

# CROET

Putting science to work for working Oregonians



CROET 2010  
ANNUAL  
REPORT

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# Mission, Purpose, and Mandate

CROET, the Center for Research on Occupational and Environmental Toxicology at OHSU, is dedicated to the promotion of health and safety in the workforce. Through basic and applied research, education, and outreach, CROET seeks to prevent disease and disability among working Oregonians and their families, during their employment years and throughout retirement.

# Message From the Director



Stephen Lloyd, PhD

Over the past year, as the Interim Director of CROET, I have had the privilege of leading a remarkably talented group of faculty, staff and researchers whose collective focus is maximizing Oregon worker safety and health. To address this objective, CROET uses a multidisciplinary approach, combining partnerships with working Oregonians, government organizations including Oregon OSHA, Universities, business and labor. We highly value these working relationships and seek a continued atmosphere of open dialogue and responsible research and recommendations.

Over the past year, CROET staff led by Dr. Kent Anger, Dede Montgomery and Dr. Fred Berman have worked with labor and management groups to promote worker safety and health education through seminars, health and safety symposia, worker training, fairs, Oregon OSHA and other local and regional conferences. A major highlight of this outreach and worker health intervention was CROET's role in facilitating the discovery of high levels of formaldehyde exposure of hair salon workers and clients who were applying certain hair straightening products. Many of these workers who experienced adverse reactions to these chemicals were previously unaware of even the possibility of exposure to formaldehyde. However, through CROET's interface with Oregon OHSA, investigations in the state were successful in drawing national and international attention to this issue. This serves

as excellent example of delivering on our charge to the Oregon worker to promote healthy and safe working environments. CROET continues to provide daily help and educational resources to Oregonians who have concerns about chemical and environmental toxicant exposure through our Toxicology Information Center led by Dr. Fred Berman, Chemical Risk Information Service led by Dr. Greg Higgins, and CROETweb.com led by Dede Montgomery.

CROET continues to be a national leader in research to reduce workplace fatalities through its FACE program led by Dr. Gary Rischitelli. Funding for these investigators was competitively renewed this year in a nationwide competition, recognizing outstanding research that directly impacts the safety of all Oregonians and especially those whose occupations are associated with the highest risks of disabling and fatal injuries. A significant portion of our faculty engage in basic, applied and translational research, that spans investigations understanding: 1) the underlying fundamental mechanisms of disease including cancer, diabetes, neurodegeneration, hypertension, obesity and neuromuscular dysfunction, 2) regulation of circadian rhythms and sleep mechanisms, 3) risks associated with pesticide exposures, 4) factors that promote safe working environments and on-the-job best safety practices.

In these times of diminishing federal support for research and record-high competition for those funds, I am extraordinarily pleased that all of the full-time CROET faculty members are funded through external sources. This is genuinely a remarkable achievement, since it requires applications to be reviewed in the top 10-15 % of the national competition for grants and bodes well for ongoing discoveries that will advance the health and safety of all Oregonians.

All of us in CROET want to reiterate our gratitude to the citizens of this state for entrusting us to work with you to help make Oregon such a fantastic place to call home. This report is designed to elaborate on our progress and accountability to our mission during 2010.

Respectfully submitted,

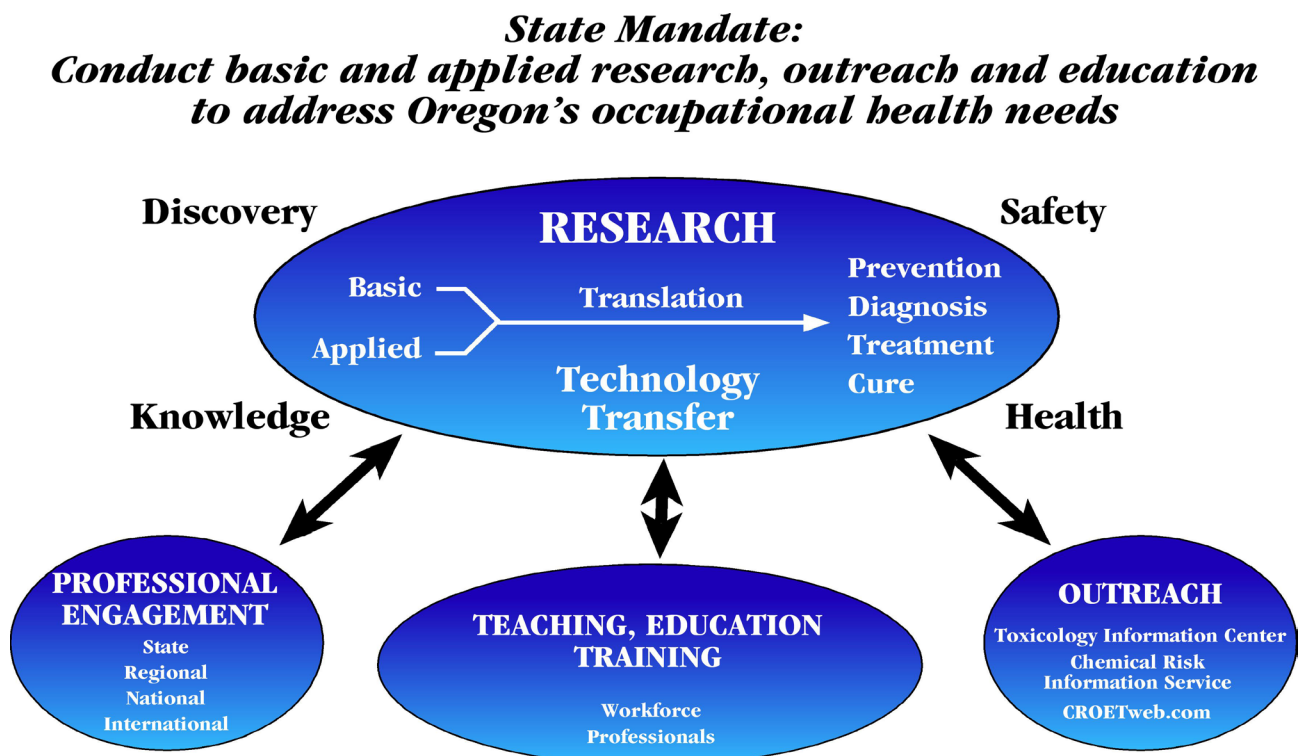
R. Stephen Lloyd, Ph.D.  
Interim Director, CROET

# CROET: a Resource for Oregon

CROET conducts research on the basic biology of workplace-related injury and disease as well as research related to workplace performance and occupational exposure. CROET also participates in doctoral and post-doctoral educational programs to train the next generation of scientists, and provides updates for health and safety specialists to ensure that the latest scientific advances are translated into enhanced workplace safety. Through its outreach efforts, CROET serves as an information conduit to Oregon workers, employers, labor, and the general public.

Applied research addresses workplace hazards, often spurred by specific safety issues of immediate concern to Oregon's workers. Research is focused on surveillance of workplace and environmental problems and on prevention of injury in agriculture, service industries, and construction. This research has short-term payoffs, including, but not limited to: (1) identifying unrecognized trends in Workers' Compensation claims, suggesting new prevention priorities; (2) training effectiveness research has shown that computer-based training can teach topics such as respirator safety, pesticide effects, and supervisor skills to people with severely limited education as well as very well-educated workers; (3) monitoring agriculture workers for exposure to pesticides and adverse nervous system health effects, and giving safety training to these groups; and (4) conducting wellness programs to improve worker health and safety.

Basic research is focused on nerve and muscle damage and repair, occupational/environmental toxicant exposures and their consequences, DNA damage and cancer. The vast majority of this research is funded through the National Institutes of Health and National Institute of Occupational Safety and Health, and requires prolonged commitment and synergy among investigators, which ultimately has a long-term payoff. It is applicable to many diseases and disorders, including those that begin in the workplace and those that arise or are exacerbated by other causes (e.g., genetic, environmental) that plague Oregonians during their working years and into retirement. While this is important for Oregonians, it obviously has a wider impact. CROET's influence and impacts are depicted in the graphic below and in this report that follows.



# CROET's Areas of Emphasis

## Education and Outreach programs

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### CROET's Education and Outreach Programs have four goals:

- Provide scientifically accurate information on Oregon's occupational issues — continuously on the Internet and daily with scientific interpretation of complex issues through the Toxicology Information Center (TIC)
- Offer educational programs on Oregon's occupational needs to health and safety specialists and medical providers
- Train health professionals who will investigate Oregon's occupational safety and health issues in the future
- Provide the scientific expertise to help Oregon industry and labor evaluate occupational safety and health questions

## Research

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### Applications and Outreach

- Cellular mechanisms that control sleep-wake cycles relevant to shift workers
- Computer-based and other training methods to enhance worker safety training
- Agricultural, construction, high tech, office-related and transportation industries

### Injury and Recovery of the Nervous System and Muscles

- The use of nanotechnology to enhance nerve growth
- Factors that govern the accuracy of nerve synapse formation
- Genetic models of nerve maldevelopment
- Toxicants that disrupt protein transport in neurons

### Chronic Disease and Working Safely

- Biomarkers of pesticide exposures and assessment of pesticides on behavior
- Ion channel mutations that underlie diseases
- Development of models of chronic disease including obesity, fatty liver disease, neurodegeneration and diabetes

### Integrity of DNA (DNA damage, genetic alterations, and disease)

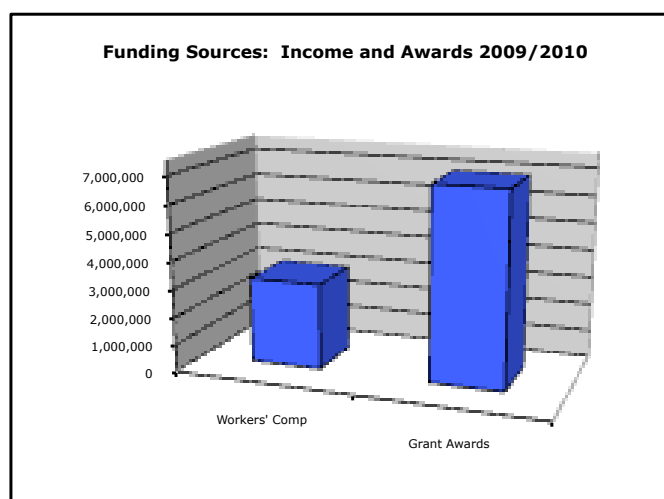
- Role of DNA repair in protecting the nervous system from chemical exposures
- Gene silencing and cancer
- Mutations induced by ionizing irradiation, oxidative stress, and other genotoxins



# CROET Highlights

## CROET brings federal dollars into the Oregon economy

CROET receives base operations funding from the Oregon Workers' Compensation System that, year after year, CROET scientists have successfully leveraged to win federal and other research dollars. For every dollar invested by the State's Workers' Benefit Fund in 2009/2010, CROET's world-class scientists brought an average \$2.24 of federal and private grant funding into the Oregon economy (see chart below). This represents an increase of \$0.72 over the last fiscal period. Federal dollars for research in Oregon have a significant positive impact on the state's economy. Expenditures for goods and services, as well as the salaries of scientific and support personnel, produce a multiplier effect on the purchase of goods and services and creation of businesses that support the needs of Oregon's research institutions. Moreover, research coming out of CROET has a greater than average impact on the state's economy from the new technologies and jobs that spin off from productive research. In a study conducted by Oregon State University, multiplier effects on the economy from the infusion of federal grant funds were estimated to range from 2 up to 10 dollars per federal dollar received.



## Workplace studies and applications research

CROET conducts workplace surveys so that prevention and research needs can be identified, and applications research to bring the benefits of science to the workplace floor. It also reaches out to provide education and information to the Oregon workforce and beyond.

## Oregon Fatality Assessment and Control Evaluation (OR-FACE) Program



D. Gary  
Risshitelli,  
MD, JD, MPH,  
FACOEM

The Oregon Fatality Assessment and Control Evaluation (OR-FACE) program is designed to prevent occupational fatalities through surveillance, targeted investigation, assessment, and outreach that are associated with traumatic work-related deaths in Oregon. Headed by Gary Rischitelli, MD, JD, MPH, FACOEM, OR-FACE is one of only nine state-based FACE programs supported by a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH).

OR-FACE preliminary data for 2010 indicate 44 work-related fatalities in 42 incidents. In 2010, OR-FACE continued to collaborate with the Oregon Young Employee Safety (O[yes]) coalition, attended meetings and events with educators and safety professionals, and gave presentations related to OR-FACE activities and findings. OR-FACE produced its 2007 Annual Report, one investigational report about a temporary mill worker who was killed after he fell down a man lift shaft, and a brochure titled "Dialing, talking, texting ...Know the Hazards of Driver Distraction"

(<http://www.ohsu.edu/xd/research/centers-institutes/croet/outreach/or-face/publications/upload/HA-8-Driver-distraction-brochure.pdf>). "Dialing, talking, texting ...Know the Hazards of Driver Distraction" was produced on

request from safety trainers at SAIF, the state's largest Workers' Compensation insurer. Response by agencies supervising employee car fleets has been enthusiastic (circulation +2,000). SAIF produced the initial print of the brochure to circulate through Oregon transportation and driver safety offices, various state agencies, and to other target audiences. OR-FACE investigational reports and other publications are available on the program's web-site (<http://www.ohsu.edu/xd/research/centers-institutes/croet/outreach/or-face/>). Investigation reports from other FACE programs are available through the National Institute for Occupational Safety and Health website ([www.cdc.gov/niosh/face](http://www.cdc.gov/niosh/face)).

In the fall of 2010, researchers from OR-FACE and the Field Research and Consultation Group at the University of Washington began a project, funded by the Pacific Northwest Agricultural Safety and Health (PNASH) center, to conduct a safety survey and field test a selection of personal flotation devices (PFD) with Oregon crab fishermen. The U.S. Coast Guard, the Oregon Dungeness Crab Commission, and researchers at the NIOSH Alaska field station are also included in the project team. The survey and PFD evaluation come in response to the very high fatality rate among Oregon commercial crab fishermen, and investigate crab fishermen's experiences and views related to critical safety issues. In total, 82 people took the survey (61 fishermen and 21 vessel captains/owners) at the primary crab port in Newport, Oregon. Together, the safety survey and PFD evaluation mirror a model study conducted earlier in Alaska. The study concludes in August 2011.

## Safety and Health Interventions for Lone Workers



Ryan Olson, PhD

Dr. Ryan Olson's research is focused on safety and health interventions for lone workers, and on behavioral self-management methods. The overarching goal of this research is to understand how organizations can best protect and promote health among workers who are physically isolated from their peers. Olson's work is also concerned with understanding workplace and personal factors that help individual's self-regulate and engage in prevention behavior.

In 2010, Dr. Olson was awarded a secondary appointment to the Department of Public Health and Preventive Medicine at OHSU. Dr. Olson also completed a research project titled Development and Evaluation of a Safety Self-Assessment Tool for Home Care Workers (Noah Sexias, PI; Dr. Olson PI OHSU subcontract). The goal of this project was to develop and evaluate the reliability of a safety self-assessment tool for home care workers that focuses on exposures to risk factors for back injuries. A secondary goal of the project was to provide research training for a graduate student in a safety discipline.

Dr. Olson also authored a chapter in the American Industrial Hygiene Association textbook: *Landsburgis, P., Schnall, P., Nicholas, W., Stellman, J., Sinclair, R., Hammer, L., & Olson, R. (in press). Occupational Health Psychology, in S.R. DiNardi (Ed), The occupational environment: Its evaluation, control, and management. Fairfax, VA: American Industrial Hygiene Association.*

## Two Vulnerable Populations from Occupational Exposure to Pesticides

### Assessment of Health Effects of Children Living in an Agricultural Community



Diane Rohlman,  
PhD

There is increasing concern regarding the use of pesticides in agricultural communities and potential impacts on public health. Organophosphate (OP) pesticides are among those of greatest concern, due to their persistence once in the home and their established neurotoxic effects. Neurobehavioral tests have identified deficits in adult populations exposed to and poisoned by OP pesticides on farms. However, little research has examined OP pesticide exposure in children. While the neurotoxic effects of acute exposure to OP pesticides are well established, chronic low-level exposure are not well studied in adults and very few studies provide evidence of neurobehavioral deficits in farmworker children compared to controls. Children of farmworkers are presumed to be exposed to pesticides throughout development, and this exposure may produce subtle health effects that would not be detected by clinical examinations nor recognized by parents. A study conducted by Dr. Diane Rohlman and funded by the National Institute of Occupational Safety and Health (NIOSH) through the Pacific Northwest Agricultural Safety & Health Center, examines health effects in children living in an agricultural community to determine if they are associated with current home pesticide exposure or an estimate of lifetime exposure. Children's exposure to pesticides from the parent's work

or residence in an agricultural community is measured through questionnaires and dust samples collected from the home. Children will be evaluated a second time, one year later, to obtain longitudinal data that will be used to characterize developmental progress and relate that progress to exposure estimates.

### **Assessing Vulnerability of the Adolescent Brain to Organophosphorus Pesticides**

Organophosphorus (OP) pesticides are used extensively in agriculture throughout the world. There is compelling evidence that repeated (chronic) low-level occupational and environmental pesticide exposures are associated with neurobehavioral performance deficits in adults. Adolescents working in agriculture are exposed to the same risks as adults but it is unknown whether their risk is equivalent to or greater than that of adults. Experimental animal studies indicate that the developing brain is more susceptible to the neurotoxic effects of OPs than the adult brain, and low-level exposures to OP pesticides cause significant neurobehavioral deficits in animal research. Adolescents (ages 15-18) in Egypt are legally hired as seasonal workers to apply pesticides to the cotton crop. This pesticide application is highly regulated and standardized across Egypt, and is limited primarily to OP pesticides (& pyrethrins), generally chlorpyrifos. This provides a unique opportunity to examine the impact of a highly consistent known OP pesticide exposure on the adolescent and their developing nervous system. Recent research in this adolescent Egyptian population found increased reports of symptoms, depressed cholinesterase, and extensive neurobehavioral deficits in adolescents applying chlorpyrifos (vs. controls). While we have preliminary evidence of some of the highest reported exposure concentrations from dermal patch and urinary samples in adult Egyptian applicators, there is no quantitative exposure data available in adolescents. Furthermore, what is not established is if these exposure-related nervous system effects accumulate across time, if the effects increase with repeated exposure, and if they reverse after exposure ends. The goal of this project is to examine the dose-related response of the adolescent nervous system to OP pesticides, to determine if repeated exposures produce a progressive deficit and to determine if this deficit is reversible.

### **Computer-based Supervisor and Worker Protection Training**

#### **Study Provides Training in Most Oregon County Governments**



W. Kent Anger,  
PhD

Intimate partner violence (IPV), commonly known as domestic violence, is a problem throughout the world. An estimated 36% to 75% of employed abused woman are monitored, harassed and physically assaulted by their partners or ex-partners while trying to get to work and while at work. Based on interviews of 300 victims and 200 perpetrators of IPV collected in Oregon, we developed interactive training to increase knowledge on how to create supportive and safe workplace for IPV victims, change perceptions and develop an intention to address domestic violence that spills over into the workplace. We conducted a pilot test of that training in a sample of managers and supervisors from a moderately large city and a medium-sized bank in northwestern Oregon, and modified the training based on responses. All participants reacted positively to the training, and there was a significant improvement in knowledge between pre- and post-training test performance (72% versus 96% correct), effect size ( $d = 3.56$  which is a very large (positive) effect size for workplace training. This work was published in 2010. In order to evaluate the effectiveness of this training and to develop a way to scale the training for delivery more widely, we are providing the training to supervisors and managers in a sample of small businesses throughout Oregon in three formats: Written Brochure, delivery of the training on the internet, and an interactive computer-based presentation. Contemporaneously, we recruited managers and supervisors in 27 (75%) of Oregon's 36 county governments to take the same training and added training on Family Medical Leave (FMLA) as a control condition, dividing the supervisors into two groups to take the IPV and the workplace training, another type of protective leave. In all, over 800 supervisors received the Domestic Violence and Workplace training. Both trainings received positive overall ratings from the participants (76.1% - 91.8% rated the training as good or excellent). This work was conducted by Drs. Anger and Rohlman with colleagues from Johns Hopkins University and Kaiser's Center for Health Research in Portland.

#### **Preventing Violence in Home Care Workers**

Workplace violence is well documented in hospitals and clinics. Little is known, however, about homecare workers who deliver medical services in people's homes where there is no security or oversight as there is in hospitals or clinics. There were only anecdotal reports of violence toward homecare workers, so CROET and Johns Hopkins University partnered with Oregon's Home Care Commission and the Service Employees International Union (SEIU) that represents all homecare workers in Oregon and the Labor Education and Research Center (LERC),



to collect systematic information about violence toward homecare workers. What is unique about this workplace is that the services are delivered in the consumer's home and the consumer employers receive the care services, as well as hire, fire and supervise the homecare workers.

We held focus groups and individual interviews with 83 Oregon homecare workers (all female), 99 Oregon case managers and other Department of Human Services employees and 11 consumer employers receiving in-home care during 2009-2010. We recruited the homecare workers in urban and rural communities throughout the state of Oregon through advertisements at professional training events and in SEIU Local 503 newsletters; case managers who oversee each through Oregon's Department of Human Services (DHS), Seniors and People with Disabilities (SPD) office; and consumer employers through the Oregon Home Care Commission, the STEPS consumer employer training program and referrals from case managers.

The participants generally agreed that workplace violence includes incidents when homecare workers were threatened or assaulted, involving any explicit or implicit challenge to their safety, wellbeing or health. And that sexual harassment was any unwanted, unreciprocated and unwelcomed behavior of a sexual nature that is offensive to the person involved, and causes the person to be threatened. Based on this, 44% of homecare workers reported experiencing physical violence at least one time in their career, 65% reported experiencing non-physical violence, 14% reported experiencing sexual violence, and 41% experienced sexual harassment. These results were generally confirmed by the case manager reports.

The next step in the project is to provide a well designed survey to determine the actual prevalence of the violence based on sampling home care workers from throughout Oregon, and at the same time begin developing a prevention training program for the homecare workers with our partners. This work is supported by a grant from the National Institute for Occupational Safety and Health (R01OH009080) provided to Drs. Kent Anger and Diane Rohlman of CROET in partnership with Dr. Nancy Glass of Johns Hopkins University.

## Outreach and Education

CROET has been proactively engaged in providing timely occupational health and safety information to employees, employers, health and safety professionals, doctors and nurses.

### CROETweb.com



Dede  
Montgomery, MS,  
CIH

CROETweb.com is an occupational safety and health resource directory that contains links to over 1200 occupational safety and health resources focusing on day-to-day workplace issues. CROETweb serves thousands of users who regularly bookmark this resource, those who subscribe to the monthly electronic newsletter, and those seeking information by search engine (e.g. Google) for occupational health and safety topics on the web. It is widely recognized and respected by industrial health and other safety professionals as well as the general public, based on feedback from user groups. CROETweb was accessed an average 11,000-13,000 times per month for a total of 123,352 hits in 2010.

- The most popular pages visited for 2010 included Materials for Safety Talks, Hospitality, Construction and Office Ergonomics
- New topics 2010: Health Promotion & Wellness; Aging Workforce and numerous new subtopics
- As of the end of 2010, CROETweb contains 3855 links and 84 main topic pages.



## Toxicology Information Center (TIC)



Fred Berman,  
DVM, PhD

CROET's Toxicology Information Center is directed by Dr. Fred Berman. The TIC provides a vital outreach function to citizens and professionals by responding to their inquiries about the potential hazards from exposure to chemicals and other agents. The goal is to provide up-to-date, unbiased information in a form that is understandable and useful to the patron. In 2010, Dr. Berman handled hundreds of consultation requests from occupational safety and health professionals, business owners, government agencies, physicians and nurses, the media, and the general working public. Inquiries covered a variety of issues, as shown on the chart. Chemical agents of concern included solvents, heavy metals, insecticides, fungicides, and herbicides. Physicians often called seeking information on a variety of potentially occupation-related health complaints. Each request took from less than an hour up to several days to respond to fully. The TIC is open from 7:30 a.m. to 4:00 p.m., Monday through Thursday. Walk-in visitors have access to a variety of resources, including computers, databases, government reports, textbooks, and journals that are devoted to toxicology-related issues and occupational health.

Dr. Berman also serves as consultant to the Oregon Department of Agriculture's Pesticide Analytical and Response Center (PARC), which is legislatively mandated to address pesticide-related incidents in Oregon that have suspected health or environmental effects (<http://www.oregon.gov/ODA/PEST/parc.shtml>), and is a co-investigator with the National Pesticide Information Center (NPIC), a U.S. Environmental Protection Agency-sponsored project operated cooperatively with Oregon State University. NPIC provides objective, science-based information about pesticides and pesticide-related topics to enable people to make informed decisions about pesticides and their use (<http://npic.orst.edu/>).

## CROET's Chemical Risk Information Service



Gregory Higgins,  
PhD

OSHA regulations require employers to maintain Material Safety Data Sheets (MSDS) for the hazardous chemicals used in their workplace. This often proves to be a difficult record-keeping task, and it can be burdensome to ensure that employees have quick access to health and safety information in the workplace when they need it. Since 1998, CROET's Chemical Risk Information Service, directed by Dr. Gregory Higgins, has helped a growing number of local and international industries manage and distribute chemical safety information through its internet-based MSDS management system. CROET's working relationship with the Oregon Poison Center also ensures that employees covered by the program have ready access to medical information in the event of exposure. During 2010, the Chemical Risk Information Service added three new clients, and now provides MSDS management services to 43 municipal, construction, and service companies, most of which are Oregon-based. One of our new clients is Tidewater, the largest inland marine transportation company in the Pacific Northwest, operating barge services throughout the Columbia-Snake River system. We also developed the second phase of our advanced program with Portland METRO, creating a system that allows METRO to select products for their workers that meet certified "green" product criteria. Enhancements were also made to the website and database that serve all of our clients during 2010. CROET continues to provide expert management services at a reasonable cost, which is attractive to both small and large organizations.

## Health and Safety Training Symposia

CROET provides two health and safety symposia per year, one sponsored jointly with Portland State University. Topics are determined based on solicited and unsolicited feedback from the Oregon occupational health and safety professional community. The target audience includes health and safety professionals, occupational nurses and physicians, loss control specialists and human resource representatives, although the targeted group varies based on the symposium topic. The purpose of the symposia is to provide timely, up-to-date presentations, forums and discussions on workplace safety and health issues. CROET presented the following symposia series in 2010:

### Creating a Healthy Workforce

Presented by CROET

Friday, June 4, 2010 at NECA/IBEW Training Center in Portland, OR

## Workplace Accommodations & Return to Work

Presented by CROET and Portland State University

Friday, November 5, 2010

University Place, Portland State University, Portland, Oregon

## Regional Health and Safety Conferences

OR-OSHA sponsors the majority of health and safety conferences that CROET attends; these conferences are an important means by which CROET reaches out to working Oregonians. Workers and businesses learn about CROET and what it has to offer, and CROET personnel learn about the needs and concerns of workers and the industries that employ them. Moreover, CROET scientists are often asked to give health and safety presentations in addition to providing conference exhibits. Overall, conferences represent a tremendous networking opportunity for CROET outreach personnel. The following are safety and health conferences attended by CROET during 2009-2010:

- **Western Pulp and Paper Workers Safety & Health Conference**
- **Southern Oregon Occupational Health and Safety Conference**
- **2010 Northwest Occupational Health Conference**
- **Central Oregon Occupational Health and Safety Conference**
- **Oregon Small Business Fair**
- **Northwest Environmental Health Conference**
- **Western Pulp and Paper Workers Safety & Health Conference**
- **Cascade Occupational Safety & Health Conference**
- **2010 Women in Trades Career Fair**
- **Blue Mountain Occupational Health and Safety Conference**

## OHSU Health Discoveries Program: Let's Get Healthy!



Jackilen  
Shannon, MPH,  
RD, PhD

Let's Get Healthy! is a popular interactive education and research exhibit that allows community members to learn important information about their body while contributing to science. Attendees are invited to enroll as research participants where they learn about the research process and the quality of their own diet, sleep, body composition and other measures. They can contribute their anonymous health information to a population database that researchers can use to study the relationship between these health factors. Schools and communities also have access to the anonymous data, which can be used to encourage healthy living in their communities or teach scientific inquiry to their students using real data. All information collected is completely anonymous. Let's Get Healthy! health fairs are open to the public and volunteers of all backgrounds are able to help with the exhibit. The program is made possible by grants from the National Institutes of Health (NIH).

Let's Get Healthy! visited several new communities this past year, including Madras, Hermiston, La Grande, Wilsonville, Canby, St Helens and West Linn. In all, 15 fairs were held in 2010 – all of which were volunteer-run. Five of these fairs were school events that enabled 3000 middle school students to go through the exhibit as part of their school day. Let's Get Healthy! was also selected by the National Institutes of Health (NIH) to travel to Washington D.C. in order to represent NIH at the USA Science & Engineering Festival in October. It was a tremendous honor. All of these events could not have been possible without the wonderful volunteers who help run the events. 2010 brought us 300 new registered volunteers around the state. These volunteers helped us implement three new research modules this year (sleep, cancer risk behaviors and evaluation) as well present 12 new exhibits about physical activity and nutrition that were created in collaboration with Oregon Museum of Science & Industry. When not running fairs, we spent much of 2010 writing funding proposals -- 14 applications were submitted in the past 12 months. We are hopeful these proposals will enable Let's Get Healthy! to continue to grow and travel to new areas. We have 5 fairs scheduled for 2011 and plan to launch a new breast cancer module developed in collaboration with OHSU Knight Cancer Institute in Fall 2011.



# Injury and Recovery of the Nervous System and Muscles

CROET scientists conduct basic research that examines the causes of injury to nerves and muscles in order to identify protective, preventative, and recovery methodologies for such injuries.

## Nerve Support Protein Required for Normal Muscle Function



Bruce Patton,  
PhD

Damage to nerves and muscles is the primary cause of workplace disability in the United States. In a typical year, five million workers (4%) are injured on the job. Four million (80%) of these involve debilitating pain and/or dysfunction from neuromuscular injuries, including trauma, tears, strains, and musculoskeletal disorders (<http://www.bls.gov>). Nearly half require a lengthy recuperative period, substantially diminishing productivity and increasing medical costs to employers and employees. Dr. Bruce Patton's laboratory is investigating molecular pathways that promote muscle stability and innervation. The overall goal is to identify molecular targets for reducing susceptibility to nerve and muscle injury and improve recovery.

Each skeletal muscle and nerve is composed of many individual fibers; the surface of each of fiber is covered by a thin, tough sheet of interconnected proteins, called a basal lamina (BL). The BL provides stability to what are some of the largest cells in the body. However, the BL also coordinates growth and functional differentiation during tissue development and after injury. How the BL encodes these activities, and how neuronal and muscle cells respond and interact through the BL, remains poorly understood. The laboratory of Bruce Patton has been testing the real (in vivo) function of BL components in nerve and muscle using genetic engineering methods in mice. Neuromuscular systems of all mammals, including mice and humans, are highly similar in structure, physiology, and response to injury.

The primary component of nerve and muscle BLs is laminin-211, a self-polymerizing glycoprotein that provides the main framework of the BL. In humans, dogs, and mice, gene mutations that prevent laminin-211 expression also prevent the formation of the myofiber BL. Because these mutations also cause a severe, degenerative muscle disorder called type IA congenital muscular dystrophy, it has long been assumed that laminin-211 stabilizes the muscle fiber surface membrane during contractions by forming a structurally stable BL along the cell surface. However, in collaborative work with Dr. Rob Burgess (The Jackson Laboratory, Bar Harbor, ME), mutations in the laminin alpha2 protein (a component of laminin-211) were identified that disrupt the ability of laminin-211 to polymerize, but which result in very little dystrophy or muscle membrane damage (Patton et al., 2008, J. Cell Science, 121:1593). The results suggested that laminin-211 may stabilize the muscle surface by alternative mechanisms. To further test this idea, mice were developed which expressed a second polymerizing laminin in the mature muscle fiber BL, namely laminin-511. Laminin-511 is not normally expressed in mature muscles. Mouse muscles that co-expressed laminin-511 along with the normal laminin-211 isoform were normal in structure and function; laminin-511 is therefore not harmful. However, when over-expressed in dystrophic mice that lacked laminin-211, laminin-511 restored the integrity to the muscle fiber BL, but nevertheless did not prevent rapid degeneration of the muscle fibers. Thus, an intact BL does not, by itself, stabilize the myofiber membrane. This result combines with the previous work to strongly indicate laminin-211 supports the myofiber membrane by an alternative mechanism.

To develop this idea, the formation of receptor complexes on the muscle fiber surface was compared in normal, laminin-211-deficient, and laminin-511-overexpressing mice. It was discovered that laminin-211 was uniquely active in stabilizing the form and molecular composition of the costameres, which are the main cytoskeletal attachment sites on muscle surfaces. While even non-polymerizing forms of laminin-211 were effective, laminin-511 was not at all effective. Further, it was discovered that during contractions, muscle membranes lacking laminin-211 did not properly fold at costameres, and that a BL of laminin-511 was unable to restore this folding. The results suggest that laminin-211 stabilizes muscles mostly by maintaining tight adhesion between the costamere complex and the intracellular cytoskeleton (which are required to prevent damage to the cell's internal membrane system), rather than adhesion to the extracellular matrix, and that laminin-211 acts primarily by recruiting stabilizing components to the assembly of a mature costamere complex. Future work is aimed at 1) characterizing laminin:receptor interactions that lead to stable costamere:cytoskeletal adhesions; 2) determining costamere modifications which promote muscle stability; and 3) identifying small agents that may similarly promote costamere maturation to inhibit muscle fiber damage during over-exercise in normal as well as dystrophic muscles.



## Chronic Disease and Working Safety

Chronic disease takes a significant toll on our workforce just as it does in the broader community. CROET research seeks to discover causes of chronic diseases that are produced or exacerbated by workplace factors and identifies processes or procedures that can prevent or ameliorate those diseases and improve workplace safety.

### Fruit Flies Are Aiding our Understanding of Alzheimer's Disease



Doris  
Kretzschmar, PhD

Alzheimer's Disease is the most common form of dementia, with approximately 26 million people suffering worldwide. It is also expected that with the increase in life span, this number will quadruple over the next four decades, and people will continue working later in life than they do today. Starting with memory loss, AD eventually leads to severe mental impairment, and although therapeutic drugs can slow down the progression of cognitive decline, there is currently no cure.

One of the hallmark features of Alzheimer's disease is the accumulation of amyloid plaques, which consist of small protein segments called amyloid beta ( $A\beta$ ).  $A\beta$  is cleaved from the larger Amyloid Precursor Protein (APP) by several enzymes, which in addition to  $A\beta$  results in the production of several other protein fragments. The normal physiological function of APP and its fragments as well as its interaction with other proteins are, however, still not well understood. Due to methodological difficulties and ethical concerns, studies in humans have obvious limitations.

Therefore, the Kretzschmar lab uses a well-established biological model system, the fruit fly *Drosophila*, to model this condition.

In previous work, the Kretzschmar lab created flies that express APP and produce  $A\beta$ . These flies show accumulations of  $A\beta$  in the brain, neuronal cell death, and behavioral deficits similar to human Alzheimer patients. Having established that the deleterious effects of APP and  $A\beta$  are conserved in flies, the Kretzschmar lab has used this system to identify genetic factors that influence the severity of these effects.

In 2010, the Kretzschmar laboratory also used the *Drosophila* Alzheimer model for drug testing to find treatments that could eventually lead to increased quality of life and productivity of workers in retirement. They have identified a compound that blocks calcium channels as a potential therapeutic agent. This work was conducted in a collaborative project using models from cell culture to transgenic mice funded by the Dean's Fund. A paper describing these studies has been submitted and together with another similar collaborative study (Wang et al, 2010), this has now established the use of Dr. Kretzschmar's model for drug testing. Another achievement of 2010 was the successful completion of Jill Wentzell's PhD work focusing on the molecular and functional analysis of Swiss-Cheese/Neuropathy Target Esterase, a protein involved in inherited spastic paraplegia and organophosphate-induced neuronal degeneration.

### Sleep Deprivation Costs Oregon Workers and Oregon Businesses - Business Meets Biology

Collaborating Investigators: Drs. Harvey Mohrenweiser; Jackilen Shannon; Ryan Olson; Diane Rohlman; Charles Allen



Harvey  
Mohrenweiser,  
PhD

Fifty percent of the workforce arrives at work with some degree of sleep deprivation. Sleep deprivation, a consequence of non-traditional work schedules, biological disorders/sleep apnea and/or lifestyle, negatively impacts a worker's physiological functions and performance, leading to an increased risk of injury and disease. Many critical skill professions, including health care professionals, public safety workers, transportation workers, plant operators and managers/"white collar" workers, commonly require a 24/7 workforce and non-traditional work schedules. It is noteworthy that many of these individuals must rapidly respond to evolving situations and make complex decisions. These decisions impact lives – and errors have consequences.

Sleep is regulated by two mechanisms: the circadian system generates 24-hour rhythms of sleep and homeostatic sleep processes whereby sleep pressure increases during wake and dissipates during sleep. Alterations in the timing of activity and rest disrupt the normal circadian system, with consequences for physiological and neurological function. Overnight operations pose a challenge; it is estimated

that performance impairment on the first night of a worker's shift is similar to a blood alcohol level of 0.10.

Health care services must be available on a 24-hour basis, making shift work a necessity and extended work schedules common practice. In most settings, over 50% of hospital staff nurses routinely work shifts of 12 hours or more, often for 6 or more consecutive days. Nurses working long shifts are at increased risk of making medical errors. An analysis of Oregon workers' compensation data for 1990-1997 (Horwitz and McCall; Occup Med (Lond). 54:556-63, 2004) found that evening/night shift hospital workers reported twice as many injuries as day workers. Similar results were observed when studying only nurses. Days off for injury disability were elevated 30% for night shift workers compared to day shift, and the average per-claim costs were increased 10%.

The cost of sleep deprivation, through lost productivity, absenteeism and increased risk of injury, is estimated to be \$3-5,000 per affected worker or 1% of the U.S. gross national product. This estimate does not include the health care costs of chronic diseases associated with sleep deprivation, for example, cardiovascular disease, diabetes, and obesity. Sleep deprivation has dramatic consequences for individuals, businesses and society.

This new initiative will bring together researchers with expertise in lab-bench and population focused basic and translational research to address the impact of non-traditional work schedules on hospital and non-hospital based health care workers, individuals who often work both extended schedules and non-day shifts. Educational and outcome-based outreach programs will be integral to achieving the goal of improving the health, safety and productivity of Oregon workers and businesses through minimization of the incidence and cost of injury, impaired performance and illness/disease associated with exposure to non-traditional work schedules.

## New Discoveries of Circadian Clock Function Aids Understanding of Sleep-Wake Cycles



Charles Allen,  
PhD

In humans, many physiological processes cycle with a period of twenty-four hours. These circadian rhythms are driven by an internal biological clock so that we are active during the day and sleep at night, which has significant ramifications in our 24-hour society. Approximately 20% of American workers have jobs that require them to work outside of the traditional 8-5 workday. These workers are therefore awake when their internal clock is telling them to sleep. Short-term disruption of the circadian rhythms can lead to higher rates of on-the-job accidents, impairments in cognitive function including poor decision-making, altered hormone activity, and gastrointestinal distress. Long-term disruption of the circadian system contributes to the development of breast and colorectal cancer, cardiovascular disease, mood disorders and a number of metabolic derangements including diabetes.

A small brain region structure called the suprachiasmatic nucleus (SCN) contains a molecular time-keeping mechanism that drives biological circadian rhythms. This biological clock sends signals throughout the body that coordinate circadian rhythms in multiple tissues and organs. The long-term goal of our basic research program is to identify the cellular mechanisms underlying the generation and entrainment of circadian rhythms. Successful completion of our work will provide a better understanding of the mechanisms underlying regulation of circadian processes such as sleep. This knowledge can lead to better and more rational treatment of circadian-based sleep and mood disorders.

Neuroactive peptides and the intracellular calcium concentration ( $[Ca^{2+}]_i$ ) play important roles in light-induced modulation of gene expression in the SCN neurons that ultimately control behavioral rhythms. Two messenger molecules, vasoactive intestinal peptide (VIP) and arginine vasopressin (AVP), are expressed rhythmically within populations of SCN neurons. Removal of VIP but not AVP completely disrupts the generation of biological timing signals. In 2010, Dr. Allen's laboratory examined the role of several messenger molecules, known as neuropeptides, on  $Ca^{2+}$  signaling, simultaneously imaging multiple neurons within the SCN neural network. They found that VIP reduced the  $[Ca^{2+}]_i$  in populations of SCN neurons during the day, but had little effect at night. Stimulation of the optic nerve input to the SCN at frequencies that simulate light input signaling evoked transient  $[Ca^{2+}]_i$  elevations that were not altered by VIP. AVP elevated the  $[Ca^{2+}]_i$  during both the day and night.

The relationship between the  $[Ca^{2+}]_i$  and the neuron's action potential firing frequency are closely correlated in SCN neurons, with peaks occurring during the day. Dr. Allen's laboratory found that, during the day, VIP lowered the  $[Ca^{2+}]_i$  to near nighttime levels while AVP elevated  $[Ca^{2+}]_i$  during both the day and night, suggesting that the VIP effects on  $[Ca^{2+}]_i$  were dependent, and the AVP effects independent of the action potential firing activity of

the neuron. We conclude that VIP and AVP regulate, at least in part,  $\text{Ca}^{2+}$  homeostasis in SCN neurons and may be a major point of regulation for SCN neuronal synchronization.

## Organic Solvents Illuminate our Understanding of Neurological Disorders



Daniel D. Tshala-Katumbay, MD, PhD

Workers exposed to certain organic solvents (such as n-hexane and 1,2-diethylbenzene) can develop nerve and spinal cord damage that leads to a crippling disease known as peripheral neuropathy. While n-hexane neuropathy is all too common today in certain low- and middle-income countries, improved workplace practices have virtually banished the disease from U.S. industry. Now, the neurotoxic metabolites of n-hexane and 1,2-diethylbenzene are used as valuable laboratory tools with which to probe the vulnerabilities of the nervous system. The detoxification products (metabolic byproducts) of such solvents induce abnormal modifications of proteins in the nervous system. Dr. Tshala-Katumbay's research group has used state-of-the-art proteomic tools to identify these aberrant protein modifications and have developed small molecules to be tested for their potential to protect neurons from these adverse effects. Potentially neuroprotective molecules were selected and linked through chemical conjugation to a synthetic analog of the non-virulent C fragment of tetanus toxin (Tet1). Tet1 itself is known to be transported specifically to neurons in the central nervous system; therefore, any molecule linked to Tet1 will theoretically be targeted to these neurons as well. Potentially neuroprotective molecules linked to Tet1 were screened for delivery to neuron targets and were found to be successfully and specifically delivered to nerve cells in experimental models (patenting in progress). Ongoing studies will determine whether the neuroprotective effects of these molecules are seen in experimental models relevant to the neurotoxicity mechanisms associated with exposure to industrial solvents.

## Integrity of DNA (DNA damage, genetic alterations and disease)

Human health and risk for disease ultimately depend on the integrity of our DNA, the genetic material that provides the body's blueprint for manufacturing proteins that carry out the function of cells and organs. Aberrant forms of DNA can produce inherited diseases, and changes in DNA during life are believed to trigger cancer and many other chronic diseases. Such changes can result from exposure to certain chemicals found in the workplace and others in the diet and medications, and to sunlight in outdoor workers. Two broad types of DNA changes are recognized: DNA damage and DNA silencing.

### Insights Into Mechanisms that Lead to Cancer



Mitchell Turker,  
PhD, JD

The causes and treatment of cancer are important to Oregon workers because some workplace exposures can cause cancer. Moreover, cancer is a disease that will strike a significant number of workers at some point during their career. Work in the Turker laboratory is focused on the underlying causes of cancer at the level of gene and chromosome defects. Each chromosome contains a very large number of specific genes and the correct number of chromosomes is important for a cell to function properly. A hallmark of cancer cells is abnormal numbers of chromosomes because some chromosomes are lost and others are duplicated. These changes lead to cells in which expression of many genes is decreased, increased, or lost entirely. One accomplishment of the Turker laboratory this year was to complete a study that uncovered unexpected levels of chromosome loss in cells obtained from apparently normal (i.e., non-cancerous) kidneys. While this study revealed that chromosome loss per se may be insufficient for cancer to occur, it also revealed that cells vulnerable to become cancerous are unexpectedly common. A second completed study focused on a phenomenon termed "gene silencing", which causes genes that should be expressed to turn off inappropriately. Gene silencing is an important cause of cancer. Silenced genes can be turned back on again, which is the basis for ongoing clinical trials by drug companies to identify treatments for cancer based on gene reactivation. However, results from this second study showed that gene reactivation is not stable long term. Therefore, additional treatment approaches will be required for the envisioned therapeutic goals to be maximally effective.

### Enhancing the Effectiveness of Chemotherapeutic Protocols



R. Stephen Lloyd,  
PhD

Cancer is the second leading cause of death in the United States, with over 1,500,000 new cases reported in 2010, a figure that does not include the 1,300,000 new cases of non-melanoma skin cancers diagnosed each year. Lifetime probabilities of having cancer are nearly 50% for men and 35% for women, and this results in greater than 600,000 deaths in the United States each year, nearly 25 percent of all deaths. The nationwide costs for treating and managing these diseases are estimated to be in excess of \$264 billion per year. In 2010, more than 21,000 Oregonians were diagnosed with a new cancer and more than 7,500 died as a direct result of these diseases. Many of these cancers are at least partially the result of environmental toxicant exposures, making their prevention and effective treatments a high priority for research in the Lloyd laboratory. A major focus in the laboratory has been to identify more effective cancer treatments that use chemotherapeutic agents.

Cancer chemotherapy frequently uses drugs that kill cells by virtue of their ability to chemically fuse together complementary strands of DNA, creating what is referred to as an inter-strand DNA crosslink. The therapeutic efficacy of crosslink-inducing agents resides in their ability to disrupt processes that are essential for cancer cell survival, including DNA replication, RNA transcription, and recombination. For example, the drug Melphalan is used for the treatment of myelomas, Cytoxan for lymphomas, Cisplatin for head and neck, testis and ovarian cancers, and Busulfan for bone marrow cancers. Mitomycin C is used against gastric, pancreatic, and colorectal cancers.

The processing and repair of DNA crosslinks in human cells is extremely complex, involving multiple DNA repair and damage tolerance pathways. One such pathway utilizes molecular scissors, called endonucleases, which cut the affected DNA strand on both sides of the crosslink, and translesion synthesis (TLS) polymerases that fill in the gap created by the endonuclease, thereby restoring normal function. The Lloyd laboratory has obtained biochemical data that one translesion synthesis polymerase, known as polymerase kappa (pol  $\kappa$ ), efficiently and



accurately restores the function of DNAs that contain crosslinks produced by chemotherapeutic agents. These data suggest that pol  $\kappa$  is essential for restoring crosslink-containing DNAs to a condition in which normal replication, transcription and homologous recombination can occur. Such an activity would limit the effectiveness of crosslink-inducing chemotherapeutic agents to kill targeted cancer cells. Therefore, there is an urgent need for development of new therapies that do not allow cancer cells to repair crosslinks and avoid being killed by these agents. The Lloyd laboratory has made it a priority to identify small molecule inhibitors targeting pol  $\kappa$  as crucial for improving the therapeutic efficacy of chemotherapeutic agents.

Specifically, it is hypothesized that pol  $\kappa$  specific inhibitors, given in conjunction with crosslinking agents, will increase the therapeutic effectiveness of crosslink-inducing drugs. To identify pol  $\kappa$  inhibitors, preliminary high throughput screens were conducted on 16,000 compounds in collaboration with the NIH Chemical Genomics Center (NCGC) using a fluorescence-based assay. Preliminary candidates were identified and verified using a secondary assay that confirmed the robust nature of high throughput screens to identify potential therapeutic agents. Biological assays were developed to extend these investigations into cell-based studies. The future aims of this investigation are to: 1) conduct high throughput screening of the ~400,000-member Molecular Libraries Small Molecule Repository (MLSMR) collection using the fluorescence-based assay described above; 2) expand the number of related compounds through combinatorial chemistry; and 3) analyze inhibitor effectiveness in biological assays.

In addition to pol  $\kappa$ , other specialized DNA polymerases have been implicated in repair of DNA crosslinks induced by chemotherapeutic agents. Depending on the identity of the DNA polymerase and the structure of the DNA crosslink, the result of repair of these lesions can be either error-free or mutagenic. The latter outcome is most deleterious, since mutagenic repair is likely a primary cause of both secondary cancers and acquired drug-resistance, the two most common complications associated with the clinical use of DNA-crosslinking agents. Thus, it is critically important to identify individual DNA polymerases that might contribute to mutagenic repair of DNA crosslinks. As a result of collaborative efforts between Dr. Lloyd and Dr. Minko, it has been found that human DNA polymerase eta (pol  $\eta$ ) can cause mutations when synthesizing DNA across Mitomycin C-induced crosslinks. However, replication of DNA containing structurally different crosslinks appeared to be accurate and was most efficiently performed by human DNA polymerase nu (pol  $\nu$ ). These latest data were reported in *Chemical Research in Toxicology*, 2010 (Yamanaka et al, 2010).

## Novel Therapeutic Strategy for the Prevention of Skin Cancer



Amanda  
McCullough, PhD

Ultraviolet (UV) light causes DNA damage in skin cells, leading to more than one million cases of non-melanoma skin cancer diagnosed annually in the United States. Human cells possess only one mechanism to repair UV-induced DNA damage, and lack a DNA enzyme that can specifically initiate an alternative DNA repair pathway that is present in other organisms. Certain bacteria and viruses have very efficient systems for the repair of sunlight-induced DNA damage. The McCullough and Lloyd laboratories have identified a DNA repair enzyme from a virus that infects single cell green algae, *Chlorella virus PBCV-1*, and have engineered this enzyme to contain a nuclear localization sequence (NLS) and a membrane permeabilization peptide (TAT) for enhanced delivery to human skin cells. Drs. Lloyd and McCullough currently have multiple patents either awarded, or in review, for the application of this enzyme and related enzymes in the prevention of skin cancer. Their laboratories have recently demonstrated that this UV-specific DNA repair enzyme can be delivered to human skin cells in culture and to a human skin tissue model via the transmembrane permeabilization peptide, a method which bypasses the more traditional liposomal encapsulation approach of most topical drugs of this nature. The McCullough lab has discovered that, once delivered to the skin cells, the DNA repair enzyme rapidly initiates removal of the DNA damage. The development of this enzyme as a topical therapeutic is being done in collaboration with an Oregon biotechnology research and development company, Restoration Genetics, Inc. (RGI). Drs. Lloyd and McCullough are the founders of RGI and Dr. Lloyd serves as the Chief Scientific Officer and Dr. McCullough as the President of the company. This latest work was published in the *Journal of Investigative Dermatology* in 2010.

## CROET Expenditures Fiscal Year 2009/2010

Workers' Compensation Expenditures		Federal and Other Grant Expenditures	
<b>Salaries</b>		<b>Salaries</b>	
Salaries - research (16% of all salaries)	671,496	Salaries - research (68% of all salaries)	2,859,181
Salaries - outreach (2% of all salaries)	96,324	Salaries - outreach (0% of all salaries)	0
Salaries - education (1% of all salaries)	50,634	Salaries - education (0% of all salaries)	0
Salaries - administration (9% of all salaries)	366,319	Salaries - administration (3% of all salaries)	106,269
Salaries - core services <sup>1</sup> (<1% of all salaries)	15,719	Salaries - core services (<1% of all salaries)	29,717
<b>Supporting Services (includes cores)</b>		<b>Supporting Services (includes cores)</b>	
Supplies and equipment	436,389	Supplies and equipment	1,728,241
Miscellaneous support <sup>2</sup>	109,097	Miscellaneous support <sup>2</sup>	10,458
<b>Outreach and Education</b>		<b>Outreach and Education</b>	
Services, supplies and equipment	590,531	Services, supplies and equipment	0
<b>Other Expenses</b>		<b>Other Expenses</b>	
Bond principal & interest	353,482	Building operations & maintenance	0
OHSU administrative charges	50,000	OHSU administrative charges	250,000
<b>Total</b>	<b>\$2,739,991</b>	<b>Total</b>	<b>\$4,983,866</b>

## Programs Fiscal Year 2009/2010

	Amount paid by W/C	Amount paid by grants	Total Cost
<b>Outreach and Education</b>			
Information dissemination (e.g., TIC <sup>3</sup> , website, newsletters, brochures)	503,100	0	503,100
Education & training programs (professional & para-professional)	86,310	0	86,310
Chemical risk information service <sup>5</sup>	148,079	0	148,079
<b>Basic and Applied Research</b>			
Factors that affect workplace performance	251,957	864,583	1,116,540
Damage and repair of the nervous system and muscle	150,367	317,521	467,888
Occupational/environmental exposures and their consequences	276,169	1,084,060	1,360,229
DNA damage, genetic alterations & disease	281,539	2,329,857	2,611,396
Core services support <sup>1</sup>	42,042	29,717	71,759
Non-program-specific expenses <sup>4</sup>	1,000,428	358,127	1,358,555
<b>Total Expenses</b>	<b>\$2,739,991</b>	<b>\$4,983,865</b>	<b>\$7,723,856</b>

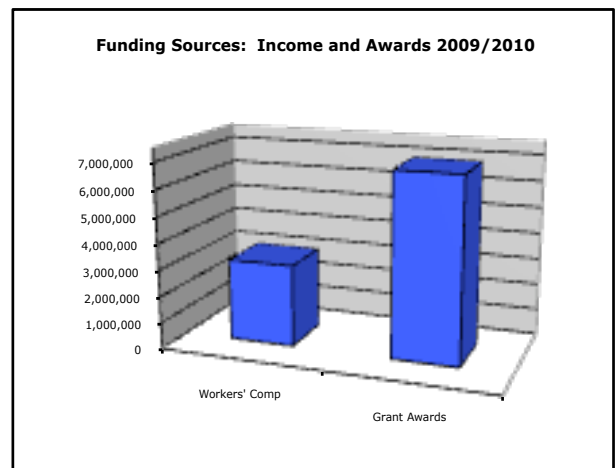
<sup>1</sup> core services - centralized graphics, statistics, and imaging

<sup>2</sup> e.g., office supplies, equipment maintenance and repair, phone rental and line charges

<sup>3</sup> Toxicology Information Center

<sup>4</sup> includes supporting services, administrative salaries, bond principal and interest, OHSU administrative charges, building operation & maint.

<sup>5</sup> Chemical risk information service is self-supporting. This amount reflects current year expenses and income only, however, prior year carry forward was used to cover all costs.



# CROET

The Center for Research on Occupational and Environmental Toxicology (CROET) conducts research, trains health professionals, provides consultation, and offers the public information on hazardous chemicals and their health effects. CROET includes scientists and research staff exploring a range of questions relating to prevention of injury and disease, and promotion of health, in the workforce of Oregon and beyond. CROET's Toxicology Information Center (TIC) is staffed to answer Oregonians' questions about chemical and other occupational exposures, and the Center's CROETweb web site makes health and safety information continuously available.

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For additional copies of this report, call CROET at the numbers listed above or visit [www.ohsu.edu/croet](http://www.ohsu.edu/croet) and click on "About"

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### Associate Director and Senior Scientist

W. Kent Anger, PhD

### Assistant Director for Operations

Gregory Higgins, PhD

### Assistant Director for Business Affairs

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Roman Kassa, PhD  
Anuradha Kumari, PhD  
Naima Laharjnar, Dip. Psychology  
Mike Lasarev, MS

## FRONT COVER

### Top Photo

Trucking is important to the Oregon economy. This photo documents Dr. Ryan Olson's research on the transportation industry.

### Middle Photo

Picture of county supervisors and managers taking training on the effects of domestic violence on the workplace provided by a CROET grant-funded research study in Deschutes County, one of 27 Oregon counties receiving training during the study.

### Bottom Photo

Basic research into factors that affect the health of working Oregonians is one major area of emphasis for CROET scientists.

## BACK COVER

View of CROET and its iconic marble sculpture of the 'half head', as seen from an unusual viewpoint.

Lisa Mariott, PhD  
Mykhaylo Moldavan, PhD  
Dede Montgomery, MS, CIH  
Amy Palma, RD  
Harini Sampath, PhD  
Vladimir Vartanian, PhD  
Bradley Wipfli, PhD  
Erika Zoller, MS





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