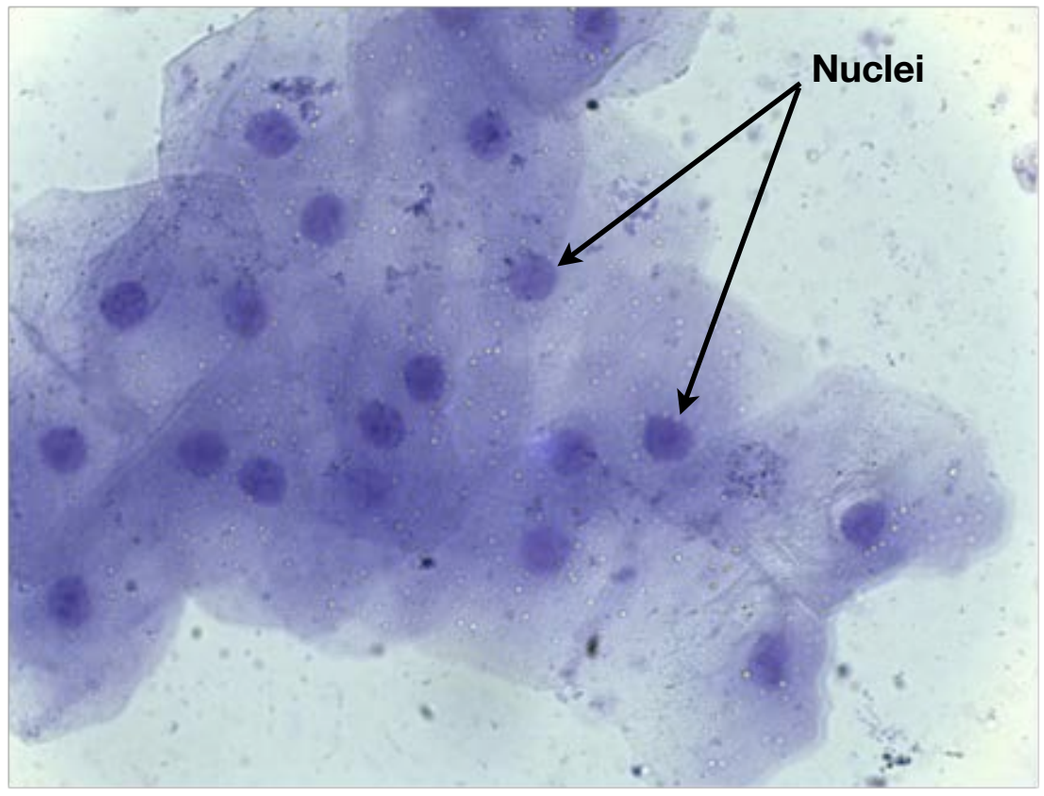
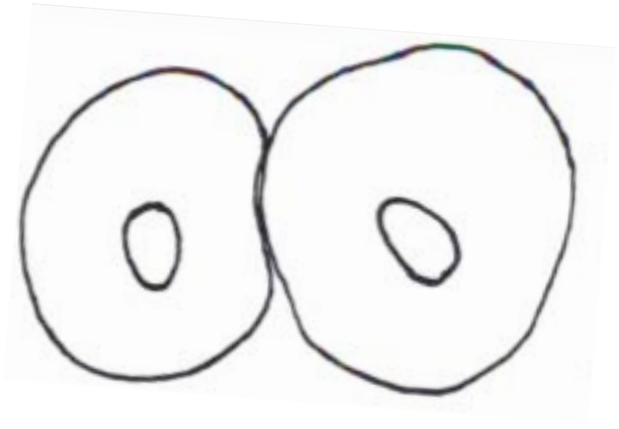


Figure 1D

Transitional Epithelial Cells

DESCRIPTION

Transitional epithelial cells are plump, round, and can occasionally stain slightly darker than squamous cells. They have a smoother shape than squamous cells and are much larger than leukocytes, even macrophages. The diagram below depicts the most typical shapes of this type of cell.



Transitional epithelial cells are larger and are less uniformly round than white blood cells. They should only be seen in urine samples, as this type of epithelium lines the bladder and urinary tract.

Normal Concentrations

Transitional epithelial cells are only observed in *urine samples*; these cells line the bladder and urethra and shed less readily than squamous cells. Squamous epithelial cells are the most commonly seen, and are used to determine the concentration of a sample.

Recording Your Findings

Since these cells are not very commonly observed, they can be counted per slide and noted in the ‘comments’ section of the individual animal’s lab spreadsheet.

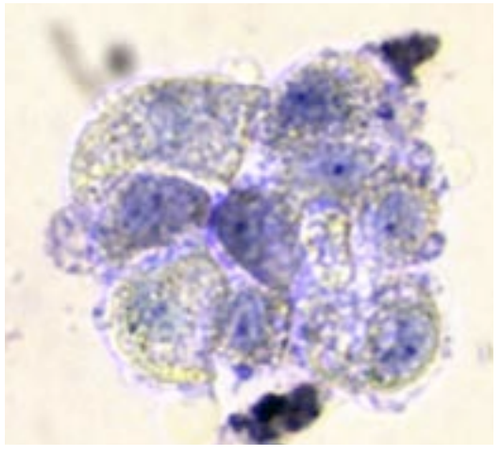


Figure 1E

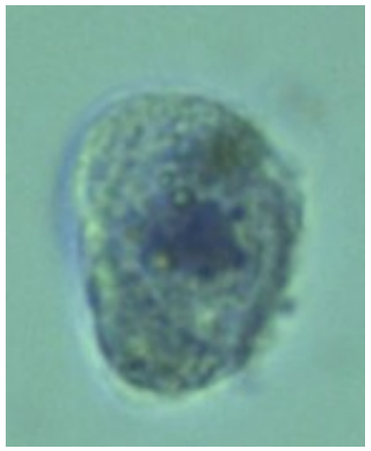


Figure 1F

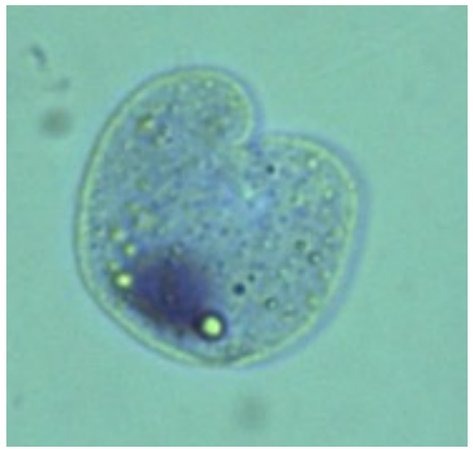


Figure 1G

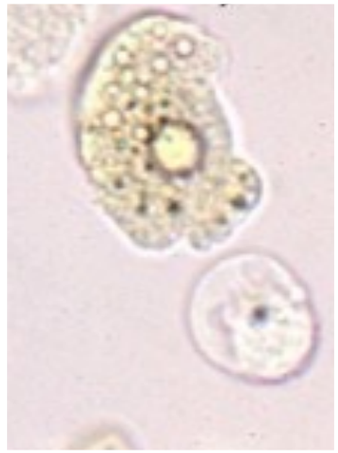


Figure 1.4

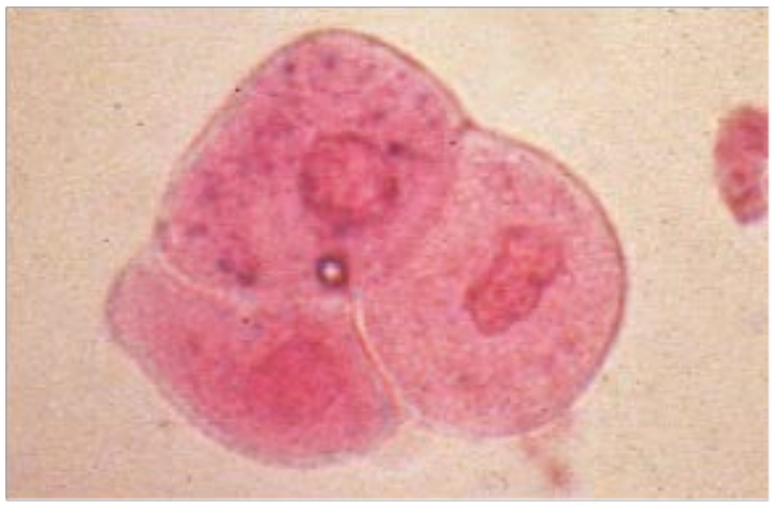


Figure 1.5

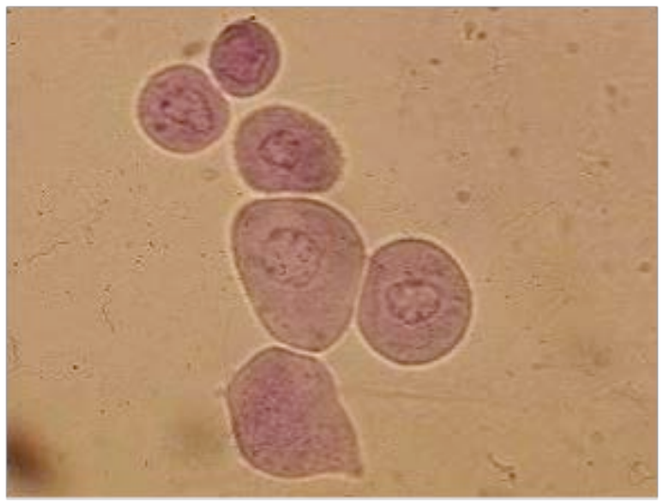


Figure 1.6

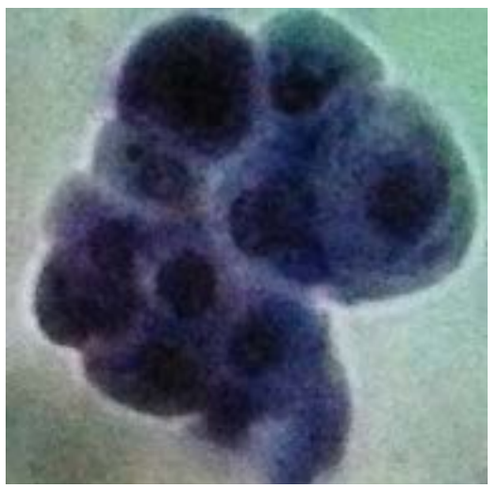


Figure 1.7

Figure 1E: Transitional epithelial cells grouped together in a urine sample. These cells are seen using the 40x objective lens.

Figure 1F & 1G: Transitional epithelial cells.

Figure 1.4, 1.5, 1.6, 1.7: Good examples of transitional epithelial cells. *See References*.

Columnar Epithelial Cells

DESCRIPTION

Columnar epithelial cells are rectangular cells with elongated nuclei, and may or may not have cilia. These types of cells line the respiratory and gastrointestinal tract. They are designed to endure abrasion, so they are not as commonly seen in samples as squamous epithelial cells, which shed readily. The diagram below depicts the typical shape of a columnar epithelial cell.

These cells are elongated and column-shaped, with nuclei that are also elongated and are usually located near the base of the cells. Columnar epithelium forms the lining of portions of the stomach and the intestines. Some columnar cells have hair-like extensions called cilia and are specialized for lining the respiratory tract and oviduct.

Normal Concentrations

Columnar epithelial cells are not as commonly observed in samples as squamous epithelial cells, but may appear in *gastric* and *fecal samples*, and occasionally *sputum samples*.

Recording Your Findings

Any columnar epithelial cells observed in a sample should be counted per slide and noted in the ‘comments’ section of the individual animal’s laboratory spreadsheet.

Figure 1H: A columnar epithelial cell photographed using the 40x lens.

Figure 1I: These cells were observed in a fecal sample.

Figure 1J: A columnar epithelial seen in a blow sample.

Figure 1K: Columnar epithelial cells that incorporate **goblet cells** make up glandular epithelium. This is a specialized epithelium capable of synthesizing various secretions in the body.

Figure 1L: A columnar epithelial taken from a fecal sample.

Figure 1H

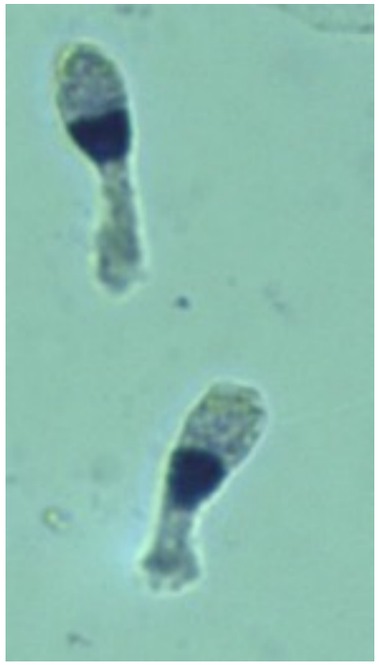


Figure 1I

Figure 1J

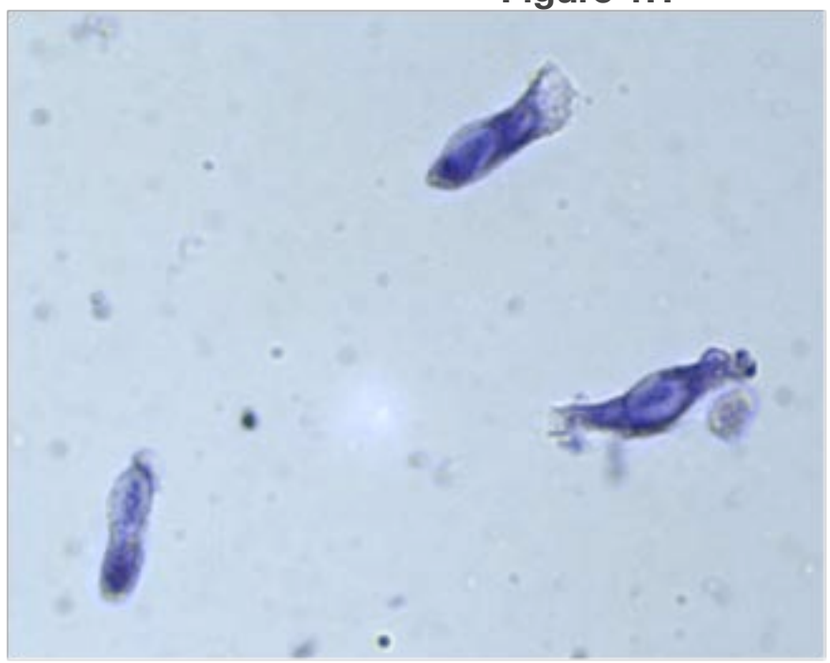


Figure 1K

Figure 1L

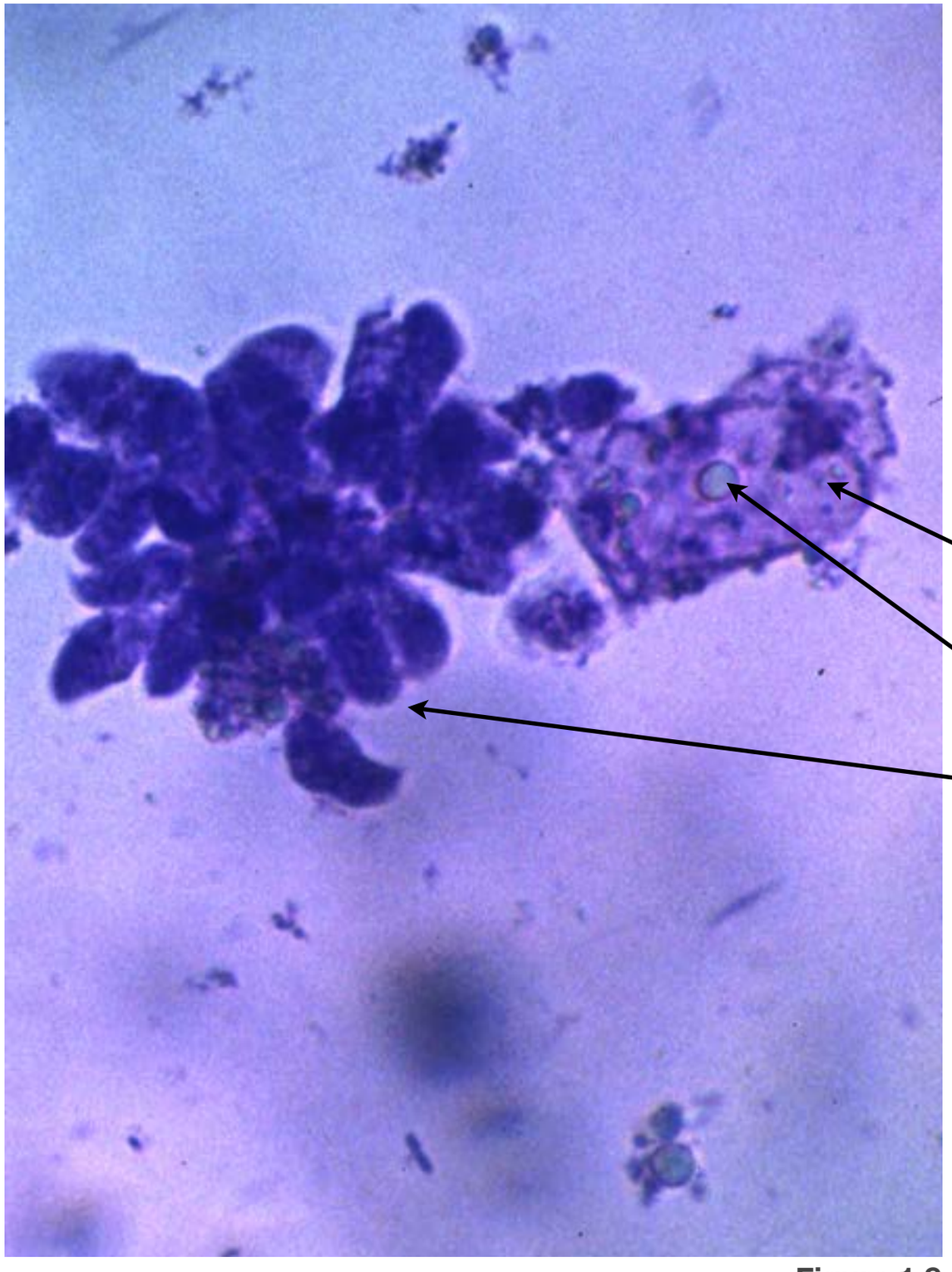


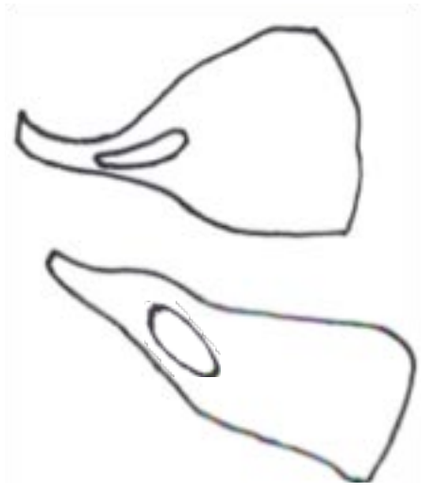
Figure 1.8 This image, taken from *The Handbook of Cetacean Cytology* (see *References*), depicts a clump of columnar epithelial cells in a fecal sample. Also seen within the sample are lipid droplets, and amorphous debris. The material to the right of the columnar cells may be a squamous epithelial cell, however the nucleus is not readily apparent in this image. Adjusting the fine focus knob back and forth on the microscope can often reveal important characteristics of organisms, such as nuclei and other structures. This image was viewed using the 10x objective lens.

Figure 1.8

Gland Cells (Goblet Cells)

DESCRIPTION

Epithelial cells that are specialized for secretion. Glands in the body may be unicellular or multicellular; cells on the slide may appear in clumps or individually. Goblet cells are one type of glandular cell. The diagrams below depict the commonly observed shape of mucous gland cells.



Goblet cells are unicellular gland cells. They are typically observed in the context of columnar epithelial cells, and are therefore more commonly seen in sputum, gastric, or fecal samples. They are slightly tapered at one end, inspiring the 'goblet' terminology.

Normal Concentrations

Gland cells are not as commonly observed in samples as squamous epithelial cells, but can appear in *gastric* and *sputum samples*, and more often *fecal samples*.

Recording Your Findings

Gland cells observed in a sample can be recorded as a per slide count on the animal's lab results sheet in the 'comments' column of the individual animal's lab spreadsheet.

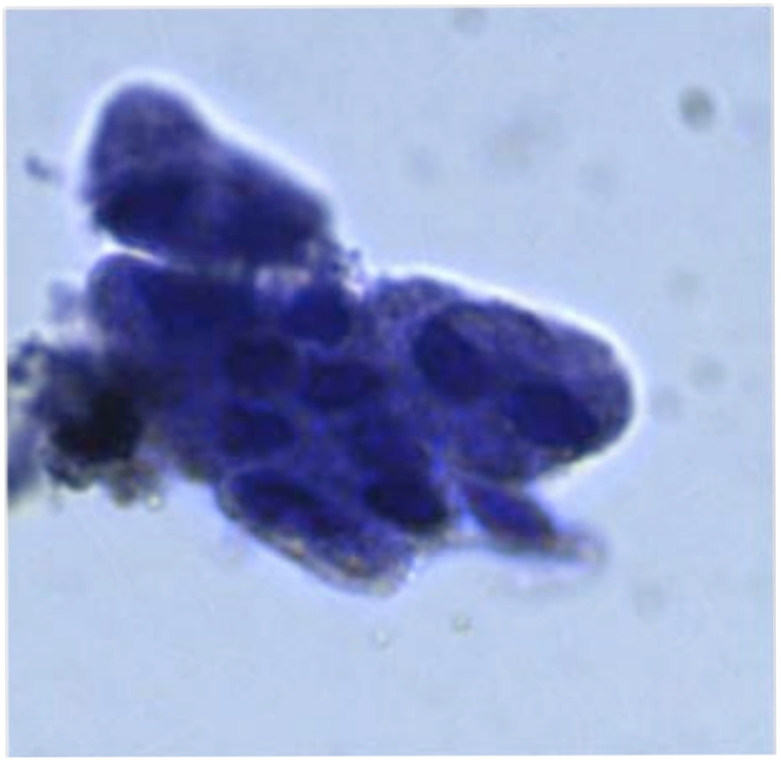


Figure 1M

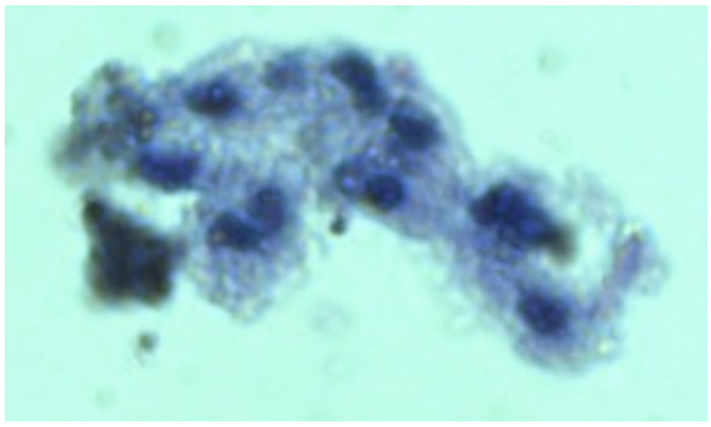


Figure 1P

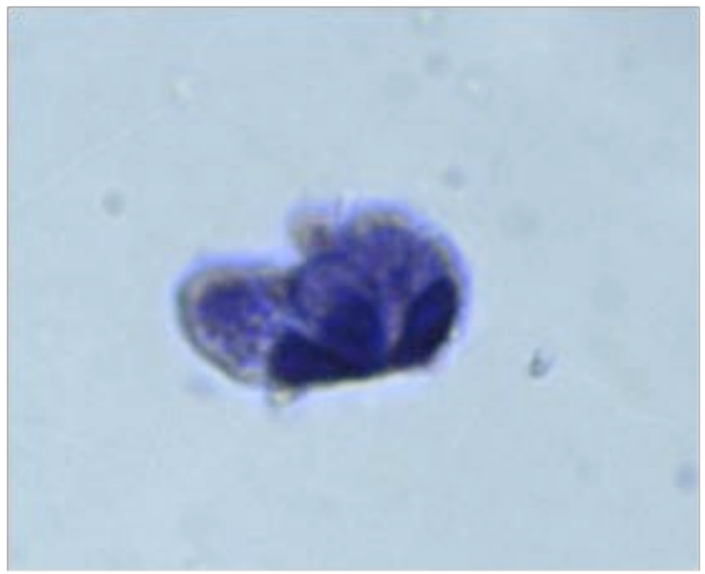


Figure 1N

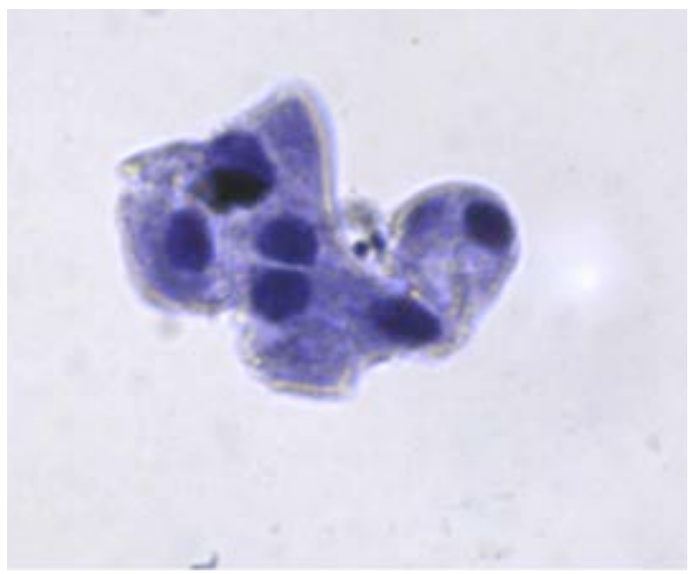


Figure 1O

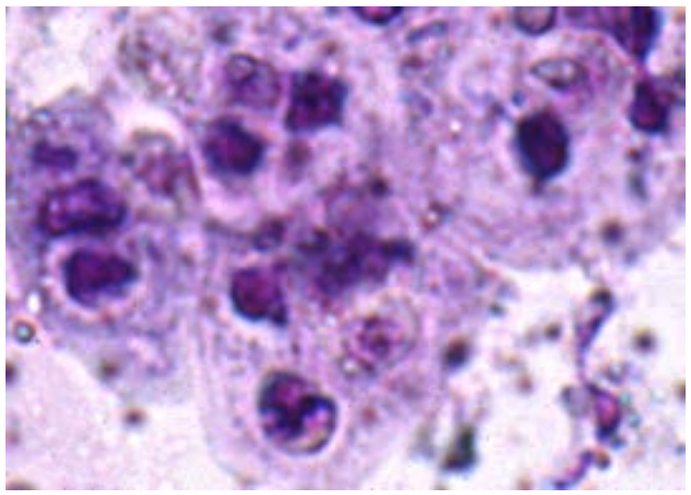


Figure 1.9

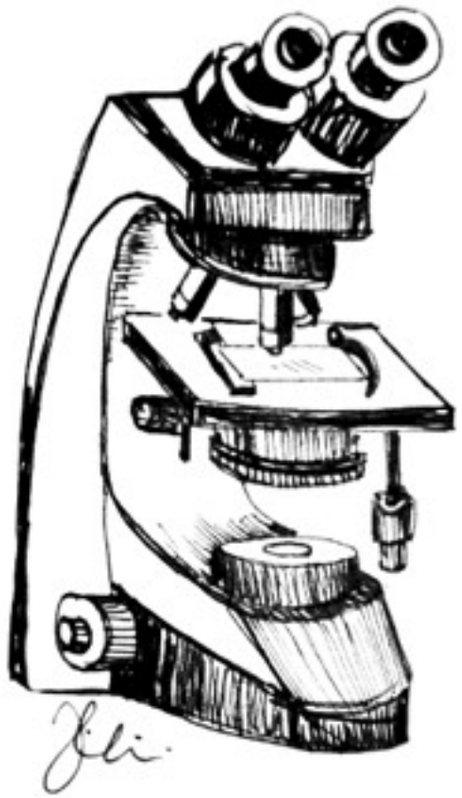
Figure 1M, 1N, 1O & 1P: Groups of gland cells observed in separate fecal samples.

Figure 1.9: Mucus gland cells (see *References*).

References

References

Photo and Video Credits



All photos used in this manual were taken at Dolphin Quest Bermuda by DQ staff unless otherwise noted in the figure caption or in the adjacent *Image References.* Micrographs and videos taken at Dolphin Quest Bermuda by Jennifer Camilleri and Liselotte Rijnink. Illustrations by Jennifer Camilleri (2011). Underwater photography by Kelly-Anne Winfield (2012). Special thanks to Laura Hillman and Rebecca Pollock for providing additional images (*Samples and Collection* chapter photography).

Image References

Figure 1.0 See ATJ's Marine Aquarium Site (2002)

Figure 1.1 See Varela, R. A., et al (2007)

Figure 1.2 See Varela, R. A., et al (2007)

Figure 1.3 See Varela, R. A. et al (2007)

Figure 1.4 See Crowley, I. (2010)

Figure 1.5 See Crowley, I. (2010)

Figure 1.6 See Crowley, I. (2010)

Figure 1.7 See Dierauf, L.A. and Gulland, M.D. (2001)

Figure 1.8 See Sweeney, J. C. et al (2003)

Figure 1.9 See Sweeney, J. C. et al (2003)

Figure 2.0 See Ohio State University (2014)

Figure 3.1 See Dierauf, L. A. and Guilland, M. D. (2001)

Figure 3.2 See Sweeney, J. C. et al (2003)

Figure 3.3 See Sweeney, J. C. et al (2003)

Figure 3.4 See Sink, C. A. and Weinstein, N. M. (2012)

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