ABSTRACT
The teaching of pathology within the veterinary medical curriculum extends through the entire training period and has a dual role. General pathology deals with principles of disease processes as a basis for understanding the reactions of a multi-cellular organism to adverse effects; organ pathology builds on the principles of general pathology and explains the malfunctions of individual organs. Pathology is heavily image dependent and best taught in a highly interactive manner. The Institute of Veterinary Pathology, University of Zurich (IVPZ), has been actively developing concepts for teaching pathology in the new veterinary curriculum, which demands more active participation from students, with 20% of their study time devoted to individual study using traditional materials (books, articles, etc.) and e-learning modules. The Swiss Virtual Animal Pathologist is designed to cover and support the central elements of the Veterinary Pathology curriculum of the Vetsuisse faculty. The needs of students and staff of the participating institutions for an interactive learning platform to supplement the existing face-to-face lectures and tutorials are the highest priority of this initiative.

Key words: e-learning in veterinary pathology; online self-study tools for students; digital microscopy

INTRODUCTION
The role of the veterinary pathologist in science and medicine is wide-ranging and profound. Discoveries made by veterinary pathologists have had important impacts on the health and well-being of humans, animals, and the environment. In animal diagnostics, the pathologist takes a central role in investigating the causes of diseases of individual patients and groups of animals and in determining their zoonotic or epidemic potential. In the chemical and pharmaceutical industries, veterinary pathologists help ensure the safety of medicines, chemicals, and materials used in our daily lives. In the areas of wildlife and environmental conservation, veterinary pathologists are involved in assessing impacts on captive animals and wild animal populations. In governmental agencies, veterinary pathologists are closely involved in decisions on food safety, vaccines, bioterrorism, and legislation on communicable diseases. In research and teaching, veterinary pathologists contribute to the advancement of medical science and share their knowledge with tomorrow’s leaders in the field.

The challenge to the teaching of pathology within veterinary or human medical curricula is correspondingly profound, extending through the entire course of training, and has a dual role (see Figure 1). General pathology deals with principles of disease processes as a basis for understanding the reactions of a multicellular organism to adverse effects from within the organism itself or from the environment. Organ pathology builds on the principles of general pathology, explaining the malfunctions of individual organ systems (organ-based teaching) and relating them to disease processes of a patient as a whole (case-based teaching).

NECESSARY KNOWLEDGE, SKILLS, AND ATTITUDES OF VETERINARY GRADUATES IN GENERAL
Since there is no generally accepted catalog of learning objectives for veterinary medicine in general or veterinary pathology in particular, the following description is based on the Swiss Catalogue of Learning Objectives for Undergraduate Medical Training.1 These objectives were set by a joint commission of Swiss medical schools, a body uniting representatives of all Swiss medical faculties and of the federal authorities involved in medical teaching and training. The last five decades have seen an unprecedented development of knowledge but also of international scientific exchange. As a result, medical and veterinary diagnosis and treatment have been largely standardized. Unfortunately, the curriculum and objectives of undergraduate medical and veterinary training still vary widely from one country to another. Despite this variation, there is extensive movement and exchange of medical personnel across national borders. This mobility requires that all countries accurately define their training objectives, that is, the knowledge and skill levels to be acquired for the medical or veterinary degree.

Within this same period there has been an exponential increase in basic and clinical knowledge and in newly available diagnostic and therapeutic techniques. From this plethora, medical and veterinary educators must carefully select the knowledge and skills their students must acquire and decide when and how they should be taught. Undergraduate training can only hope to provide a small fraction of the necessary knowledge to students. Medical and veterinary educators therefore have no choice but to make a careful selection and clearly fix their objectives.
DIFFERENT LEVELS OF COMPETENCE FOR “SKILLS” IN VETERINARY MEDICINE AND THEIR APPLICATION TO VETERINARY PATHOLOGY

Pathology is heavily image dependent, didactically best taught in a highly interactive manner. For this reason, considerable efforts have been invested in CD-based e-learning modules over a number of years. In Zurich, the “New Course of Study” in veterinary medicine now demands even more active student participation, with at least 25% of study time devoted to individual study. In Zurich in August 2005, a Swiss federal examination in general veterinary pathology was held online for the first time, based on the e-learning modules used in teaching and self-study.

To meet these needs, and those of advanced students studying for European board qualifications (i.e., the European College of Veterinary Pathology, or ECVP), a significant step further must be taken in building on the strengths of an online platform to develop a new integrated online e-learning platform in veterinary pathology. We are currently developing such a platform that encompasses three major areas: lectures accompanying modules, a veterinary pathology trainer for student self-study, and an expert forum for communication. There will be integrated links to other platforms, such as the University of Zurich’s Online Learning and Training (OLAT) portal and Pathobasiliensis (human pathology).

The platform under construction will address the different levels of competence, based on the model in Table 1, and the challenge is to consider how these levels can be applied to learning and teaching in veterinary pathology. Level 1 includes general veterinary pathology, whereas levels 2–4 are equally applicable to organ-based and case-based veterinary pathology.

This means that general veterinary pathology deals in theory (level 1), with principles of disease processes as a basis for understanding the reactions of a multicellular organism to adverse effects from within the organism itself or from the environment. This subject is best taught as a classical lecture-type unit with additional, preferably electronic, self-study modules using flowcharts, graphics, histopathology, and, if appropriate, ultrastructural imaging as explanatory tools.

Organ-based and case-based veterinary pathology builds on the principles of general pathology (levels 2–4) and leads from rare or geographically absent organ lesions or diseases (which the students in level 2 are able to see in tissue samples, in post-mortem investigations, or in electronic pictures or cases available for self-study) to level 3, where students will be taught the basic skills of post-mortem investigation and the subsequent reading of related histopathologic slides under supervision. Students should also have the opportunity to be trained in these skills individually (by performing post-mortem examinations or by examining histopathology slides, using microscopes or electronically).

At level 4 (case-based veterinary pathology), students will gain routine skills in interpreting macroscopic lesions of diseases in animal species occurring regularly in their geographic region as a basis for making a diagnosis in a live patient. Interpretation of histopathology slides (using microscopes or electronically) is an explanatory tool and is not considered a core competence at the undergraduate level.

HISTORICAL ASPECTS OF E-LEARNING IN VETERINARY PATHOLOGY

Computer laboratories to facilitate the learning and teaching of veterinary pathology are now more and more common in veterinary schools, and individual students frequently have access to high-speed Internet connections from their personal computers outside the classroom. Computer-assisted instruction, which offers the benefits of self-paced learning and the ability to revisit material as often as possible for clarification, is especially appropriate to pathology because of its highly visual nature.
Development of such learning tools began in the 1970s, when the first auto-tutorial methods were introduced in teaching and learning veterinary pathology. At this time students could obtain information from 35-mm slide transparencies accompanied by audiocassette tapes, histological specimens, reprint references, preserved gross specimens, and textbooks. A weekly quiz session allowed close supervision of students’ progress by instructors and provided feedback to students for evaluation of their own progress. In 1979 the American College of Veterinary Pathologists launched a National Program for Instructional Development in Veterinary Pathology. At the University of Georgia such an approach was used for nine consecutive years and evaluated by students; some of the major conclusions were as follows:

- Students prefer auto-tutorials over conventional teaching.
- Students accept the responsibility of setting their own schedules.
- After finishing such a course, students have a strongly positive attitude toward the field of pathology.

The application of computer-assisted learning approaches therefore opened new approaches to teaching pathology. A further example in human pathology is reviewed and discussed by Harkin et al.7 The next step in the development of electronic teaching and study material was the use of electronic data storage and database tools for use in veterinary pathology. One of the most widespread commercial products internationally is Noah’s Arkive (the International Veterinary Pathology Slide Bank, or IVPSB) at the University of Georgia, a collection of macroscopic and histological transparencies of gross lesions, histopathology, normal histology, cytology, and hematology including schematics, radiographs, electron micrographs, and techniques related to veterinary pathology. The project was initiated by Tyler, Crowell, and Smith and was originally designed as a videodisc. It is now distributed on CD-ROM using PC software, and a Macintosh-based version of IVPSB was made available in the early 1990s.

Many of the early developments in computer-assisted teaching of veterinary pathology did not encourage students to explore microscopic pathology, not least because of the limitations of fixed-field displays. Rapid progress in computing power, combined with the development of digitized virtual slides, now provides an innovative and remarkably effective solution to this problem, which to date has been used primarily in human anatomy, pathology, and hematology. In one example, students remarked repeatedly that the use of virtual slides is appreciated because everyone sees the same image at the same time; from a didactic standpoint, this is valuable because it encourages collaboration and interaction among students using the same workstation.

CONCEPT FOR E-LEARNING IN VETERINARY PATHOLOGY INTRODUCED AT THE INSTITUTE OF VETERINARY PATHOLOGY, UNIVERSITY OF ZURICH (IVPZ)

For several years, the Institute of Veterinary Pathology, University of Zurich (IVPZ), has been actively developing concepts for teaching pathology in the new veterinary curriculum. General Pathology is now taught as one of the non-organ-based subjects offered in year 2, while Organ Pathology is fully integrated into the network of organ-based subjects taught in years 2 and 3. Case-based teaching and learning now take place in years 4 and 5 of the new curriculum. Students in year 4 are introduced to major disease symptoms and syndromes; in year 5, rotations through clinical units and departments are designed to improve the skills of future graduates. The new veterinary curriculum demands a more active participation from students, with 20% of their study time devoted to individual study using traditional materials (books, manuscripts, etc.) and e-learning modules. Unfortunately, e-learning modules for pathology were virtually non-existent in the university’s previous veterinary curriculum and therefore needed to be developed.

General Veterinary Pathology is taught primarily through lectures as part of the basic science program and deals with principles of disease processes as a basis for understanding the reaction of a multicellular organism to adverse effects from within the organism itself or from the environment. Online modules provide supplementary material through online histopathology slides, lecture notes, and standard textbooks.

Specific Organ Pathology is similarly taught through a lecture series, supplemented by lecture notes. This is currently supplemented by CD-ROM e-learning modules, developed or under construction at the IVPZ. The modules were developed partly in cooperation with other disciplines and other European veterinary schools (Università di Torino, Italy; Tierärztliche Hochschule Hannover, Germany; Universiteit Utrecht, Netherlands).

Practical courses are complemented by a database of images, created using Canto Cumulus, showing the morphology of normal and diseased organs. These aspects were integrated into our CD-ROMs devoted to specific organs, namely the liver, the lung, and the GI tract; the kidney CD-ROM is under development. Also available are CD-ROMs describing post-mortem inspection, the anatomic pathological changes in organs as a basis for meat inspection, and an overview of histological stains and methods.

Students are presented with clinical reports and anatomic and histologic pathology findings of a diseased animal patient (a case), to which they add the findings from additional investigations (bacteriology, parasitology, virology). From this they build a diagnosis as a basis for therapy or prophylaxis.

The pedagogical challenge to the veterinary pathologist is to integrate visually based learning with in-depth understanding of disease processes. This process is heavily image dependent and best taught in a highly interactive manner. For these reasons we decided to develop the Swiss Virtual Animal Pathologist, an online e-learning platform based around three didactic modules: Lectures, Trainer, and Forum. Lectures will contain in-depth information on individual topics (such as oncology, cellular pathology, microscopy, or organ-specific topics). Trainer will test knowledge and create...
“real-life” situations for the student to solve. Forum allows the exchange of expertise between students and experts.

The Swiss Virtual Animal Pathologist\textsuperscript{16} is designed to cover and support the central elements of the Veterinary Pathology curriculum of the Vetsuisse Faculty. The need of students and staff at participating institutions for an interactive learning platform to supplement the existing face-to-face lectures and tutorials is at the forefront. To facilitate the implementation of the e-learning modules, a lecture room at IVPZ has been equipped with 50 laptop computers and WLAN, allowing students to be trained in the technology. The integration of the former veterinary faculties of the Universities of Bern and Zurich into the new Vetsuisse Faculty has placed considerable demands on lecturers’ mobility and time. A single dynamic online platform, tailored to the needs of the individual student and incorporating our current CD-based learning and virtual microscope modules (Scanscope\textsuperscript{17}) and the online Vetpath trainer\textsuperscript{18} would be a major step forward. Additional modules can be specifically developed to take full advantage of the new platform. Ready familiarity with the use of online platforms not only facilitates individual study but is becoming essential, as an online examination in General Pathology is now under development.

CONCLUSIONS

The challenges of teaching pathology within veterinary and human medicine curricula are profound, extending through the entire training program. Pathology is heavily image dependent and is best taught in a highly interactive manner. For this reason, considerable efforts have been invested in CD-based e-learning modules over a number of years. Now the Swiss Virtual Animal Pathologist\textsuperscript{16} is designed to cover and support the central elements of the Veterinary Pathology curriculum of the Vetsuisse Faculty. The needs of students and staff at participating institutions for an interactive learning platform to supplement the existing face-to-face lectures and tutorials are the highest priority of this project. It is our hope that through this process we will be able to develop an e-learning platform in veterinary pathology that will find application in a wider European setting.

NOTE


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