

CURRICULUM VITÆ RICHARD FREDERICK DRUSHEL

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Current Occupation: Senior Research Associate and Adjunct Instructor, laboratory of Dr. Hillel Chiel,
Department of Biology, Case Western Reserve University (CWRU), Cleveland, Ohio 44106-7080.

2. Education.

- 1987-1992: Graduate student, Department of Biology, CWRU. Thesis advisor: Dr. Arnold I. Caplan. Thesis research: ultrastructure and immunohistochemistry of embryonic chick muscle proteoglycans; 3-dimensional anatomical reconstruction of embryonic chick leg muscle; basement membrane formation in *in vitro* muscle culture systems. Received Ph.D. degree 15 January 1993. Dissertation entitled: "Anatomical and Extracellular Matrix Development of Embryonic Chick Leg Muscle *In Vivo* and *In Vitro*."
- 1984-1986: School of Medicine, CWRU. Withdrew at the end of the 2nd year for personal and financial reasons.
- 1980-1984: Undergraduate, CWRU. Major: Biology. Minor: Chemistry. Undergraduate research in the laboratory of Dr. Arnold I. Caplan (1983-1984), studying vascular and extravascular fluid dynamics in embryonic chick wing development, leading to an Honors Thesis. Graduated *summa cum laude* with Honors in Biology, receiving the degree of B.A. in Biology.
- 1980: Graduated as Salutatorian from Liberty High School, Shady Road, Youngstown, Ohio 44505.

3. Teaching Experience.

- Fall 2002: BIOL/EECS 375/475, Autonomous Robotics , with Dr. Hillel Chiel. This undergraduate/graduate course involves the construction of autonomous robots using a 68HC11 microprocessor board programmed in C, various touch and photosensors, and peripheral structures constructed from LEGO bricks, motors, and gears. Duties include preparing student exercises in C programming, LEGO construction, and sensor calibration; sensor construction; designing, building, and writing system software for new sensors; debugging microprocessor hardware; assisting students with design, programming, and hardware debugging.
The end-of-semester Egg Hunt competition will be held at the Great Lakes Science Center on 14 December 2002
, and also webcast live around the world through APKnet.
- Spring 2002: BIOL/EECS 375/475, Autonomous Robotics (primary instructor), with Dr. Hillel Chiel. The end-of-semester
Egg Hunt competition was held at the Great Lakes Science Center on 28 April 2002, and also webcast live around the world through APKnet.
- Fall 2001: BIOL/ECES 375/475, Autonomous Robotics, with Dr. Randy Beer. The end-of-semester Egg Hunt competition was held at the Great Lakes Science Center on 9 December 2001, and also webcast live around the world through APKnet.
- Summer 2001: BIOL 803, Autonomous Robotics for High School Science Teachers. A 10-day course which introduces principles of automous robotics, C programming, and mechanical construction with LEGOs to high school science teachers. Teachers are allowed to borrow robot kits for use during the school year.
There were 6 participants. 18-29 June.

- Spring 2001: BIOL/ECES 375/475, Autonomous Robotics (primary instructor), with Dr. Hillel Chiel. The end-of-semester Egg Hunt competition was held at the Great Lakes Science Center on 24 April 2001, and also webcast live around the world through APKnet.
- Fall 2000: BIOL/ECES 375/475, Autonomous Robotics, with Dr. Randy Beer. The end-of-semester Egg Hunt competition was held at the Great Lakes Science Center on 10 December 2000.
- Summer 2000: BIOL 803, Autonomous Robotics for High School Science Teachers. There were 10 participants, including one high school student working with a teacher from her school. 19-30 June.
- Spring 2000: BIOL/ECES 375/475, Autonomous Robotics (primary instructor), with Dr. Hillel Chiel. The end-of-semester Egg Hunt competition was held at the Great Lakes Science Center on 30 April 2000, and also webcast live around the world through discovery.com.
- Summer 1999: BIOL 803, Autonomous Robotics for High School Science Teachers. There were 7 participants. 14-25 June.
- Fall 1999: BIOL/ECES 375/475, Autonomous Robotics, with Dr. Randy Beer.
- Spring 1999: BIOL 121, Concepts for a Molecular View of Biology II. The second semester of a 2-semester core course for freshman B.S.N. students at the Frances Payne Bolton School of Nursing. Topics include: carbohydrates, lipids, proteins, enzyme kinetics, metabolic pathways and bioenergetics, DNA and RNA, methods of molecular biology, and nutrition. Applications to human physiology and medicine are emphasized.
- BIOL/ECES 375/475, Autonomous Robotics (primary instructor), with Dr. Hillel Chiel.
- Fall 1998: BIOL 119, Concepts for a Molecular View of Biology I. The first semester of a 2-semester core course for freshman B.S.N. students at the Frances Payne Bolton School of Nursing. Introduction to the principles of inorganic and organic chemistry essential to the study of biochemistry, molecular biology, and pharmacology. Topics include: atomic theory, the periodic table, chemical bonds, molecular geometry, ideal gas laws, equilibrium and reaction rates, acids and bases, nuclear chemistry, and nomenclature and reactions of organic compounds (including alkyl, aryl, alcohol carbonyl, and amino compounds). Problems involving numeric computation are emphasized.
- BIOL/ECES 375/475, Autonomous Robotics, with Dr. Randy Beer.
- Spring 1998: BIOL 121, Concepts for a Molecular View of Biology II.
- BIOL/ECMP 375/475, Autonomous Robotics (primary instructor), with Dr. Hillel Chiel.
- Fall 1997: BIOL 119, Concepts for a Molecular View of Biology I.
- BIOL/ECMP 375/475, Autonomous Robotics, with Dr. Randy Beer.
- Spring 1997: BIOL/ECMP 375/475, Autonomous Robotics (primary instructor), with Dr. Randy Beer and Dr. Hillel Chiel.
- Fall 1996: BIOL/CMPS/NEUR 479, Seminar in Computational Neuroscience (the precursor to Autonomous Robotics; the same course with a different name), with Dr. Randy Beer.
- Spring 1996: BIOL/CMPS/EBME/NEUR 479, Seminar in Computational Neuroscience (primary instructor), with Dr.

Hillel Chiel.

- Spring 1995: BIOL/CMPS/EBME/NEUR 479, Seminar in Computational Neuroscience (teaching assistant), supervised by Dr. Randy Beer and Dr. Hillel Chiel. This was the first time the LEGO robotics course was offered, and I was deeply involved in the construction of the course.
- Fall 1986: BIOL 111, Introductory Biology Laboratory (teaching assistant), supervised by Dr. Norman Alldridge (deceased), Department of Biology. Duties included brief weekly lectures, preparing weekly quizzes for my lab section, setting up lab practicals, and grading examinations.
- Spring 1986: BIOL 113, Comparative Vertebrate Anatomy (teaching assistant), supervised by Dr. Darhl Foreman, Department of Biology. Duties included dissections of rabbits and sharks, demonstration of vertebrate osteological specimens, teaching dissection techniques, preparing lab practicals, and grading examinations.
- Fall 1985: BIOL 346, Human Gross Anatomy (teaching assistant), supervised by Dr. Martin Rosenberg, Department of Biology. This is a core course for N.D. students at the Frances Payne Bolton School of Nursing. Duties included dissection of cadavers, demonstration of dissections, preparing lab practicals, and grading examinations.
- Spring 1985: BIOL 113, Comparative Vertebrate Anatomy (teaching assistant), supervised by Dr. Darhl Foreman, Department of Biology.
- Fall 1984: BIOL 346, Human Gross Anatomy (teaching assistant), supervised by Dr. Jocelyn Zika, Department of Anatomy.

4. Research Experience.

- Jun 1996-date: Senior Research Associate, laboratory of Dr. Hillel Chiel, Department of Biology, CWRU. Continuing to develop dynamic 3-D kinematic models of the radula-odontophore of the marine slug *Aplysia californica*, including validation techniques using data from MRI imaging.
- Jun 1993-Jun 1996: Research Associate, laboratory of Dr. Hillel Chiel, Department of Biology, CWRU. Developed a 3-dimensional model of the buccal mass of *Aplysia californica*, using computer-assisted graphical reconstruction techniques, as well as performing detailed kinematic studies of *Aplysia* feeding behavior. Also supervised kinematic data acquisition by undergraduate students.
- Dec 1992-Jun 1993: Research Assistant, laboratory of Dr. Hillel Chiel, Department of Biology, CWRU. Began development of a 3-dimensional model of the *Aplysia* buccal mass from serial cross sections.
- 1986-1987: Laboratory Technician I, laboratory of Dr. Arnold Caplan, Department of Biology, CWRU. Duties included routine light microscopic procedures (fixation, paraffin embedding, microtomy, staining, photomicrography), rotary shadowing of molecular sprays for electron microscopy, standard photographic darkroom work (developing, printing, figure preparation).

5. Research Publications.

- Drushel, R.F., Sutton, G.P., Neustadter, D.M., Mangan, E.V., Adams, B.W., Crago, P.E., and H.J. Chiel (2002). Radula-centric and odontophore-centric kinematic models of swallowing in *Aplysia californica*. *J. Exp. Biol.* **205**: 2029-2051.

- Neustadter, D.M., Drushel, R.F., and H.J. Chiel (2002). Kinematics of the buccal mass during swallowing based on magnetic resonance imaging in intact, behaving *Aplysia californica*. *J. Exp. Biol.* **205**: 939-958.
- Neustadter, D.M., Drushel, R.F., Crago, P.E., Adams, B.W., and H.J. Chiel (2002). A kinematic model of swallowing in *Aplysia californica* based upon radula/odontophore kinematics and *in vivo* MRI. *J. Exp. Biol.* **205**: in press.
- Neustadter, D.M., Drushel, R.F., Crago, P.E., and H.J. Chiel (2001). A 3-dimensional model of the odontophore of *Aplysia* throughout a swallowing cycle. Abstract 943.7, 31st Annual Meeting, Society for Neuroscience.
- Secrist, D., and R. Drushel (2001). Kicking robutt: How one teen used physics to build a mean fighting machine for TV's *Battlebots*. *Current Science* **86**: 4-6.
- Sutton, G.P., Drushel, R.F., Neustadter, D.M., Crago, P.E., and H.J. Chiel (2000). A kinematic model of *Aplysia* swallowing based on MRI imaging. Abstract, 30th Annual Meeting, Society for Neuroscience.
- Beer, R.D., Chiel, H.J., and R.F. Drushel (1999). Using autonomous robotics to teach science and engineering. *CACM* **42**: 85-92.
- Chiel, H.J., Neustadter, D.M., Sutton, G., Drushel, R.F., and P.E. Crago (1999). MRI imaging and kinematic modeling of feeding responses of the buccal mass of *Aplysia californica*. Abstract, 29th Annual Meeting, Society for Neuroscience.
- Neustadter, D.M., Drushel, R.F., Crago, P.E., and H.J. Chiel (1999). Modeling the biomechanics of molluscan feeding. *Comments Theor. Biol.* **5**: 119-143.
- Chiel, H.J., Neustadter, D.M., Drushel, R.F., and P.E. Crago (1998). Biomechanics and neural control of the feeding apparatus of *Aplysia californica*. Abstract 752.16, 28th Annual Meeting, Society for Neuroscience.
- Drushel, R.F., Neustadter, D.M., Crago, P.E., and H.J. Chiel (1998). Kinematic models of the buccal mass during feeding in *Aplysia californica*. *J. Exp. Biol.* **201**: 1563-1583.
- Drushel, R.F., Neustadter, D.M., Shallenberger, L.L., Crago, P.E., and H.J. Chiel (1997). The kinematics of swallowing in the buccal mass of *Aplysia californica*. *J. Exp. Biol.* **200**: 735-752.
- Drushel, R.F., Crago, P.E., and H.J. Chiel (1994). Static- and dynamic-radula/odontophore kinematic models of the buccal mass of *Aplysia californica*. Abstract 653.19, 24th Annual Meeting, Society for Neuroscience.
- Carrino, D.A., Dennis, J.E., Drushel, R.F., Haynesworth, S.E., and A.I. Caplan (1994). Identity of the core proteins of the large chondroitin sulphate proteoglycans synthesized by skeletal muscle and prechondrogenic mesenchyme. *Biochem. J.* **298**: 51-60.
- Drushel, R.F., Crago, P.E., and H.J. Chiel (1993). The muscular hydrostatic structure of the buccal mass of *Aplysia californica*. Abstract 657.1, 23rd Annual Meeting, Society for Neuroscience.
- Fernandez, M.S., Dennis, J.E., Drushel, R.F., Carrino, D.A., Kimata, K., Yamagata, M., and A.I. Caplan (1991). The dynamics of compartmentalization of embryonic muscle by extracellular matrix molecules. *Dev. Biol.* **147**: 46-61.
- Drushel, R.F., and A.I. Caplan (1991). Three-dimensional reconstruction and cross-sectional anatomy of the thigh musculature of the developing chick embryo (*Gallus gallus*). *J. Morphol.* **208**: 293-309.
- Drushel, R.F., and A.I. Caplan (1988). The extravascular fluid dynamics of the embryonic chick wing bud. *Dev. Biol.* **126**: 7-18.
- Drushel, R.F., Pechak, D.G., and A.I. Caplan (1985). The anatomy, ultrastructure and fluid dynamics of the developing vasculature of the embryonic chick wing bud. *Cell Differ.* **16**: 13-28.

6. Research Students.

Andrew Jones, Michael Krofcheck, Victor Lee, and Nicholas Lunn (Fall 2002, Spring 2003): Wireless communication project for LEGO robots, EECS 398 (Senior Project in Electrical Engineering).

Adam Feldman (Fall 1999, Spring 2000): Navigator robot project, ECES 392.

Joshua Kershner (Fall 1999): Navigator robot project, BIOL 388 (Undergraduate Research).

7. Professional Organizations, Awards, and Honors.

2002: Nominee for Carl F. Wittke Award for Distinguished Undergraduate Teaching, CWRU.

Student Leadership Award, Outstanding Faculty Advisor for a Student Organization (Beta Nu Chapter, Theta Chi Fraternity), CWRU.

2001: Alumni Award, Spring 2001 semester, Beta Nu Chapter, Theta Chi Fraternity, CWRU.

2000: Golden Key Society, honorary member, Fall 2000, CWRU.

Faculty Member of the Semester, Spring 2000, Greek Life Office, CWRU.

Faculty Member of the Month, December/January, Greek Life Office, CWRU.

1999: Hewlett Awards Committee, CWRU, award of a new desktop computer for use in undergraduate education.

1994: Society for Neuroscience.

1993: Sigma Xi Scientific Research Society, CWRU Chapter.

1984: Phi Beta Kappa, Alpha of Ohio Chapter.

1984: Richard Reichert Award: To the CWRU fraternity/sorority member who has made the greatest contribution to campus life, CWRU.

1983: William Grauer Award for Excellence in Drawing, Art Studios, CWRU.

1980-1984: Alumni Scholarship (half-tuition), CWRU.

8. Invited Seminars, Lectures, and Presentations.

20 Aug 2002: Orientation lecture, CWRU, "Autonomous Robots, Or, Frankenstein's Children."

19 Aug 2002: Gave a 4-hour autonomous robotics laboratory for incoming freshman during the Cruisin' CWRU program for Orientation, CWRU.

15-18 Jul 2002: Gave 2 4-hour autonomous robotics laboratories for incoming freshmen as part of the weeklong ACES (Academic and Computer Excellence Seminar) program run by Educational Support Services, CWRU.

15 May 2002: Gave 3 30-minute presentations about biological research, with live demonstrations

of *Aplysia californica*, to 5 classes of students at Boulevard Elementary School, Cleveland Heights, Ohio.

- 11 Apr 2002: Moderated a discussion table at a Faculty-Student Luncheon, “8-Bit Microcomputer, Video Game, and Calculator Hacking”, organized by the Greek Community Educational Consultants, the Order of Omega, and the Greek Life Office, CWRU.
- 25 Mar 2002: “Kinematic modelling of the buccal mass of *Aplysia californica*”, presented to BIOL 395 (Research Discussions) class, CWRU.
- 22 Feb 2002: Supervised the Robot Ramble competition of the 2002 Science Olympiad, CWRU. 13 robots from local high schools participated.
- 17 Feb 2002: Gave 2 tours of the autonomous robotics laboratory during Engineering Week, CWRU.
- 13 Sep 2001: “Teamwork and group dynamics”, presented to the CWRU Battlebots Club.
- 14 July 2001: Gave a 6-hour autonomous robotics workshop to ADAMcon 13, the thirteenth annual Coleco ADAM computer users convention, Cleveland, Ohio.
- 29 Jun 2001: Telephone interview for *Holiday-Travel* magazine about LEGO robotics at the Great Lakes Science Center.
- 21 June 2001: Gave a talk about my 20-year experience in research at CWRU to the participants of the SPUR program, Department of Biology, CWRU.
- 25 Feb 2001: “Kinematic modelling of the buccal mass of *Aplysia californica*”, presented to BIOL 395 (Research Discussions) class, CWRU.
- 19 Feb 2001: Gave a robot lab tour to a group of high school students competing in the CWRU Engineering Week LEGO Robot Competition, run by the student chapter of the IEEE.
- 7 Feb 2001: Invited observer/judge for Science Symposium at Laurel School, Shaker Heights, OH.
- 9 Dec 2000: Gave public robot demonstrations at Joseph Beth Booksellers, Shaker Heights, OH, as a promotion for the Fall 2000 Egg Hunt in Autonomous Robotics.
- 11 Nov 2000: Gave tours of the autonomous robotics laboratory during Engineering Open House, CWRU.
- 22 Aug 2000: Orientation lecture, CWRU, “Autonomous Robots, Or, Frankenstein’s Children.”
- 10-14 July 2000: Gave 2 robot mini-courses for incoming freshmen CS/CE students participating in a program through Educational Support Services, CWRU. Each course was 2 hours on 2 days, 20 students per course. They built and programmed autonomous obstacle-avoiding robots from plans designed and written by me.
- 20 May 2000: Gave 1-hour robot demonstration to students at Walsh Jesuit High School, Cuyahoga Falls, OH.
- 30 Apr 2000: The Spring 2000 Egg Hunt for Autonomous Robotics was held at the Great Lakes Science Center, Cleveland, OH. A live webcast of the contest was hosted by discovery.com.
- 4 Nov 1999: Howard Hughes Lecture, CWRU, “Autonomous Robots, Or, Frankenstein’s Children.”
- 22-24 Oct 1999: Invited speaker, Mindfest, a conference on autonomous robotics in education,

hosted by the MIT Media Lab, Cambridge, MA.

- 28 May 1999: Hosted the 3rd-grade science class of Bet Zefer Mizrachi, a local private elementary school, during the Spring 1999 Egg Hunt for Autonomous Robotics.
- 6 Mar 1999: Gave a 6-hour LEGO robotics demonstration to visitors at the Hudson Science Fair, Hudson High School, Hudson, OH.
- 14 Mar 1998: Gave a 3-hour LEGO robotics demonstration to participants of the 5th Annual Northeast Ohio Science and Societal Issues Symposium for High School Students, Department of Biology, CWRU.
- 18 Sep 1997: "Kinematics and Kinematic Modelling of Swallowing in *Aplysia californica*." Department of Biology Seminar Series, CWRU.
- July 1997: Taught a 5-week version of the Autonomous (LEGO) Robotics course to 3 teachers and 4 middle-school students from the Cleveland School for the Arts. Taught an all-day LEGO robotics class to a group of 15 local high school science teachers, which included constructing and operating a LEGO version of NASA's Mars Sojourner rover, designed using materials from NASA's website. Gave the keynote address to the students graduating from the summer Minority Educational Opportunities Program (MEOP).
- Spring 1997: Gave more than 10 LEGO robot presentations to visiting elementary school students, high school students, middle school teachers, CWRU alumni, and CWRU administrators.
- 6 Nov 1996: Gave 6 1-hour presentations about the BIOL 479 LEGO robot course to students and faculty at Liberty High School, Youngstown, Ohio. Students were from grades 9-12, representing classes in mathematics, biology, chemistry, computer programming, English literature and composition.
- 25 Oct 1996: As part of CWRU's annual President's Weekend, gave (with Dr. Randy Beer and Dr. Hillel Chiel) a presentation about the BIOL 479 LEGO robot course to an audience of CWRU officials, members of the Board of Trustees, and corporate and private donors. This included a demonstration of a student-built Egg Hunt robot from the Fall 1996 semester.
- 19-21 Jul 1996: Prepared and staffed an exhibit at the Cleveland Bicentennial Celebration, about the BIOL 479 LEGO robot course. Featured in a live television interview and robot demonstration for WKYC-TV Channel 3, Cleveland, Ohio at 9:35 AM 21 July 1996.
- 17 Nov 1994: "Static- and Dynamic-Radula/Odontophore Kinematic Models of the Buccal Mass of *Aplysia californica*." Poster presentation of abstract 653.19, Society for Neuroscience 24th Annual Meeting, Miami, Florida. With P.E. Crago and H.J. Chiel.
- 20 Jan 1994: "Kinematics and Three-Dimensional Anatomy of the Buccal Mass of *Aplysia californica*." Department of Biology Seminar Series, CWRU.
- 11 Nov 1993: "The Muscular Hydrostatic Structure of the Buccal Mass of *Aplysia californica*." Poster presentation of abstract 657.1, Society for Neuroscience 23rd Annual Meeting, Washington, D.C. With H.J. Chiel and P.E. Crago.
- 2 Apr 1993: "Three-Dimensional Image Analysis of *Aplysia* Buccal Mass Musculature." Applied Neural Control Laboratory Seminar Series, Department of Biomedical Engineering, CWRU.

9. Invited Reviews.

- 2001-2002: Paid consultant, reviewer, and evaluator of an NSF-funded, web-based autonomous robotics class, CSC 390, developed by Dr. John C. Gallagher, Wright State University, Dayton, Ohio.
- March 2000: Invited reviewer of revised LEGO robotics textbook by Dr. Fred Martin, MIT Media Lab.
- March 1999: Invited by Prentice Hall to review the manuscript of the 6th edition of Hill, Baum, and Scott-Ennis, *Chemistry and Life*, a chemistry/biochemistry textbook for nursing students.
- May 1997/8: Invited by Addison-Wesley Publishing to review a forthcoming textbook on LEGO robotics by Dr. Fred Martin, MIT Media Lab.

10. Laboratory Skills.

Tissue culture, light microscopy, microtomy, transmission electron microscopy (thin sections and rotary shadowing), immunohistochemistry, 3-dimensional reconstruction from serial sections, vertebrate and invertebrate dissection.

11. Computer Skills.

Platforms and Operating Systems: Win95/NT, Apple Macintosh, Unix, MS-DOS 80x86, Coleco ADAM, CP/M, pdp-11/34.

Programming Languages: Extensive experience in Microsoft BASIC/GW-BASIC/ QuickBASIC and other BASIC dialects (AppleSoft, BASIC-11). Proficient in C, some experience with FORTRAN and IDL. Expert in Z80 assembly language, proficient in 80x86 and 6801/6811 assembly languages.

Webpage Design: Proficient in HTML which looks good on all browsers, including text-based browsers.

Graphics Software Packages: Canvas, Adobe Photoshop.

Software Design: For my recent work with Hillel Chiel, I have written software (using compiled QuickBASIC 4.5 on 80386 and 80486 systems) to perform voxel-based three-dimensional reconstructions from serial cross sections, incorporating true vanishing-point perspective and the ability to view the reconstructed volume from any degree of rotation about the x -, y -, and z -axes. Source images are greyscaled TIFF files captured with a video camera and processed with commercial graphics software.

I have also implemented a kinematic model of the *Aplysia* buccal mass during feeding behavior in QuickBASIC 4.5, based upon a preliminary version in C, published in Drushel *et al.* (1998).

I wrote plotting and display programs which were used in Biology 315/415 (Quantitative Biology Laboratory) from 1986-1990: XYPLOT, a point/line plotting program; HISTOG, a histogram analysis program, and DISPLAY, used to retrieve/print graphical output saved from XYPLOT and HISTOG. These programs were written in compiled Microsoft BASIC for an IBM-PC/XT computer network.

For my hobby computer, the 1983 Coleco ADAM, I have written and patched application programs in Z80 assembly language, including a SmartBASIC programming language interpreter, a telecommunications program, and a color graphics painting program. Some of these programs existed only as binaries, for which I regenerated source code by disassembly. I am currently the head of the design team for a revised EOS operating system for the ADAM. I have extensive experience in writing low-level device drivers for serial ports, parallel ports, hard disks, and other peripheral devices. I was Chairman of ADAMcon XIII, an international computer convention for the Coleco ADAM, held 12-15 July 2001 in Cleveland, Ohio.

12. Other Skills.

Medical and technical illustration and drawing; cartooning; electronic hardware design and troubleshooting.

13. Non-Professional Organizations.

- 2002-date Faculty Advisor, CWRU Film Society.
- 1998-date Faculty Advisor, Beta Nu Chapter, Theta Chi Fraternity, CWRU.
- 1980-1987: CWRU Bands (Marching, Concert, Jazz Ensemble II). Served as Drum Major 1983-1985.
Primary instrument: Alto saxophone.
- 1983-1984: Beta Nu Chapter, Theta Chi Fraternity, CWRU. Held elected offices of Chaplain and Librarian.

14. References.

Dr. Randall D. Beer, Professor of Computer Engineering and Science, Department of Computer Engineering and Science, CWRU, Cleveland, Ohio 44106-7071 (216) 368-2816.

Dr. Hillel J. Chiel, Professor of Biology, Department of Biology, CWRU, Cleveland, Ohio 44106-7080 (216) 368-3846.

Dr. Patrick E. Crago, Chairman and Professor of Biomedical Engineering, Department of Biomedical Engineering, CWRU, Cleveland, Ohio 44106-7207 (216) 368-3977.

Dr. Darhl Foreman, Emeritus Professor of Biology, Department of Biology, CWRU, Cleveland, Ohio 44106-7080 (216) 368-3557.

Dr. Joseph Koonce, Chairman and Professor of Biology, Department of Biology, CWRU, Cleveland, Ohio 44106-7080 (216) 368-3561.

Dr. Norman B. Rushforth, Emeritus Professor of Biology, Department of Biology, CWRU, Cleveland, Ohio 44106-7080 (216) 368-1979.