

Message from the department chairs

Greetings! We'd like to introduce you to our two new departments—Genetics, Development and Cell Biology (GDCB) and Ecology, Evolution and Organismal Biology (EEOB). Although our organization is new, we hope you'll come to think of yourselves as our alumni and friends in one or both of our departments.

The goal of the recent reorganization of biological sciences at Iowa State was to create departments that would bring together natural research and teaching associations organized around levels of biological organization rather than biological kingdoms. This structure fosters a tremendous synergy among faculty and students studying similar processes, problems, or issues in very different organisms but using similar tools and research perspectives.

Just as important, the reorganization aligns Iowa State with the organization of fundamental biological science disciplines at our peer institutions nationally and internationally.

Here's a quick look at our two departments:

- GDCB focuses on biological function at the cellular and subcellular levels. We use molecular, genetic, computational, and biochemical approaches to understand biological function within the context of the whole organism and how it grows, develops, and responds to its internal and external environment. GDCB overlaps and complements the Department of Biochemistry, Biophysics and Molecular Biology (BBMB) at the molecular scale and EEOB at the organismal scale. We invite you to visit our Web site, www.gdcb.iastate.edu, and contact us by e-mail (GDcb@iastate.edu), telephone (515 294-7322), or mail (either using the convenient card in this newsletter or your own stationary). Let us know what you're thinking, update us on your life, and comment on the reorganization and the new department.
- EEOB is the life-science department that is committed to exploring organismal diversity and the interactions of organisms with each other and with the environment. Research and teaching explore all kingdoms of life using tools and questions that range



MARTIN SPALDING



JONATHAN WENDEL

in scale from molecules to the biosphere. Visit our Web site, www.eeob.iastate.edu, and contact us by e-mail (jfw@iastate.edu), telephone (515 294-3523), or mail (either using the convenient card or your own stationary). Tell us your thoughts, update us on your life, and give us feedback on the reorganization and on the new EEOB.

Like our predecessors, our departments represent the core of fundamental biological sciences at Iowa State. So no matter which of our previous titles you identify with—botany, botany and plant pathology, genetics, zoology, zoology and entomology, or zoology and Genetics—we hope you'll embrace our new departments with as much enthusiasm as we bring to the reorganization.

We hope this newsletter helps you begin to know us better and acquaints you with new faces and exciting directions—as well as reacquaints you with familiar names and programs. Our message is that our departments have bright futures. We're very excited to be building on the excellence in teaching and research in fundamental biological sciences that you received when you were at Iowa State.

A handwritten signature in black ink that reads "Martin Spalding".

Martin Spalding
Chair, Department of Genetics, Development and Cell Biology
(GDCB)

A handwritten signature in black ink that reads "Jonathan F. Wendel".

Jonathan Wendel
Chair, Department of Ecology, Evolution and Organismal Biology
(EEOB)

Classify new biological sciences structure under “ISU Excellence”

Iowa State has implemented a major departmental reorganization for the biological sciences. In a world that’s no longer simply delineated along the Linnaean classification of animal and plant kingdoms, the reorganization is part of an effort to better prepare students and help faculty with their research.

In days gone by, botanists and zoologists rarely found a scientific need to build interdisciplinary teams. Not so today.

Whether they have a passion for velvet leaf or vetch, fruit flies or field mice, biologists are likely to struggle with similar problems and pursue similar experimental approaches as they attempt to answer scholarly questions.

Two new departments—Genetics, Development and Cell Biology (GDCB) and Ecology, Evolution and Organismal Biology (EEOB)—have been created from this reorganization. Both are jointly administered by the College of Agriculture and the College of Liberal Arts and Sciences.

GDCB and EEOB represent the new units that emerged from parts of the

former departments of botany, zoology and genetics, animal ecology, and microbiology.

“In GDCB, we gaze toward the organism and the role cells and molecules play in how the organism functions,” explains **Martin Spalding**, GDCB department chair. “In EEOB, faculty study the function of the whole organism, the role it plays in a population and ecosystems, as well as how it came to be that way—its evolutionary path.”

The reorganization has also created a third new department called natural resources and ecology management, which amalgamates the former departments of forestry and animal ecology. Furthermore, the reshuffling brought about the addition of several faculty members to the Department of Biochemistry, Biophysics

and Molecular Biology (BBMB). Microbiology is now an interdepartmental program led by faculty in plant pathology and animal science.

“Because plants and animals do similar things differently, this reorganization will help our faculty bring new insight into solving similar problems in different organisms,” says Spalding.

At the cellular level, the respective development of a fruit fly and a corn plant are studied in much the same way, though researchers approach the questions from entirely different perspectives—zoological or botanical.

For example, if one is trying to understand cellular function, such as how a particular enzyme interacts with its substrate during development, be it *Drosophila melanogaster* or *Zea mays*, it is fundamentally the same question and will be answered using the same molecular tools.

So, issues like which imaging technique should be used to visualize molecular architecture or how best to monitor the dynamic metabolic activity inside a cell

EEOB FACULTY

ACKERMAN, RALPH

Professor

ADAMS, DEAN

Assistant Professor

ANDREWS, ROBERT

Associate Professor

BOWEN, BONNIE

Lecturer

BRONIKOWSKI, ANNE

Assistant Professor

CLARK, LYNN

Professor

CLARK, WILLIAM

Professor

COLBERT, JIM

Associate Professor

CRUMPTON, BILL

Associate Professor

DANIELSON, BRENT

Associate Professor

DEBINSKI, DIANE

Associate Professor

DOWNING, JOHN

Professor

DREWES, CHARLES

Professor

FARRAR, DON

Professor

FARRAR, EUGENIA

Associate Professor

JANZEN, FRED

Associate Professor

JURIK, TOM

Associate Professor

LAVROV, DENNIS

Assistant Professor

LESHAM-ACKERMAN, ADAH

Clinician

MOLONEY, KIRK

Associate Professor

NASON, JOHN

Associate Professor

PLEASANTS, BARBARA

Adjunct Assistant Professor

PLEASANTS, JOHN

Adjunct Assistant Professor

POWELL, ED

Associate Professor

PROULX, STEPHEN

Assistant Professor

RAICH, JIM

Associate Professor

SERB, JEAN

Assistant Professor

VALENZUELA, NICOLE

Assistant Professor

VAN DER VALK, ARNOLD

Professor

VLECK, CAROL

Associate Professor

VLECK, DAVID

Adjunct Associate Professor

WALLACE, ROB

Associate Professor

WENDEL, JONATHAN

Professor

WILSEY, BRIAN

Assistant Professor

ASSOCIATED FACULTY

DOLPHIN, WARREN

University Professor of Genetics, Development and Cell Biology

HENDRIX, STEPHEN

Collaborator

HORNER, JACK

University Professor of Genetics, Development and Cell Biology

KOFORD, ROLF

Collaborator

NEWTON, TERESA

Collaborator

OTIS, DAVID

Collaborator

PIERCE, CLAY

Collaborator

ROSBURG, THOMAS

Collaborator

EMERITUS FACULTY

BROWN, GEORGE

Emeritus Professor

BUTTREY, BEN

Emeritus Professor

LERSTEN, NELS

Emeritus Professor

REDMOND, JIM

Emeritus Professor

SHAW, KEN

Emeritus Associate Professor

TIFFANY, LOIS

Distinguished Emeritus Professor

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Assistant Professor

DOBBS, DRENA

Associate Professor

DOLPHIN, WARREN

University Professor

DORMAN, KARIN

Assistant Professor

DOYLE, ROBERT

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EMERY, DENNIS

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HENDERSON, ERIC

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HOWELL, STEPHEN

Professor and Director of the Plant Sciences Institute

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MAYFIELD, JOHN

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MCCLOSKEY, MICHAEL

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XIANG, CHENGBIN

Affiliate Assistant Professor

YIN, YANHAI

Assistant Professor

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CAMPBELL, ARDEN

Professor of Agronomy

DANILEVSKAYA, OLGA

Professor (Collaborator)

FORD, CLARK

Associate Professor of Food Science and Human Nutrition

GIRTON, JACK

Associate Professor of Biochemistry, Biophysics and Molecular Biology

LEE, MIKE

Professor of Agronomy

LINK, CHARLES

Professor (Collaborator)

MAHAJAN, PRAMOD

Associate Professor

(Collaborator)

PALMER, REID

Professor (Collaborator)

PECCOUD, JEAN

Professor (Collaborator)

PETERSON, PETER

Professor of Agronomy

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Professor of Agronomy

SHOEMAKER, RANDY

Professor (Collaborator)

TUCKER, ROBERT

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WENDEL, JONATHAN

Professor and Chair of the Department of Ecology, Evolution and Organismal Biology

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BISHOP, STEVE

Emeritus Professor

IMSANDE, JOHN

Emeritus Professor

LAMOTTE, CLIFF

Emeritus Professor

MILLER, WILMER

Emeritus Professor

PATTEE, PETER

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POLLAK, EDWARD

Emeritus Professor

ROBERTSON, DONALD

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Emeritus University Professor

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can more easily be discussed among colleagues who share the same technical knowledge base and speak the same scientific language.

“Technological advancements and the natural progression toward a more complete understanding of living things has brought the scientific questions being asked today down to a common level,” says Spalding.

Collaborative research efforts routinely involve members from different departments and different institutions, each bringing their expertise to the problem at hand.

But defining curriculum, hiring new faculty, performing faculty evaluations, and recommending promotions is where individual departments perform their major role.

With this reorganization, the departments can carry out their administrative responsibilities with the benefit of peers that bring a cohesive technical background into these academic discussions.

“TECHNOLOGICAL ADVANCEMENTS AND THE NATURAL PROGRESSION TOWARD A MORE COMPLETE UNDERSTANDING OF LIVING THINGS HAS BROUGHT THE SCIENTIFIC QUESTIONS BEING ASKED TODAY DOWN TO A COMMON LEVEL,”
 — Spalding

Spalding says Iowa State’s biology curriculum is now designed to let students learn the similarities and differences between plants, animals, and microbes simultaneously, rather than studying each in a different course and then having to discover the shared qualities themselves.

Because students learn the fundamentals of biology early on, they preserve their freedom to decide which area of the life sciences they would like to explore further.

Students can delve into the details of microbiology, zoology, or botany once

they reach the upper-level courses where the curriculum can diverge into the more traditional specialties.

Students also can choose to remain focused on, for example, development, evolution, or genetics without regard to the kingdom of the organisms.

Deep and varied skills have been brought together by the departmental reorganization, creating natural opportunities for unique synergisms.

This provides the means for graduate students and postdoctoral associates to interact more easily with others working on similar problems without actually being collaborators.

The interdepartmental undergraduate biology major is administered by the two new departments, GDCB and EEOB. Together with BBMB, they also administer the interdepartmental undergraduate genetics major.

“Our faculty draw from the excellent spectrum of interdepartmental graduate programs for graduate students,” explains Spalding.

The two new departments have created a new system of specialization for biology undergraduate students. Upper-level students move through the large impersonal style classes into a more personal setting with faculty mentors. Internships, summer field experiments, and other more focused opportunities are now available to GDCB and EEOB students.

“We are experiencing a complete sense of enthusiasm and renewal with the undergraduate and graduate curriculum and tremendous interdepartmental synergy from interactions between faculty and students,” says **Jonathan Wendel**, EEOB department chair.

One concern from the reorganization is how students might acquire an appreciation and the capacity to recognize the variety of organisms and their interrelationship within an actual ecosystem. Wendel says that while EEOB remains very strong in this area, he has developed a strategy whereby new faculty

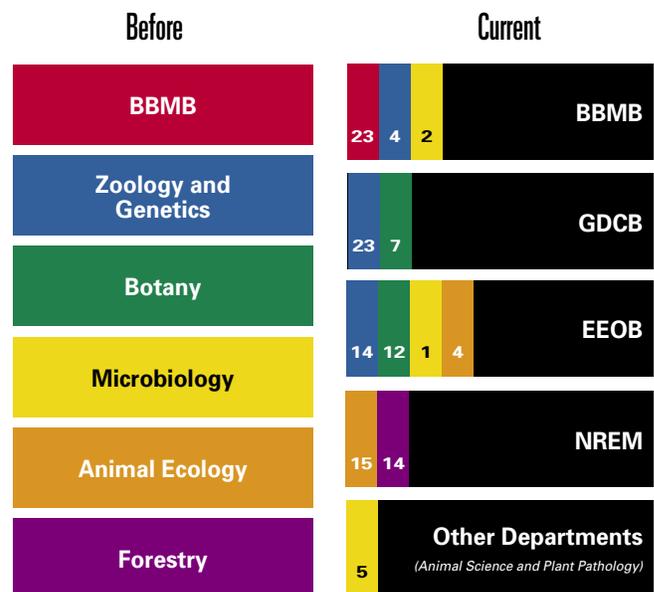
members hired in conceptual areas such as evolutionary biology or co-evolutionary theory must also be experts on a particular group of organisms.

“The students really benefit,” says **Dan Voytas**, a professor in the GDCB department, who says he finds it much easier to drop in on fellow departmental colleagues with students in tow with questions to be answered. “In GDCB we are all experts in cellular and molecular biology. This reorganization lets us focus our teaching efforts.”

Where'd they go?

In the reorganization of biological sciences departments, some faculty members found new homes in the new configuration. The graphic shows the departments before the reorganization and the current departments. The bars of the current departments include colored segments showing where faculty members transferred. A legend of the acronyms is below. For the full roster of current faculty in EEOB and GDCB, see the lists on pages 2 and 3.

BBMB = Biochemistry, Biophysics and Molecular Biology
 GDCB = Genetics, Development and Cell Biology
 EEOB = Ecology, Evolution and Organismal Biology
 NREM = Natural Resources and Ecology Management



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GDCB Alumni, GDCB Department, 1210 Molecular Biology, Iowa State University, Ames, Iowa 50011-3260; e-mail GDCB@iastate.edu; or find this form on the Web at www.gdcb.iastate.edu.

Name _____ Today's Date _____

Degree/Major/Year _____

E-mail Address _____

Home Address _____

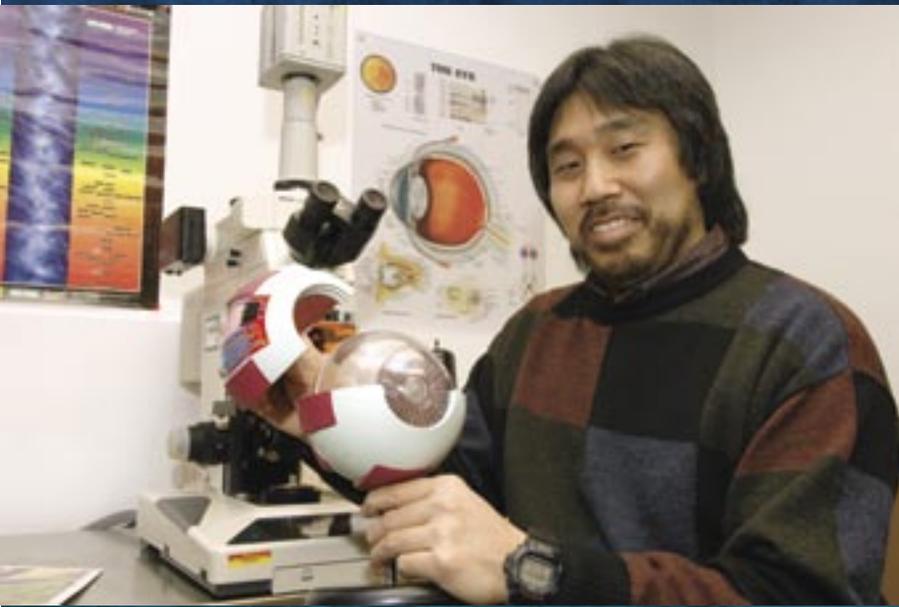
Business Title _____ Employer _____

Business Address _____

I'm most interested in: GDCB EEOB Both

What's New _____

Strong clear vision



Over three million Americans are afflicted with glaucoma, an eye disease that damages the optic nerve. If left untreated, the disease can lead to blindness.

The underlying cause of glaucoma is uncertain. However, elevated fluid pressure within the eye is a primary risk factor associated with its development.

As the disease develops, nerve cells essential for relaying visual images from our eyes to our brain, called retinal ganglion cells, are deprived of nutrition and oxygen from the elevated pressure and soon begin to die. Eventually the person affected can no longer see.

But if the retinal ganglion cells could be revitalized, vision might be restored.

Figuring out what factors these nerve cells need and finding a way to deliver them to the affected area is one of the challenges embraced by **Donald Sakaguchi**, GDCB associate professor and developmental neurobiologist.

Sakaguchi is involved in a highly competitive and extremely collaborative research effort exploring treatment strategies for restoring vision to damaged or diseased eyes like those with glaucoma.

Working with animal models —rats and mice — Sakaguchi and his colleagues at Iowa State, as well as from the University of Iowa, the University of Miami, Harvard University, and Yale University, are

trying a variety of methods to deliver therapeutic interventions to important nerve cells in the eye.

By artificially elevating the pressure inside the eye, Sakaguchi and his colleagues can mimic some of the effects of glaucoma.

Tiny channels in the eye, called the trabecular meshwork, are how fluid is normally drained from the eye. Sakaguchi's group uses a laser beam to cauterize and clog the channels. This increases the eye's internal pressure, simulating the cellular damage that glaucoma afflicts on the optic nerve.

It is the axons of these cells that connect the light-sensitive portion of the eye to the brain. Their vitality is essential for vision.

Sakaguchi and his colleagues hypothesized that molecules called neurotrophic factors are no longer being made at the normal rate after an eye is injured. These molecules are needed by immature nerve cells to develop and are thought to be essential for survival.

"So a potential therapy might involve delivering these factors to the injured eye," Sakaguchi says. "Then the next challenge is how to get these factors into the eye and to the affected area."

As one approach, Sakaguchi and his colleagues are using neurotrophic factors engineered into little biodegradable beads. When the beads are injected into the injured eye, they slowly release the compounds.

Their preliminary research results indicate that this method of releasing neurotrophic factors helps protect the eye from additional damage and may restore visual function.

Stem cell transplantation is another approach Sakaguchi is pursuing as a treatment method.

Adults have stem cells—those therapeutically promising subjects of much debate—that are present in many of our tissues including bone marrow, brain, and eyes.

"Transplanting these stem cells into the diseased or injured eye may help to recover its normal function and to protect the remaining nerve cells from further harm," explains Sakaguchi.

Adult stem cells may be able to replace dead cells or produce the vital molecules to fortify the existing nerve cells, he says.

Employing the latest technology, Sakaguchi and his colleagues are trying to engineer human adult stem cells to act as tiny workshops, making and pumping out important neurotrophic factors. They are also working out the finer points of transplanting the stem cells into the injured or diseased eye.

"Think of stem cells as mini-biofactories for the production of these factors that can migrate and possibly integrate into tissue," says Sakaguchi.

The adult stem cells are particularly advantageous because they do not pose the ethical issues surrounding embryonic stem cells. Additionally, many of the immunological issues can be eliminated if a person's own stem cells can be

engineered and used for treatment.

The principles that Sakaguchi learns from his experiments may also hold promises for other nerve-related problems such as spinal cord injuries and strokes, as well as a host of diseases such as Parkinson's.

"We are still at the basic research level," says Sakaguchi, "trying to understand how cell transplants might be useful." 

"Transplanting these stem cells into the diseased or injured eye may help to recover its normal function and to protect the remaining nerve cells from further harm."

— Donald Sakaguchi

Pathways in plants

How to regulate oil and protein production in soybean seeds or how to best make biobased plastics in plants depends on an understanding of the finer details of plant metabolism.

Eve Syrkin Wurtele, GDCB professor and plant biologist, is studying the interconnected regulatory networks that control plant metabolism.

In particular, Wurtele is interested in the metabolic pathways that lead to and radiate from a centrally important and highly regulated metabolite called acetyl-coenzyme A, or acetyl-CoA.

"It's the end product people are interested in, but we need to know about the flow of precursors towards that end product to control its accumulation," explains Wurtele. "And acetyl-CoA is right in the middle."

Collaborating with many colleagues to study acetyl-CoA metabolism, Wurtele is using *Arabidopsis thaliana*, the small flowering plant from the mustard family used by plant biologists, as a model organism, much the same way animal biologists use the mouse.

Acetyl-CoA's importance in plant welfare is illustrated by a mutant *Arabidopsis* Wurtele is studying. The mutant has been engineered to make less acetyl-CoA than its normal counterpart. Its growth is dramatically stunted.

Because of acetyl-CoA's central role in metabolism and its important role in many biological reactions, Wurtele identified it as an ideal place to start studying how the different regulatory pathways in plant cells are connected.

Inside the plant cell, Wurtele and her collaborators have found at least five different regions or "compartments" where acetyl-CoA is made. It forms when the sugar glucose and a variety of compounds such as fats are broken down.

Once formed, acetyl-CoA is either used by the cell to help produce many of the nearly 30,000



different products the cell needs to function or it's broken down to generate energy for the cell.

Wurtele and her colleagues have identified a set of genes that code for the proteins that make and use acetyl-CoA. The genes are different for each of the five cellular compartments they have identified as containing acetyl-CoA.

Also unique to each compartment is how the acetyl-CoA is used by the cell, its mode of formation, and the manner in which it is regulated.

To study the interconnection within the labyrinth of the cell's metabolic networks, Wurtele has turned toward genomic approaches that allow researchers to find differences at the chemical level.

Using microarray techniques, Wurtele and her colleagues have compared the activity of 22,000 genes from the normal and mutant plants, looking for differences. They found 170 genes that differed in their activity.

Among these are 20 genes that are involved in the synthesis and degradation of trehalose, an unusual six-carbon sugar that appears to interconnect acetyl-CoA with starch production.

"It may be a regulatory factor," says Wurtele. "We will explore in more detail to see if trehalose is involved in the regulation of starch synthesis."

RNA signifies gene activity, as well as the spectrum and relative amounts of the proteins and metabolites found in the normal plant compared with those found in the stunted one. Comparing the amounts of the RNAs can highlight biological differences in the biochemical functioning of each plant, Wurtele says.

These comparison studies become more intricate by scrutinizing RNAs, proteins, and metabolites present before and after ultraviolet light exposure and over a series of time points.

At their fingertips is a complex computer package Wurtele and colleagues **Julie Dickerson**, associate professor of electrical and computer engineering, and **Dianne Cook**, associate professor of statistics, are designing to make sense of the large sets of data being generated.

The programs allow Wurtele to pull out statistically significant differences between the compounds she is analyzing and to recognize those that show similar patterns of accumulation.

"From these analyses, we find unexpected associations that may have biological functions that we can begin to explore," says Wurtele. 🇺🇸

"It's the end product people are interested in, but we need to know about the flow of precursors towards that end product to control its accumulation."

— Eve Wurtele

Precision decisions

Using retroviruses to deliver therapeutic genetic material to people afflicted with disease has long been a promising approach for gene therapy.

Retroviruses readily insert themselves into the host's chromosome, making them an ideal vector to deliver a permanent copy of a desired gene. Using retroviruses for gene therapy may help cure a plethora of diseases caused by single gene defects.

However, major complications can arise if the virally delivered genes settle down in the wrong place. Because their method of insertion appears to be random, retroviruses can disrupt normal gene function, bringing about devastating diseases or a variety of cancers if they end up in the wrong place. This recently occurred during a gene therapy trial in France. Patients being treated for an autoimmune disease developed leukemia.

But if the integration of retroviruses could be precisely directed, gene therapists might be able to capitalize on all the advantages they offer as vectors.

Dan Voytas, GDCB professor and molecular biologist, is working toward making this scenario a reality.

Voytas' research centers on the mysterious subject of transposable elements — chunks of DNA that readily move around within the genome.

Transposable elements are "ancient and ubiquitous genome parasites," says Voytas. "The transposable elements we work on—called retrotransposons—have many similarities to retroviruses but do not have a life outside the host cell as infectious particles."

Close to 50 percent of the human genome appears to be made up of these moveable elements. The maize genome is about 75 percent mobile DNA. Baker's yeast has about 3 percent of its genome peppered with transposable elements.

These pieces of DNA stay within their specific host. However, they are not just genetic parasites. Because some mutations are advantageous, transposable elements give the genome an opportunity to rapidly restructure itself, making it able to withstand new selective pressure.

Using baker's yeast, *Saccharomyces cerevisiae*, as a model organism, Voytas

and his colleagues are working to decipher the mechanism by which these retroviral cousins determine where they will integrate.

The yeast genome is small and compact compared to that of plants and animals. This means when transposable elements integrate, their choice of site must be one where vital yeast genes are not disrupted. Otherwise the "host" will die, and the elements will, in essence, reach a genetic dead end.

"These mobile elements need to find a safe haven that the host can tolerate, a site where they can integrate and persist without causing abnormalities that wreak havoc within the host genome," explains Voytas.

Voytas recently discovered that yeast transposable elements recognize specific sites within the genome where they will consistently integrate. For example, some only jump to the end of chromosomes, or telomeres.

"If the integration of retroviruses could be precisely directed, gene therapists might be able to capitalize on all the advantages they offer as vectors."

— Dan Voytas

Voytas and his colleagues focused their efforts on the telomere-favoring element cryptically called Ty5 (transposable element of yeast number 5).

Because yeast telomeres had already been thoroughly studied, Voytas and his colleagues were able to crack this decade-old puzzle relatively quickly.

"Yeast was an ideal model system to get at the heart of the biological problem," says Voytas. "So we could discover what features of the chromosomal landing pad determined Ty5's integration site."

Voytas discovered that the Ty5 protein recognizes a protein that coats the end of the chromosome or telomere. By engineering the Ty5 to recognize different proteins, Voytas was able to make this transposable element integrate into new target sites on the chromosome.

Voytas and his collaborators are now applying the principles of their yeast retrotransposon discovery to gene therapy vectors in an attempt to make precisely targeted vectors that won't carry the possibility of secondary consequences along with them.

"We're teasing apart the basic biology here," says Voytas. "We use a model system because it is the most facile way to get at the heart of this biological problem." 



Message from the deans

The life sciences are critically important to the education of Iowa State students and for laying the foundation for new discoveries across many fields that will expand our knowledge, contribute to our economy, and shape our future.

That's why the reorganization of departments at Iowa State University was initiated more than four years ago.

The driving force behind the reorganization was to enhance the academic excellence and national recognition of our programs in basic biological sciences.

As the leaders of the College of Agriculture and the College of Liberal Arts and Sciences, we believe the new structure is strengthening undergraduate and graduate education and offering new opportunities for interaction among faculty with diverse talents but common goals.

The new Department of Genetics, Development and Cell Biology and the new Department of Ecology, Evolution and Organismal Biology are two of the key players in our new structure. We believe the faculty and staff of GDCB and EEOB bring fresh, new energies to the classroom and the laboratory.

The reorganization has helped our departments and many others on campus bring new focus to the interconnectivity



CATHERINE WOTEKI



MICHAEL WHITEFORD

of all aspects of biology, whether at the molecular, cellular, organismal, or population level of study.

We see biology education and research continuing to play a central role in the science and technology mission of Iowa State, just as it has from our institution's beginnings nearly 150 years ago. We look forward to the exciting results from these labs and from the successes of our outstanding graduates.

Catherine Woteki
Dean, College of Agriculture

Michael Whiteford
Dean, College of Liberal Arts and Sciences

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