CD-ROM Teaching Unit On The Digestive System Of Vertebrates

C. Edward Stevens

College of Veterinary Medicine, North Carolina State University, Raleigh, North Carolina USA

Key words: comparative physiology; extinction; gastrointestinal tract; adaptations

The present-day vertebrates are comprised of approximately 45,000 species of fish, amphibians, reptiles, birds and mammals that have adapted to a wide-range of freshwater, marine, and terrestrial habitats. Their digestive system provides for the assimilation of the energy and nutrients required for maintenance, growth, and reproduction. This is accomplished by complex series of episodic events that reduce food to a limited number of readily absorbable nutrients and reject or destroy most toxic or infectious agents. Many of the basic characteristics of the vertebrate digestive system are common to all species. However, its various components show a wide range of structural and functional adaptations to the habitat, diet, energy requirements, and other physiological characteristics of the species. Some of these adaptations are the result of divergence from a common or more primitive form. Others represent convergence on similar structures or functions in distantly related species. These adaptations tell us a great deal about the basic functions of the digestive system, their integration with other systems of the body, and how these may have evolved.

Comparative studies of the digestive system have made numerous contributions to our understanding of basic physiological mechanisms associated with digestion, secretion, and absorption, and how they evolved. The adaptations of species to a wide range of habitats and diets provide many excellent examples of the integration between the digestive system and other systems of the body. The applications of this information to the care and maintenance of agricultural, companion, laboratory, and captive animals are obvious. However, one of the most compelling reasons for the study of comparative physiology is the need to preserve endangered species. Paleontologists have recorded six massive and numerous other major extinctions of plants and animals in the past 500 million years. Most of extinctions were the result of tectonic and climatic changes that occurred over relatively short periods of geological time.

The most recent mass extinction, which eliminated both the dinosaurs and other terrestrial vertebrates over 10 kg body weight, is believed to have resulted from the catastrophic impact of a meteor at the Cretaceous/Tertiary boundary about 65 mya. The most recent major extinction occurred at the end of the last glacial period, around 11,000 years ago, with the extinction of numerous species of large European and American mammals [Owen-Smith, 1988]. This extinction has been attributed to both rapid climatic changes and human predation.

However, many biologists agree that the present rate of plant and animal extinction is greater than this and due largely to humans alone.

The United Nations Environmental and Development Program, World Resources Institute, and World Bank conducted a Pilot Analysis of Global Ecosystems [Rosen, 2000]. It shows that human consumption of freshwater rose six-fold in the past century and we now use 54% of that available. Silts, fertilizers, sewage, and other contaminants have killed lakes and poisoned rivers, and the introduction of nonnative species has destroyed many indigenous species or clogged waterways. The Colorado, Yellow, and Ganges rivers dry up at times before reaching the sea. Two-thirds of all harvested fish are dependent on coastal wetlands and seas, or coral reefs at some stage in their development. Yet, half of the world's wetlands have been drained and pollution and plant nutrient runoffs produce algae blooms and other conditions that have resulted in the complete absence of fish and invertebrates in some regions of coastal waters.

Our global forests are inhabited by about two-thirds of all terrestrial species and store 40% of the terrestrial CO_2. Rain forests, which cover 6% of earth's surface, contain most of these species. Yet, almost all of the original forests of industrial nations, other than Russia and Canada, have been cleared. Logging in developing countries is faster than tree growth and much of the rain forest has been destroyed by logging or by slashing and burning for agriculture. The UN report concludes with a summary of the economic, moral, and ethical reasons for addressing these problems, but points out that some multimillion-dollar attempts have failed, because we simply do not know enough about the needs and interrelationships of plants and animals. This is due partly to the advances in cellular and molecular physiology that leaves little time for the teaching of comparative or integrative physiology.

This CD-ROM is patterned after a graduate course that has been taught for the past 25 years at Cornell and N. C. State Universities and the text on *Comparative Physiology of the Vertebrate Digestive System* [Stevens and Hume, 1995]. However, it is designed for use in the teaching of comparative physiology and nutrition, and as a supplement for courses on general and human physiology. Therefore, it begins with a brief discussion of the taxonomic classifications, diets, and distribution of vertebrates, and pictures of representative species. This is followed by discussions of their basic energy and nutrient requirements and the general characteristics of their digestive system. Subsequent sections discuss variations in the motor (muscular) activities of the digestive tract, digestion by endogenous enzymes and indigenous microorganisms, absorption of nutrients, secretion and absorption of electrolytes and water, and the neuroendocrine control of these processes. The final section summarizes the major digestive adaptations and strategies, and discusses how these may have evolved.

Comparisons of the structural and functional variations in the digestive system are aided by over 200 figures and tables, which often include silhouettes of the animals to aid in their recognition. Animals are referred to by their common names and their genus and species. The table of contents and index allow retrieval of information and illustrations on each subject for independent viewing or presentation, and a list of references is provided for more detailed information.

ACKNOWLEDGEMENTS

CD layout and design by Brenda L. Bunch, MAMS, North Carolina State University, College of Veterinary Medicine Biomedical Communications. Functionality and usability reviewed by Esther J. Finegan, Animal and Poultry Science, University of Guelph, Guelph, Ontario.

REFERENCES

Owen-Smith RN. 1988. Megaherbivores. The influence of very large body size on ecology. Cambridge University Press, Cambridge (UK): Cambridge University Press. 369 p.

Rosen C. 2000. World Resources 2000-2001. People and Ecosystems: The fraying web of life. Oxford, UK: Elsevier Science. 390 p.

Stevens CE, Hume ID. 1995. Comparative Physiology of the Vertebrate Digestive System, 2nd ed. New York: Cambridge University Press. 400 p.