Many veterinary practices incorporate digital images of new patients when creating patient records. Veterinary practices also use digital imaging to document specific patient conditions and, increasingly, to obtain images in the radiology suite. Many practices take “before and after” images of patients undergoing dental procedures to provide visual evidence of treatment to clients. Photographs can be used to help explain concepts or disease conditions to pet owners, which may lead to increased client compliance. Digital images can also be used to share patient information during consultations with other veterinary professionals and to create an image library for teaching purposes.

REASONS TO USE DIGITAL MICROSCOPY
Adding digital photomicrography, also known as digital microscopy, can also enhance a veterinary practice (BOX 1). Photomicrographs of abnormalities seen on blood films or tissue cytology preparations, parasite evaluations, urine sediment evaluations, and similar diagnostic tests can be used to document findings in a patient’s record. This can be especially beneficial when handling legal issues that arise from diagnosis or treatment of patients. Photomicrographs can be added to electronic patient records as a simple way to document diagnoses. Regardless of the type of microscope used, having it professionally serviced according to manufacturer’s recommendations is essential.

Digital microscopy has become more affordable, even for small practices. Three common types of digital systems are generally used: those that incorporate a digital microscope, those that attach to the third eyepiece of a trinocular microscope (FIGURE 1), or those that replace one of the eyepieces on a standard binocular microscope. Some systems incorporate a small viewing screen in addition to interfacing with a computer screen or monitor. While it may be possible to obtain an adapter to attach a microscope eyepiece to a standard handheld digital camera for obtaining photomicrographs, some newer cameras cannot be used in this way, and the adapters may be cost prohibitive. Digital microscopy systems may include computer software that allows captured images to be categorized and archived in standard formats such as jpg, bmp.

BOX 1 Benefits of Digital Microscopy

- Enhanced communication with consultants
- Improved client education
- Archiving of images for teaching
- Legal documentation of a patient’s condition

Margi Sirois, EdD, MS, RVT, CVT, LAT
Ashworth College
Norcross, Georgia

Margi received her doctorate in instructional technology and distance education from Nova Southeastern University. She also holds an associate in applied science degree in veterinary technology, and bachelor’s and master’s degrees in biology. She is certified as a veterinary technician and a laboratory animal technician and has over 25 years of experience as a veterinary technician educator in both traditional and distance education programs. Dr. Sirois is program director for the veterinary technology program at Ashworth College and a frequent speaker at veterinary technician education conferences. She has numerous publications, including several textbooks for veterinary technicians. She is past-president of the Kansas Veterinary Technician Association and co-chair of the proposed Academy of Veterinary Technician Specialists in Education.

Adapted with permission from Sirois M. Laboratory Procedures for Veterinary Technicians. 6th ed. St. Louis, MO: Elsevier Mosby; 2015.
and tif. Some of these programs can directly export images to a photo editing program.

In addition to still images, most of the systems can capture video, which can be played back in real time on a monitor or computer screen. This can serve as a training tool for new staff members, allowing multiple individuals to view microscopic images as a veterinary technician performs a microscopic evaluation. Real-time streaming of images via the internet may also be possible and can greatly enhance consultations with other veterinary professionals.

**RESOLUTION**

Digital microscopy systems vary in image resolution capability. Resolution refers to the degree of clarity and visible detail in images. Resolution is measured in pixels: the greater the number of pixels, the greater the degree of detail and clarity and the more the image can be enlarged without loss of clarity.

The two primary types of digital imaging methods use different types of image sensors. Charge-coupled device (CCD) and complementary metal-oxide semiconductor (CMOS) image sensors vary in the degree of sharpness of the images they produce. CCD cameras are recommended because they tend to provide higher-quality images than a comparable CMOS camera at the same resolution. In addition, a CMOS camera may not allow smooth real-time projection of images. The resolution of an image is limited by the resolution of the output device used, such as the computer screen or monitor used to display the image.

Unless the images are to be submitted to a professional publication, the veterinary practice should choose the highest-resolution camera system within its budget. If the practice wishes to print images to give to clients, a resolution of 2 megapixels is generally sufficient for printing images up to 5 × 7 inches without loss of clarity.

**TYPES OF SYSTEMS**

Digital microscopes that incorporate a digital camera and include software to download and save images to a
computer are generally compatible with both Windows and Mac operating systems. These integrated systems tend to be much more costly than purchasing a separate camera to attach to a standard binocular or trinocular clinical microscope. However, integrated systems have the advantage of always being ready to capture images, which they generally do quickly. A very busy practice laboratory may find the higher cost worthwhile.

Various less expensive digital cameras are available to add to a standard clinical microscope for photomicroscopy. Digital cameras that attach to trinocular microscopes are the most efficient. The camera attachment is mounted to the third eyepiece and the system attached to a computer, most often via a universal serial bus (USB) attachment. Some systems contain an integrated media device, such as a secure digital (SD) card, that can be removed to transfer images to a computer. These systems allow veterinary technicians to obtain images quickly in a clinical setting.

An eyepiece camera that attaches to a binocular microscope usually requires replacing one of the microscope eyepieces with the eyepiece camera to capture images directly on a computer (FIGURE 2). These systems are highly cost effective but tend to be slightly slower than the systems discussed above. With an eyepiece camera system, a veterinary technician would remove one of the microscope eyepieces, attach the camera, and capture an image directly on a computer (FIGURE 3). The technician would then remove the camera and replace the eyepiece to continue the remainder of the evaluation.

Devices are also available to allow capture of digital images via a smartphone or tablet attached to a platform that is connected to the microscope eyepiece (FIGURE 4). The platform contains adjustable grips to hold the phone in proper alignment. Each different phone or tablet used requires modification of the grip adjustment. An additional eyepiece can be purchased that is left permanently attached to the platform so that the camera alignment does not have to be adjusted before each use. Many smartphones and tablets also have ports that allow the device to be connected to an external monitor or video projector.

**IMAGE QUALITY**

It is important that microscopes used for obtaining photomicrographs have high-quality optics. The overall

---

**FIGURE 3.** Images can be captured directly on a computer using software provided by the camera manufacturer.

**FIGURE 4.** The miPlatform system attaches to any microscope to allow capture of photos and video using a smartphone or tablet.
quality of digital photomicrographs is greatly influenced by the quality of a microscope’s optics. The microscope should have plan achromatic (flat field) objectives. Many older clinical microscopes use filament light sources (generally halogen or tungsten) and are configured for Köhler illumination. To obtain high-quality images, the microscope must be adjusted to proper Köhler illumination (BOX 2). Without proper illumination and adjustments, the image may appear to be unevenly illuminated, containing bright and dark areas or shadows. A tutorial for performing adjustments to obtain Köhler illumination can be found at microscopyu.com/tutorials/java/kohler/; other resources for online tutorials on obtaining high-quality digital microscope images are listed in BOX 3. Newer clinical microscopes that use light-emitting diodes (LEDs) tend to produce the highest-quality images as a result of enhanced color balance and greater stability of light output.

**BOX 2 Steps for Köhler Illumination**

1. Secure a slide on the microscope stage.
2. Adjust the light source to approximately half its total brightness.
3. Place the 10× ocular lens in position.
4. Verify that the eyepiece is at the correct interpupillary distance and is focused.
5. Use the coarse adjustment knob to focus on the specimen (FIGURE A).
6. Close the field diaphragm and condenser until a small ring of light is visible through the specimen in the field of view.
7. If needed, adjust the condenser screws until the light is centered in the field of view (FIGURE B).
8. Open the diaphragm until the circle of light just touches the edge of the circumference of the field of view.
9. Adjust the condenser until the light is in sharp focus. If this makes the image darker, adjust the brightness to compensate.
10. Repeat this procedure for each ocular objective.

**BOX 3 Online Tutorial Resources**

- Microscopy U (Nikon Instruments)
  microscopyu.com/articles/digitalimaging/index.html
- Microscopy Resource Center (Olympus)
  olympusmicro.com/primer/digitalimaging/index.html

**FIGURE A.**

**FIGURE B.**
**AUTOMATED SYSTEMS**

Automated microscopy systems have long been used in human reference laboratories. These systems are now becoming available to veterinary clinics. One significant advantage of automated systems is improved consistency in preparation and evaluation of samples. Many of these systems are affordable for even smaller-volume veterinary facilities. The specific functions performed by the systems vary.

One type of system is capable of preparing a variety of fluid sample types for evaluation in addition to capturing digital images (FIGURE 5). This system can be used to smear and stain specimens, to stain previously prepared samples, or to scan samples that have already been smeared and stained. The scanned image is saved as a DICOM (Digital Imaging and Communications in Medicine) image and can easily be shared with a pathologist when additional review is needed. Automated systems are also available that can scan a prepared blood smear and provide initial classification of the cell types (FIGURE 6). The veterinary technician can then view the preclassified cells and confirm or reclassify them as needed. This system also allows review and initial evaluation of red blood cell morphology and platelet estimate.

**CONCLUSION**

Digital microscopy can greatly enhance practice recordkeeping and can become a valuable tool for client education and staff training. While image resolution is a significant factor, choosing a system that allows simple image acquisition, storage, and management may be more important. The busy practice laboratory may benefit from the use of one of the automated systems that also provides digital image capture.

**FIGURE 6.** Automated system designed to capture images and classify cell types. (Photo courtesy of Cellavision NorthAmerica, Durham, NC. cellavision.com/en/)

**FIGURE 5.** This Microview system automates the process of smearing, staining, and viewing blood smears and other types of samples and captures a digital image of the slide. (Photo courtesy of Revo Squared. Kennesaw, GA. revosquared.com/microview.html)