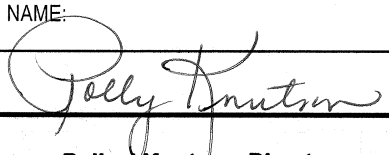
COVER SHEET FOR GRANT PROPOSALS

State Board of Education

SBOE PROPOSAL NUMBER: (to be assigned by SBOE)	AMOUNT REQUESTED:$50,000
TITLE OF PROPOSED PROJECT: PRODUCTION OF GENDER-SORTED SPERM FOR APPLICATIONS IN THE ANIMAL REPRODUCTION INDUSTRY USING THE INVADER TECHNOLOGY	
SPECIFIC PROJECT FOCUS: Biotechnology, Agriculture and Chemistry	
PROJECT START DATE: July 1, 2013	PROJECT END DATE: June 30, 2014
NAME OF INSTITUTION: University of Idaho	DEPARTMENT: Chemistry
ADDRESS: 875 Perimeter Drive MS 2343, Moscow, ID 83844-2343	

		E-MAIL ADDRESS:	PI PHONE NUMBER:
		Hrdlicka@uidaho.edu	208-885-0108

	NAME:	TITLE:	SIGNATURE:
PROJECT DIRECTOR	Patrick J Hrdlicka	Associate Professor	
CO-PRINCIPAL INVESTIGATOR			
CO-PRINCIPAL INVESTIGATOR			
CO-PRINCIPAL INVESTIGATOR			

	NAME:	SIGNATURE:
Authorized Organizational Representative	 **Polly J Knutson, Director** **Office of Sponsored Programs** **University of Idaho**	

SUMMARY PROPOSAL BUDGET

Name of Institution: University of Idaho

Name of Project Director: Patrick J Hrdlicka

A. FACULTY AND STAFF

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
Patrick J. Hrdlicka	$47.08/h			0.5	$3,800
% OF TOTAL BUDGET: 7.6 %				**SUBTOTAL:**	$3,800

B. VISITING PROFESSORS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
% OF TOTAL BUDGET:				**SUBTOTAL:**	

C. POST DOCTORAL ASSOCIATES / OTHER PROFESSIONALS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
% OF TOTAL BUDGET:				**SUBTOTAL:**	

D. GRADUATE / UNDERGRADUATE STUDENTS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
Dale C Guenther	$19.23		9.0	3.0	$20,000
% OF TOTAL BUDGET: 40.0 %				**SUBTOTAL:**	$20,000

E. FRINGE BENEFITS

Rate of Pay (%)	Salary Base	Dollar Amount Requested
35.2% (Hrdlicka)	$3,800	$1,400
3% (Guenther)	$20,000	$600
SUBTOTAL:		$2,000

F. EQUIPMENT: (List each item with a cost in excess of $1000.00.)

Item/Description	Dollar Amount Requested
SUBTOTAL:	

G. TRAVEL:

Dates of Travel (from/to)	No. of Persons	Total Days	Transportation	Lodging	Per Diem	Dollar Amount Requested
Jan 3-5 2013	1	3	Air	NA	NA	$800
					SUBTOTAL:	$800

H. Participant Support Costs:

	Dollar Amount Requested
1. Stipends	
2. Travel (other than listed in section G)	
3. Subsistence	
4. Other: health insurance	
SUBTOTAL:	

I. Other Direct Costs:	Dollar Amount Requested
1. Materials and Supplies	$15,400
2. Publication Costs/Page Charges	
3. Consultant Services (Include Travel Expenses)	
4. Computer Services	
5. Subcontracts	
6. Other (specify nature & breakdown if over $1000) Tuition and fees	$8,000
SUBTOTAL:	$23,400
J. Total Costs: (Add subtotals, sections A through I) **TOTAL:**	$50,000
K. Amount Requested: **TOTAL:**	$50,000
Project Director's Signature:	Date: 05/06/2013

INSTITUTIONAL AND OTHER SECTOR SUPPORT

(add additional pages as necessary)

A. INSTITUTIONAL / OTHER SECTOR DOLLARS

Source / Description	Amount

B. FACULTY / STAFF POSITIONS

Description

C. CAPITAL EQUIPMENT

Description

D. FACILITIES & INSTRUMENTATION

Description

SBOE Idaho Incubation Fund Program Proposal

PRODUCTION OF GENDER-SORTED SPERM FOR APPLICATIONS IN THE ANIMAL REPRODUCTION INDUSTRY USING THE INVADER TECHNOLOGY

Name of Idaho public institution: University of Idaho (UI)

Faculty member directing project: Patrick J. Hrdlicka (Department of Chemistry)

Previous submission of technology to SBOE Idaho Incubation Fund Program: in part - Dr. Hrdlicka received award IF13-001 (07/2012-06/2013) for the project "Development of diagnostic kits for gender determination of animal embryos", which was based on the same UI intellectual property that forms the basis of the present proposal (i.e., DNA-targeting Invaders). However, the commercial end-goals are different (i.e., production of gender-sorted semen vs kits for embryo sexing). As the embryo project evolved and major progress was made, we and our commercialization partner (Minitube of America), realized that there is a major market opportunity for a technology that enables efficient production of gender-sorted semen for applications in animal reproduction industry (*~$480 mill/year*, see 'market opportunity'). It is this opportunity that we want to tap into with the proposed project.

Executive summary: Dr. Hrdlicka and his UI-based team have developed a class of chemically modified oligonucleotides called **Invaders***, which bind to specific regions of genomic DNA*. While the full potential of this *patent-pending technology* extends to applications in fundamental research and development of drug candidates against diseases of genetic origin, this project focuses on *developing a process that utilizes Invaders to gender-sort sperm from animals used in food production and sport breeding*. An *exclusive licensing agreement* for the use of Invaders in animal reproduction technologies has already been executed between UI, Dr. Hrdlicka and Minitube of America (Verona, WI). The *commercial goals* are to: i) sell gender-sorted sperm for

different target species shortly after the end of the project period, and ii) create a Moscow-based start-up company that manufactures Invaders for Minitube, as well as, for new customers/partners using Invaders for research and in non-overlapping commercial applications.

Gap project objective and total amount requested: We request $50,000 in incubator funds to develop DNA-targeting Invaders as central components of a process that produces gender-sorted sperm from economically important livestock and companion animals.

Project relationship to home institution priorities: The project goals *closely align* with central components of UI's mission: enhancing the scientific and economic assets of Idaho, fostering entrepreneurial activities, developing solutions for complex problems facing society, and creating transformational interdisciplinary educational experiences for students. Students will be trained in synthetic nucleic acid chemistry, biophysical chemistry and molecular biology. Hrdlicka group alumni receiving similar training have been in high demand in the marketplace.

Potential impact to Idaho's economy: The project's most immediate economic impact will be *revenue generation* as outlined in the exclusive licensing agreement that has already been executed between UI, Dr. Hrdlicka and our industry partner, Minitube of America (Verona, WI). Minitube estimates that the *annual retail revenue* from sales of gender-sorted sperm *will exceed $480 mill/year* (see "Marketing opportunity" section). We will utilize the commercial launch of the gender-sorted sperm as a springboard to create a *Moscow-based start-up company*, housed in the UI Moscow Campus Incubator, which supplies Invaders to Minitube. This will create much-needed *employment opportunities for organic chemists in the Moscow area*. Initially, the company will employ 1-2 scientists. However, we expect strong growth opportunities, as additional customers/partners looking to use Invaders for non-overlapping applications in DNA-diagnostics, medicine and gene function studies, emerge.

Market opportunity: The ability to *produce mammalian offspring of a pre-determined gender* has been a long-standing goal of the animal reproduction industry, as it offers numerous advantages toward improving the economics and ethics of livestock production considering: i) different utility in production systems (e.g., females desired in dairy operations and herd replacement; males desired for beef production), and ii) different gender-specific feed conversion rates (e.g., higher rates in male pigs). Currently, a technology offered by Inguran LLC partially addresses this need, but is based on an *inefficient and wasteful* process that relies on small (~4%) fluorescence intensity differences between male and female sperm for separation. The shortcomings of the current technology only render it applicable to a limited number of bulls, and impossible to implement with boars and other species of high economic value. The *Invader-based semen sexing technology* will i) increase the efficiency of bull semen sorting by a factor of ten, and ii) enable rapid gender-sorting of entire sperm cell populations (whole ejaculates), making the technology applicable for all species (including pigs, small ruminants etc.).

Artificial insemination (AI) is a well-established technique for animal reproduction, which was introduced on a large scale in 1935 in cattle. Today in North America, AI is used in 90% of dairy cows, 10% of beef cows, ~100% of pigs and - to a more limited extent - in other species (horses, dogs, sheep, goats etc). Around 35 million doses of bull semen are produced annually just in the USA; the estimated worldwide number is over 100 million. The number of annually produced boar semen doses in North America is ~42 million while the estimated global number is ~150 million. These numbers are expected to grow based on internal and external factors: growing population and demand for animal protein (milk and meat); expansion of markets (e.g. increased adoption of AI in countries like India); continuation of the growing trend in beef cattle AI etc…

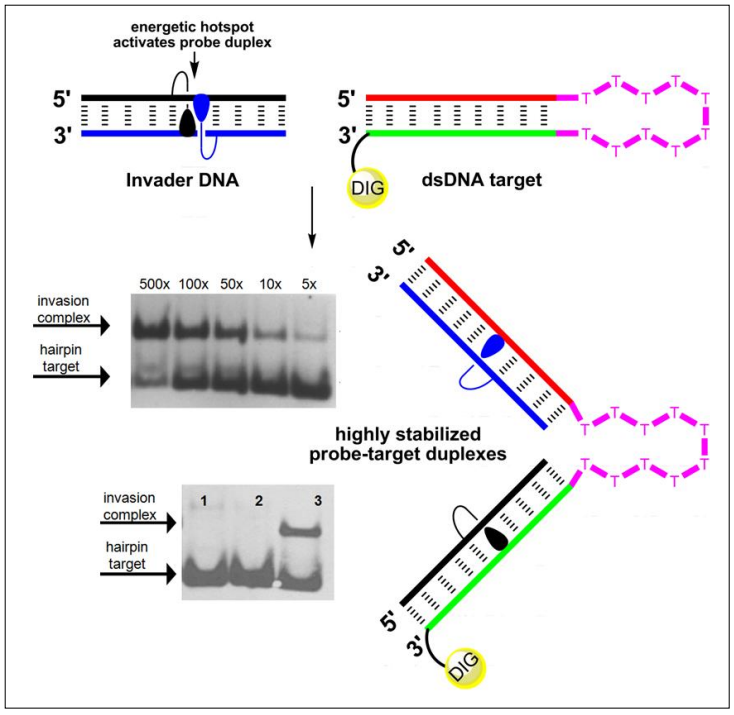
The market structure for bovine and porcine semen includes a number of large organizations and

genetics companies, which control the majority of high-quality males that are producing semen for AI. Minitube of America is already serving this industry by supplying them with equipment and supplies for semen collection, preservation and packaging. Our *Invader-based semen sexing technology* will be an important addition to Minitube's product line up. The current production of sexed semen is limited to only ~10% of all doses produced, and is mostly used in USA, resulting in a current production of sexed semen of 3.5-5 million doses per year. We estimate an adoption rate of our technology in excess of 40%, resulting in more than 40 million bull semen doses that are sexed with the Invader technology. Our annual estimate for boar semen is also ~40 million doses. Inguran LLC is currently charging a minimum of $12 per sexed semen dose. We are budgeting for an average charge of $6/dose of sexed semen using our technology, resulting in an *annual retail revenue opportunity in of $480 mill/year*.

Technology: RNA-targeting oligonucleotides, such as siRNA, are routinely used to detect and reduce expression of target genes in cells and animals. This approach has provided valuable insight into the function of many genes and led to the development of ~35 oligonucleotide drug candidates against genetic diseases such as cancer and hypercholesterolemia. In contrast, development of *oligonucleotides that target genomic DNA* has been largely unsuccessful since DNA is a far more complex target than RNA for the following reasons: i) binding to RNA targets occurs via Watson-Crick base pairing, while other and less stable binding modes must be invoked to target double-stranded DNA, ii) RNA is primarily located in the cellular cytosol where it is more accessible for binding with oligonucleotides than eukaryotic DNA, which is localized in the nucleus; and iii) genomic DNA is condensed and covered by proteins, which further reduces accessibility. *The absence of reliable DNA-targeting technologies is regrettable*

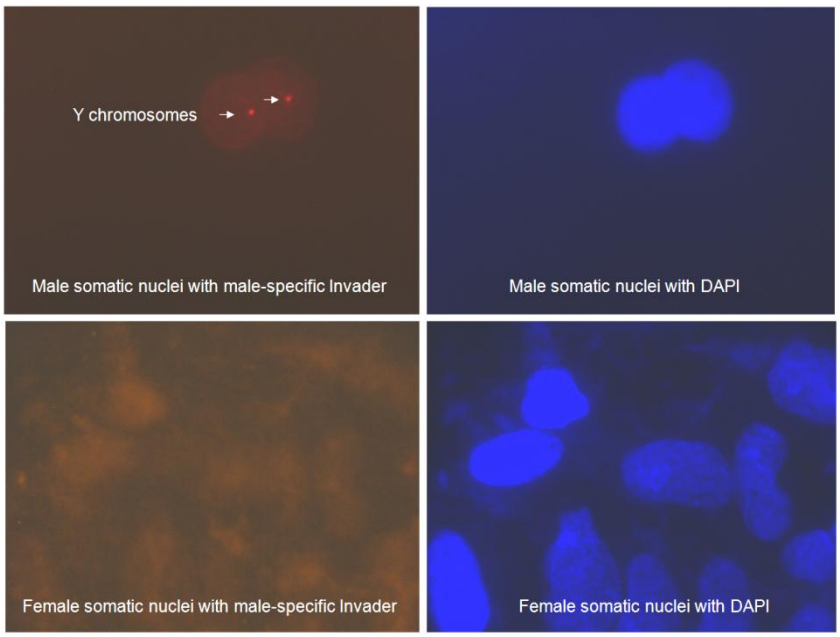
since only a small fraction of the genetic information stored in DNA is transcribed into RNA and thereby accessible for RNA-targeting probe technologies (especially true in sperm cells).

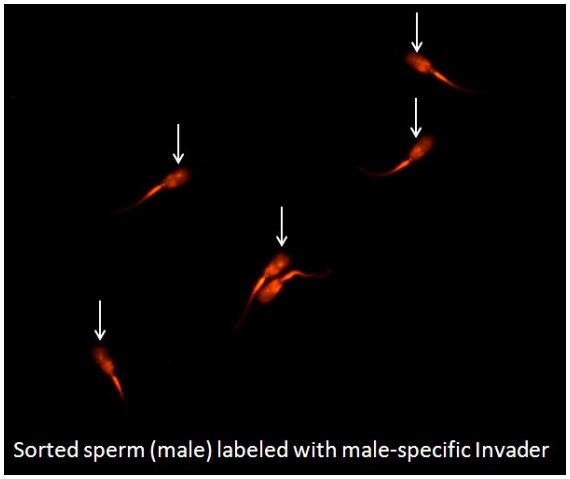
Dr. Hrdlicka and his UI-team have developed a class of chemically modified oligonucleotides termed *Invaders, which bind to specific regions of double-stranded DNA. Briefly described, Invaders are energetically destabilized DNA duplexes that are modified with intercalator-functionalized nucleotide building blocks*. The two strands comprising an Invader, display exceptional affinity toward complementary DNA strands, due to the formation of strong π-π-stacking interactions. The energy difference between probe-target and Invader duplexes generates a *strongly favorable energetic gradient that is harnessed for DNA recognition*. For example, ~50% binding is observed when a 50-fold excess of Invader is added to a double-stranded non-biological DNA target, as evidenced by the lower electrophoretic mobility of probe-target complexes (see figure). Importantly, *Invaders do not bind to incorrect DNA targets* (lanes 1 and 2: incorrect DNA targets – note absence of invasion complex bands; lane 3: correct DNA target). Unlike existing DNA-targeting approaches, such as triplex forming oligonucleotides (TFOs) and peptide nucleic acids (PNAs), there are *no limitations in the choice of targets or incubation conditions* from a chemical perspective (TFOs: targets must contain a polypurine stretch; PNA: require



unnaturally low salt concentrations). These highly promising properties form the basis for our collaboration with Minitube of America, who are interested in developing i) *diagnostic kits for gender determination of unadulterated early-stage embryos* (see IF13-001 for details), and ii) *a process for production of gender-sorted semen from animals used in food production and sport breeding*. We will be using fluorophore-labeled Invaders designed to target unique regions on the sex chromosomes of the target species, at the core of the sorting process. A solution of Invaders will be added to fresh semen collected for sexually mature males housed at Minitube's International Center for Biotechnology (Mount Horeb, WI). After a brief incubation period (<3h), gentle washing steps will remove unbound Invaders without compromising the integrity of sperm cells. Only sperm cells of the target gender will display strong localized fluorescent signals. Sperm cells will then be sorted according to gender based on their fluorescence intensity using high-throughput flow cytometry. *Our preliminary results are highly encouraging*. Invaders have been designed toward a highly repeated DNA-region on the male sex chromosome of a commercially interesting target species. Incubation of these fluorophore-labeled Invaders with fixed nuclei from a male somatic (kidney) cell line of our target species, results in the formation of a *prominent and localized signal*, while only low levels of non-specific background signal are observed (upper left image on figure next page; see electronic version for best contrast). The right panel shows nuclei stained with a non-specific control dye (DAPI), which emits blue fluorescence upon binding with DNA. Importantly, *signals are not observed* when nuclei from a corresponding female cell line of our target species are exposed to male-specific Invaders (middle left image). Preliminary experiments with fixed gender-sorted sperm are equally promising. Thus, incubation of male-specific Invaders with male sperm, results in a localized fluorescent signal in the nucleus (see arrows in lower right image), while incubation of male-

specific Invaders with female sperm does not (not shown). These results demonstrate that Invaders can predict gender of sperm cells. However, in order to render the sorting process commercially viable, we need to reduce non-specific fluorescence (i.e., red areas not marked by arrows), increase efficiency (75% → 90%), and decrease incubation time (3h→1h) using live whole ejaculates. This will be realized through chemical optimization of the Invaders (Hrdlicka) and optimization of incubation conditions (Minitube).





Financial support for initial development of the Invader Technology was secured by Dr. Hrdlicka via the competitive NIH EUREKA (Exceptional, Unconventional Research Enabling Knowledge Acceleration; $523,940) and INBRE-ITHS ($40,000) programs. In addition, Dr. Hrdlicka received start-up funds from Idaho EPSCoR ($250,000) for initial laboratory setup (in 2006), which were partially used toward Invader development. UI's Office of Technology Transfer recently converted a number of Dr. Hrdlicka's provisional patent applications into a Patent Cooperative Treaty (PCT) filing (PCT/US2012/047442). Minitube has patent-protected the use of the Invader technology in animal reproduction applications. Furthermore, the IP protection is

enhanced by proprietary processes and reagents that render the use of Invaders possible in high volume production settings, which Minitube plans to either patent or keep as trade secrets. Minitube currently obtains Invaders through a partial cost reimbursement arrangement with the Hrdlicka group under a Material Transfer Agreement with UI.

Commercialization partners: Our commercialization partner, Minitube of America, is a Wisconsin-based biotechnology company that specializes in advanced reproduction technologies and cell biology. Since its inception, the company has invested a large percentage of revenue into research and development of cutting edge technologies that lead the fields of food animal production, companion and sport animal breeding, clinical research and cellular diagnostics. Minitube has a successful track record of licensing and commercializing animal reproduction technologies developed by academic collaborators. As stated previously, an exclusive licensing agreement on the use of the Invader technology for diagnostic applications within animal reproduction has already been executed. Specific project responsibilities are described below.

Specific project plan and detailed use of funds: The *goal of the proposed project* is to develop Invaders that display high levels of target-specific fluorescence, low levels of background fluorescence, and fast binding kinetics in live whole ejaculates. We intend to *accomplish these goals in the following manner*: i) optimization of the current 'lead' Invaders, which will entail variations in the modification pattern, the use of improved Invader building blocks from Dr. Hrdlicka's research pipeline, and optimized probe architectures (months 1-4) – rationale: Invader constructs with high DNA affinity will result in the formation of stronger and more gender-specific fluorescent signals with reduced non-specific labeling; and ii) attachment of nucleus-directing entities to optimized Invaders (months 1-12) – rationale: certain dyes, peptides and nanoparticles are specifically transported to the nucleus where genomic DNA is located, and

attachment of such entities to Invaders is therefore expected to result i) in more efficient nuclear localization and specific signal formation, ii) decreased localization at irrelevant sites otherwise leading to non-specific fluorescence, and iii) reduced assay time due to the facilitated transport. Invaders will be designed, synthesized and characterized (e.g., duplex thermostability; affinity toward non-biological DNA targets) by the Hrdlicka lab, which has extensive experience in synthetic nucleic acid chemistry, biophysical chemistry and molecular biology (>40 peer-reviewed articles since 2004). Minitube will screen Invaders at optimized incubation conditions using fixed and live sperm and provide feedback to facilitate chemical Invader optimization.

Our milestones are: identification of a "lead" Invader (before month 5), identification of a 'lead' nucleus-targeting entity (before month 8), evaluation of a 'lead compound' comprised of optimized Invader and nucleus-targeting units (before month 10), and proof-of-concept for the process resulting in gender-sorted sperm (before end of project period; Minitube). Project results will be disseminated in peer-reviewed journals after proper IP protection.

The requested funds ($50,000) will be used toward: a) salary ($20,000), fringe (~3%, $600) and tuition ($8,000) for one research assistant (12 month appointment, Ms. Dale Guenther, **an Idaho native**); b) summer salary (two weeks, $3,800) and fringe (~35.2%, ~$1,400) for the PI; c) travel to our commercialization partner (one visit to Minitube of America, Verona, WI; only airfare requested, $800), and d) operating expenses ($15,400) covering: i) reagents, solvents, and glassware for the synthesis of Invader nucleotides ($5,500); ii) reagents, solvents, and supplies for machine-assisted synthesis of Invader oligonucleotides ($4,400); iii) columns, solvents and consumables for HPLC purification of Invaders ($4,000); and iv) mass spectrometer instrumentation time for characterization of Invaders ($1,500). Ms. Guenther is a 4th year Ph.D-candidate with considerable practical experience within synthetic organic chemistry,

oligonucleotide synthesis, molecular biological characterization of oligonucleotides, and gene knockdown studies. She is well-prepared to advance the proposed project. The visit to Minitube, which is tentatively planned for the 3rd month of the project, will be used to discuss project progress and strategy. Moreover, we plan for Ms. Guenther to perform a short internship with Minitube (~4 weeks) where she will be exposed to the utilized optical imaging techniques, while being able to troubleshoot any chemistry related problems that may have arisen. Modern guesthouses with kitchen facilities and internet access are available free-of-charge to visitors at the Minitube International Center for Biotechnology.

Institutional and other support: The Department of Chemistry supports the PI in several ways that directly benefit the project including: reduced teaching load; access to 2.5 funded graduate student teaching assistantships; and reduced NMR usage fees. UI conferred the 2013 Excellence in Research and Creative Activity Award and the Inaugural President's Mid-Career Faculty Award (2012-2013) to Dr. Hrdlicka, which allows for a modest summer salary request.

In 2004, our commercialization partner established the Minitube International Center for Biotechnology, a state of the art research facility with over 3,600 ft^2 of lab space, which houses over 30 employees (including 12 Ph.D-level coworkers). The collaboration with Dr. Hrdlicka and UI are top development priorities and our partner's strong commitment is evidenced by: 4 PhD level employees plus support staff fully dedicated to this project; financial investments in gender determination technology in excess of $5M till date; and a corresponding ongoing annual project budget in excess of $1M. The commitment is expected to increase even further as commercialization of the technology is approaching.

NOTE: we respectfully request that the confidential information and business relationships conveyed herein are not disseminated outside of the proposal review committee. Thanks.

CURRICULUM VITAE

University of Idaho

NAME: Patrick J. Hrdlicka **DATE:** May 2013

RANK OR TITLE: Associate Professor

DEPARTMENT: Chemistry

OFFICE LOCATION AND CAMPUS ZIP:
University of Idaho, Department of Chemistry
875 Perimeter Drive MS 2343 (Renfrew Hall 313W)
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WEB: www.webpages.uidaho.edu/~hrdlicka/index.htm

DATE OF FIRST EMPLOYMENT AT UI: August 2006

DATE OF TENURE: July 2011

IMMIGRATION STATUS: Permanent resident (green card holder)

PROFESSIONAL PREPARATION:

2006 Ph.D (Chemistry), Univ. Southern Denmark, Odense, Denmark (supervisor: J Wengel)
2004 M.Sc (Chemistry), Univ. Southern Denmark, Odense, Denmark (supervisor: J Wengel)
2000 B.Sc (Chemistry), Univ. Southern Denmark, Odense, Denmark (supervisor: JJL Iversen, retired)

ACADEMIC APPOINTMENTS:

2011- Associate Professor, Dept. Chemistry, Univ. Idaho
2011- Adjunct Faculty, Dept. Chemistry, Washington State University
2006- Adjunct Faculty, Neuroscience Graduate Program, Univ. Idaho
2006-2011 Assistant Professor, Dept. Chemistry, Univ. Idaho

SCHOLARSHIP ACCOMPLISHMENTS:

Publications:
38 peer-reviewed articles and reviews (cited ~625 times across ~325 publications; h-index 14); 7 patent applications (one issued); two book chapters; >30 published conference proceedings/abstracts; one published book review.

Peer Reviewed Journal Articles:

[38] S. Karmakar and P. J. Hrdlicka*, "DNA Strands with Alternating Incorporations of LNA and 2'-*O*-(pyren-1-yl)methyluridine: SNP-discriminating RNA Detection Probes", *Chem. Sci.*, in press.

[37] M. Kaura, P. Kumar and P. J. Hrdlicka*, "Synthesis and Hybridization Properties of Oligonucleotides Modified with 5-(1-Aryl-1,2,3-Triazol-4-yl)-2'-Deoxyuridines", *Org. Biomol. Chem.*, **2012**, *10*, 8575-8578 (selected by reviewers as a "Hot communication").

[36] S. P. Sau, P. Kumar, P. K. Sharma and P. J. Hrdlicka*, "Fluorescent Intercalator Displacement Replacement (FIDR) Assay: Determination of Relative Thermodynamic and Kinetic Parameters in Triplex Formation - A Case Study using Triplex-forming LNAs", *Nucleic Acids Res.*, **2012**, *40*, e162.

[35] S. K. Rastogi,* C. M. Gibson, J. R. Branen, D. E. Aston, A. L. Branen and P. J. Hrdlicka*, "DNA Detection on Lateral Flow Test Strips: Enhanced Signal Sensitivity Using LNA-conjugated Gold Nanoparticles", *Chem. Commun*, **2012**, *48*, 7714-7716.

[34] G. Wang, M. R. Papasani, P. Cheguru, P. J. Hrdlicka and R. A. Hill*, "Gold-Peptide Nanoconjugate Cellular Uptake is Modulated by Serum Proteins", *Nanomedicine: NBM*, **2012**, *8*, 822-832.

[33] S. P. Sau and P. J. Hrdlicka*, "C2'-Pyrene-functionalized Triazole-linked DNA: Universal Hybridization to DNA/RNA", *J. Org. Chem.*, **2012**, *77*, 5-16 (cover article).

[32] M. E. Østergaard and P. J. Hrdlicka*, "Pyrene-functionalized Oligonucleotides and Locked Nucleic Acids (LNAs): Tools for Fundamental Research, Diagnostics, and Materials Science", *Chem. Soc. Rev.*, **2011**, *40*, 5771-5788.

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[30] P. Kumar, M. E. Østergaard, and P. J. Hrdlicka*, "Preparation of C5-Functionalized Locked Nucleic Acids (LNAs)", *Curr. Protocols Nucleic Acid Chem.*, **2011**, *44*, 4.43.1-4.43.22.

[29] M. E. Østergaard, P. Kumar, B. Baral, D. C. Guenther, B. A. Anderson, F. M. Ytreberg, L. Deobald, A. J. Paszczynski, P. K. Sharma and P. J. Hrdlicka*, "C5-Functionalized DNA, LNA and alpha-L-LNA: Improved Positional Control of Polarity-sensitive Fluorophores Facilitates Improved SNP-typing", *Chem. Eur. J.*, **2011**, *17*, 3157-3165.

[28] V. V. R. Sai, D. Gangadean, I. Niraula, G. Corti, D. N. McIlroy, D. E. Aston, J. R. Branen, and P. J. Hrdlicka*, "Silica Nanosprings Coated with Noble Metal Nanoparticles: Highly Active SERS Substrates", *J. Phys. Chem. C.*, **2011**, *115*, 453-459.

[27] M. E. Østergaard, J. Maiti, B. R. Babu, J. Wengel, and P. J. Hrdlicka*, "Glowing LNA as Nucleic Acid Detection Probes – Nucleobase Analogs and Insights into Probe Design", *Bioorg. Med. Chem. Lett.*, **2010**, *20*, 7265-7268.

[26] R. N. Veedu,* H. R. Burri, P. Kumar, P. K. Sharma, P. J. Hrdlicka, B. Vester, and J. Wengel, "Polymerase-directed Synthesis of C5-Ethynyl Locked Nucleic Acids", *Bioorg. Med. Chem. Lett*, **2010**, *22*, 6565-6568.

[25] M. E. Østergaard, P. Cheguru, M. R. Papasani, R. A. Hill*, and P. J. Hrdlicka*, "Glowing LNA – Brightly Fluorescent Probes for Detection of Nucleic Acids in Cells", *J. Am. Chem. Soc*. **2010**, *132*, 14221-14228.

[24] M. E. Østergaard, D. C. Guenther, P. Kumar, B. Baral, L. Deobald, A. J. Paszczynski, P. K. Sharma and P. J. Hrdlicka*, "Pyrene-functionalized Triazole-Linked 2'-Deoxyuridines - Probes for Discrimination of Single Nucleotide Polymorphisms (SNPs)", *Chem. Commun*., **2010**, 4929-4931.

[23] S. P. Sau, T. S. Kumar and P. J. Hrdlicka*, "Invader LNA – Efficient Targeting of Short DNA Duplexes" *Org. Biomol. Chem*., **2010**, *8*, 2028-2036.

[22] M. E. Østergaard, P. Kumar, B. Baral, D. J. Raible, T. S. Kumar, B. A. Anderson, D. C. Guenther, L. Deobald, A. J. Paszczynski, P. K. Sharma and P. J. Hrdlicka*, "C5-Functionalized LNA: Unparalleled Hybridization Properties and Enzymatic Stability", *ChemBioChem*, **2009**, *10*, 2740-2743.

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[19] B. Baral, P. Kumar, B. A. Anderson, M. E. Østergaard. P. K. Sharma and P. J. Hrdlicka*, "Optimized Synthesis of [3-^{15}N]-Labeled Uridine Phosphoramidites", *Tetrahedron Lett.*, **2009**, *50*, 5850-5852.

[18] T. S. Kumar, M. E. Østergaard, P. K. Sharma, P. Nielsen, J. Wengel and P. J. Hrdlicka*, "Parallel RNA-Strand Recognition by 2'-Amino-β-L-LNA", *Bioorg. Med. Chem. Lett.,* **2009**, *19*, 2396-2399.

[17] J. W. Rigoli, M. E. Østergaard, K. M. Canady, D. C. Guenther, P. J. Hrdlicka*. "Selective Deacylation of Peracylated Ribonucleosides", *Tetrahedron Lett*., **2009**, *50*, 1751-1753.

[16] T. S. Kumar, A. S. Madsen, M. E. Østergaard, S. P. Sau, J. Wengel and P. J. Hrdlicka*, "Functionalized 2′-Amino-α-L-LNA - Directed Positioning of Intercalators for DNA Targeting", *J. Org. Chem.* **2009**, *74*, 1070-1081.

[15] T. S. Kumar, P. Kumar, P. K. Sharma and P. J. Hrdlicka*, "Optimized Synthesis of LNA Uracil Nucleosides", *Tetrahedron Lett*., **2008**, *49*, 7168-7170.

[14] T. S. Kumar, A. S. Madsen, M. E. Østergaard, J. Wengel* and P. J. Hrdlicka*, "Nucleic Acid Structural Engineering using Pyrene Functionalized 2'-Amino-α-L-LNA Monomers and Abasic Sites", *J. Org. Chem.* **2008**, *73*, 7060-7066.

[13] B. Vester, A. M. Boel, S. Lobedanz, B. R. Babu, M. Raunkjær, D. Lindegaard, Raunak, P. J. Hrdlicka, T. Højland, P. K. Sharma, T. S. Kumar, P. Nielsen and J. Wengel*, "Chemically Modified Oligonucleotides with Retained RNaseH Response", *Bioorg. Med. Chem. Lett.* **2008**, *18*, 2296-2300.

[12] T. Umemoto, P. J. Hrdlicka, B. R. Babu and J. Wengel*, "Sensitive SNP Dual-Probe Assays Based on Pyrene-Functionalized 2'-Amino-LNA: Lessons to be Learned", *ChemBioChem*, **2007**, *8*, 2240-2248.

[11] T. S. Kumar, J. Wengel and P. J. Hrdlicka*, "2'-*N*-(Pyren-1-yl)acetyl-2'-Amino-α-L-LNA: Synthesis and Detection of Single Nucleotide Mismatches in DNA and RNA Targets", *ChemBioChem*, **2007**, *8*, 1122-1125.

[10] A. S. Madsen, P. J. Hrdlicka, T. S. Kumar and J. Wengel*, "Synthesis, Nucleic Acid Hybridization Properties and Molecular Modeling Studies of Conformationally Restricted 3'-*O*,4'-*C*-Methylene-Linked α-L-Ribonucleotides", *Carbohydr. Res.* **2006**, *341*, 1398–1407.

[9] T. S. Kumar, A. S. Madsen, J. Wengel and P. J. Hrdlicka*, "Synthesis and Hybridization Studies of 2'-Amino-α-L-LNA and a Tetracyclic 'Locked LNA' ", *J. Org. Chem.* **2006**, *71*, 4188–4201.

[8] P. J. Hrdlicka, T. S. Kumar and J. Wengel*, "Synthesis and Thermal Denaturation Studies of Conformationally Restricted 3'-C-Ethynyl-3'-*O*,4'-*C*-Methyleneribonucleotides", *Eur. J. Org. Chem.* **2005**, 5184–5188.

[7] P. J. Hrdlicka, B. R. Babu, M. D. Sørensen, N. Harrit and J. Wengel*, "Multilabeled Pyrene-Functionalized 2'-Amino-LNA Probes for Nucleic Acid Detection in Homogenous Fluorescence Assays", *J. Am. Chem. Soc.* **2005**, *127*, 13293–13299.

[6] P. J. Hrdlicka, T. S. Kumar and J. Wengel*, "Targeting of Mixed Sequence Double-Stranded DNA Using Pyrene-Functionalized 2'-Amino-α-L-LNA", *Chem. Commun.* **2005**, 4279–4281.

[5] B. R. Babu, P. J. Hrdlicka, C. J. McKenzie and J. Wengel*, "Optimized DNA Targeting Using *N*,*N*-Bis(2-pyridylmethyl)-β-alanyl 2'-Amino-LNA", *Chem. Commun.* **2005**, 1705–1707.

[4] P. J. Hrdlicka, N. K. Andersen, J. S. Jepsen, F. G. Hansen, K. F. Haselmann, C. Nielsen and J. Wengel*, "Synthesis and Biological Evaluation of Branched and Conformationally Restricted Analogs of the Anticancer Compounds 3'-*C*-Ethynyluridine (EUrd) and 3'-*C*-Ethynylcytidine (ECyd)", *Bioorg. Med. Chem.* **2005**, *13*, 2597–2621.

[3] P. J. Hrdlicka, J. S. Jepsen, C. Nielsen and J. Wengel*, "Synthesis and Biological Evaluation of Nucleobase-modified Analogs of the Anticancer Compounds 3'-*C*-Ethynyluridine (EUrd) and 3'-*C*-Ethynylcytidine (ECyd)", *Bioorg. Med. Chem*. **2005**, *13*, 1249–1260.

[2] P. J. Hrdlicka, B. R Babu, M. D. Sørensen and J. Wengel*, "Interstrand Communication Between 2'-*N*-(Pyren-1-yl)methyl-2'-amino LNA Monomers in Nucleic Acid Duplexes: Directional Control and Signalling of Full Complementarity", *Chem. Commun.* **2004**, 1478–1479.

[1] P. J. Hrdlicka, A. B. Sørensen, B. R. Poulsen, G. J. G. Ruijter, J. Visser and J. J. L. Iversen*, "Characterization of Nerolidol Biotransformation Based on Indirect On-Line Estimation of Biomass Concentration and Physiological State in Batch Cultures of Aspergillus niger", *Biotechnol. Prog*. **2004**, *20*, 368–376.

Submitted manuscripts:

B. A. Didion, S. Karmakar, D. C. Guenther, S. Sau, J. P. Verstegen, P. J. Hrdlicka*, "Sequence-unrestricted targeting of double-stranded DNA using duplexes modified with interstrand zippers of 2'-*O*-(pyren-1-yl)methylribonucleotides", submitted to *Nucleic Acids Res.*.

Book Chapters:

[BC2] P. J. Hrdlicka* and Michael E. Østergaard, "Fluorophore-functionalized Locked Nucleic Acids (LNAs)" in "DNA Conjugates and Sensors, RSC Biomolecular Science Series", edited by K. R. Brown and T. Brown (RSC Publishing, 2012), Vol. 26, 1-33.

[BC1] D. Choi*, D. McIlroy, J. Nagler, E. Aston, P. J. Hrdlicka, K. Gustin, R. Hill, D. Stenkamp and J. Branen, "1-Dimensional Silica Structures and Their Applications to the Biological Sciences" in "Nanomaterials for the Life Sciences, Nanostructured Oxides", edited by C. Kumar (Wiley, 2009), Vol. 2, 83-108.

Patent Applications:

[PA7] P. J. Hrdlicka*, "Embodiments of a probe and method for targeting nucleic acids", PCT/US2012/047442, Univ. Idaho, July 19, 2012.

[PA6] P. J. Hrdlicka* and Sujay P. Sau, "Universal DNA/RNA hybridization probes", provisional patent application, Univ. Idaho, October 31, 2011.

[PA5] P. J. Hrdlicka*, "Embodiments of a probe and method for targeting nucleic acids", provisional patent application, Univ. Idaho, September 30, 2011.

[PA4] P. J. Hrdlicka* and S. Karmakar, "Selective targeting of single-stranded DNA using intercalator-functionalized oligonucleotides for diagnostic and biotechnological applications", provisional patent application, Univ. Idaho, July 19, 2011.

[PA3] P. J. Hrdlicka*, P. Kumar and Michael E. Østergaard, "Nucleobase-functionalized conformationally restricted nucleotides and oligonucleotides for targeting of nucleic acids", PCT/US2010/048520. Issued Apr 2013.

[PA2] P. J. Hrdlicka*, P. Kumar and Michael E. Østergaard, "The use of oligonucleotides modified with conformationally restricted C5-functionalized pyrimidine nucleotide building blocks for targeting of nucleic acids", provisional patent application, Univ. Idaho, Sep 4, 2009.

[PA1] P. J. Hrdlicka* and P. Kumar, "Synthesis and applications of C5-Functionalized Locked Nucleic Acid (LNA)", provisional patent application filed, Univ. Idaho, July 31, 2008.

License agreement:
Technology for use in diagnostic assays in animal reproduction technology licensed to an undisclosed US company. Agreement executed on November 1st 2011.

Published Conference Proceedings/Abstracts:

[CP31] S. Karmakar, B. A. Anderson, R. L. Rathje, S. Andersen and P. J. Hrdlicka*, "High-Affinity DNA Targeting Using Simplified Mimics of N2'-Intercalator-Functionalized 2'-Amino-α-L-LNA", 2012 67th Northwest Regional Meeting of the American Chemical Society (Boise, ID), NORM-231.

[CP30] P. J. Hrdlicka*, "Sequence-unrestricted targeting of double stranded DNA (dsDNA): How to 'unlock' the dsDNA-targeting potential of Invader LNAs", 2012 67th Northwest Regional Meeting of the American Chemical Society (Boise, ID), NORM-129.

[CP29] P. J. Hrdlicka*, "Nucleobase-functionalized Locked Nucleic Acids (LNAs): Optimized probes for nucleic acid targeting", 2012 Abstracts of Papers, 243rd ACS National Meeting (San Diego, CA), ORGN-328.

[CP28] P. J. Hrdlicka*, "Sequence-unrestricted targeting of double stranded DNA (dsDNA): How to 'unlock' the dsDNA-targeting potential of Invader LNAs", 2012 Abstracts of Papers, 243rd ACS National Meeting (San Diego, CA), CARB-55.

[CP27] D. C. Guenther, P. Kumar and P. J. Hrdlicka*, "C5-Amino Acid Functionalized LNA: Synthesis, Evaluation of Biophysical Properties, and Potential for Antisense Therapeutics", 2012 Abstracts of Papers, 243rd ACS National Meeting (San Diego, CA), BIOL-152.

[CP26] D. C. Julien, A. Giri, M. Papasani, G. Murdoch, P. Hrdlicka and R. A. Hill, "Anti-K-Ras siRNA to treat pancreatic cancer", Nanotech Conference & Expo 2010: An Interdisciplinary Integrative Forum on Nanotechnology, Biotechnology and Microtechnology (Anaheim, CA), 401-404.

[CP25] M. R. Papasani, D. Pokharel, A. Giri, V. V. R. Sai, P. Hrdlicka, R. A. Hill, "Oligoethylene glycol mediates knockdown effect of small interfering RNAs conjugated goldnanoparticles", Nanotech Conference & Expo 2010: An Interdisciplinary Integrative Forum on Nanotechnology, Biotechnology and Microtechnology (Anaheim, CA), 358-360.

[CP24] G. Wang, M. R. Papasani, P. J. Hrdlicka, R. A. Hill, "Role of serum proteins in the cellular uptake of gold-peptide nanoconjugates", Nanotech Conference & Expo 2010: An Interdisciplinary Integrative Forum on Nanotechnology, Biotechnology and Microtechnology (Anaheim, CA), 304-307 (featured on Nano Science and Technology Institute webpage January 2011).

[CP23] P. Cheguru, M. Ostergaard, Michael; M. R. Papasani, V. V. R. Sai, J. Wengel, P. J. Hrdlicka, R. A. Hill, "Novel nanoprobes to detect mRNA in situ, directed against mouse pyruvate dehydrogenase", Nanotech Conference & Expo 2010: An Interdisciplinary Integrative Forum on Nanotechnology, Biotechnology and Microtechnology (Anaheim, CA), 300-303.

[CP22] V. V. R. Sai, D. Gangaden, I. Niraula, G. Corti, D. N. McIlroy, D. E. Aston, J. Branen, P. J. Hrdlicka, "Characterization of Au and Ag nanoparticle coated silica nanosprings - toward SERS based diagnostic applications", Nanotech Conference & Expo 2010: An Interdisciplinary Integrative Forum on Nanotechnology, Biotechnology and Microtechnology (Anaheim, CA), 19-22.

[CP21] S. Gibbon, J.R Branen, M. Frederickson, P. J. Hrdlicka*, "Identification of important food pathogens using LNA (Locked Nucleic Acid) probes", 2010 Joint 65th Northwest and 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA), NWRM-207.

[CP20] V. V. R. Sai, D. Gangadean, I. Niraula, G. Corti, D. N. McIlroy, D. E. Aston, J. R. Branen, and P. J. Hrdlicka*, "Au and Ag nanoparticle coated silica nanosprings: characterizarion of SERS-active materials and detection of DNA from biological threat agents", 2010 Joint 65th Northwest and 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA), NWRM-206.

[CP19] B. A. Anderson, S. Karmakar, S. S. Iversen, R. L. Rathje, S. P. Sau, P. J. Hrdlicka*, "DNA targeting using next-generation invader LNAs", 2010 Joint 65th Northwest and 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA), NWRM-53.

[CP18] S. P. Sau, S. S. Iversen, R. L. Rathje, B. A. Anderson, S. Karmakar, J. Onley, M. R. Papasani, R. A. Hill, P. J. Hrdlicka*, "Invader LNA - efficient targeting of iso-sequential double stranded DNA", 2010 Joint 65th Northwest and 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA), NWRM-52.

[CP17] M. E. Østergaard, P. Kumar, B. Baral, D. C. Guenther, F. M. Ytreberg, P. J. Hrdlicka*, "Pyrene-functionalized oligonucleotides as probes in nucleic acid diagnostics", 2010 Joint 65th Northwest and 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA), NWRM-51.

[CP16] M. E. Østergaard, S. P. Sau, P. Kumar, B. A. Anderson, B. Baral, D. C. Guenther, M. Kaura, P. J. Hrdlicka*, "Optimized nucleic acid targeting using C5-functionalized LNA (Locked Nucleic Acid)", 2010 Joint 65th Northwest and 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA), NWRM-50.

[CP15] M. E. Østergaard, B. Baral, P. J. Hrdlicka*, "Discrimination of single nucleotide polymorphisms (SNPs) using brightly fluorescent C5-functionalized Locked Nucleic Acid (LNA) probes", 2010 Abstracts of Papers, 239th ACS National Meeting (San Francisco, CA), PHYS-671.

[CP14] M. E. Østergaard, S. P. Sau, P. Kumar, B. A. Anderson, B. Baral, D. C. Guenther, P. J. Hrdlicka*, "Optimized nucleic acid targeting using C5-functionalized LNA (Locked Nucleic Acid)", 2010 Abstracts of Papers, 239th ACS National Meeting (San Francisco, CA), ORGN-429.

[CP13] S. P. Sau, P. J. Hrdlicka*, "Invader LNA: Efficient targeting of short double stranded DNA", 2010 Abstracts of Papers, 239th ACS National Meeting (San Francisco, CA), ORGN-323.

[CP12] B. A. Anderson, R. L. Rathje, P. J. Hrdlicka*,"DNA targeting using invader nucleic acids", 2010 Abstracts of Papers, 239th ACS National Meeting (San Francisco, CA), ORGN-305.

[CP11] S. Gibbon, M. E. Østergaard, J.R Branen, P. J. Hrdlicka*, "Identification of important food pathogens using LNA (Locked Nucleic Acid) probes", 2010 Abstracts of Papers, 239th ACS National Meeting (San Francisco, CA), AGFD-173.

[CP10] T. S. Kumar, A. S. Madsen, J. Wengel and P. J. Hrdlicka*, "N2'-Functionalized 2'-amino-alfa-L-LNA: A novel class of locked nucleic acids as emerging tools for nucleic acid therapeutics and diagnostics" 2008 Abstracts of papers, 235th ACS National Meeting (New Orleans, LA), CARB-009.

[CP9] M. E. Østergaard, J. Maity, J. Wengel and P. J. Hrdlicka*, "2'-N-(Pyren-1-yl)carbonyl-2'-amino-LNA (locked nucleic acid): A versatile label for nucleic acid detection", 2008 Abstracts of papers, 235th ACS National Meeting (New Orleans, LA), BIOL-032.

[CP8] N. K. Andersen, J. Wengel and P. J. Hrdlicka*, "N2'-Functionalized 2'-Amino-α-L-LNA Adenine Derivatives - Efficient Targeting of Single Stranded DNA", *Nucleosides Nucleotides Nucleic Acids* **2007**, *26*, 1415-1417.

[CP7] T. S. Kumar*, J. Wengel and P. J. Hrdlicka, "Pyrene-Functionalized 2'-Amino-α-L-LNA as Potential Diagnostic Probes", *Nucleosides Nucleotides Nucleic Acids* **2007**, *26*, 1407-1409.

[CP6] T. S. Kumar*, A. S. Madsen, J. Wengel and P. J. Hrdlicka, "Synthesis and Biophysical Studies of N2'-Functionalized 2'-Amino-α-L-LNA", *Nucleosides Nucleotides Nucleic Acids* **2007**, *26*, 1403-1405.

[CP5] T. Umemoto*, P. J. Hrdlicka, B. R. Babu and J. Wengel, "Dual-probe System Using Pyrenylmethyl-modified Amino-LNA for Sensitive SNP Genotyping in a Homogeneous Fluorescence Assay", *Nucleosides Nucleotides Nucleic Acids* **2007**, *26*, 1261-1263.

[CP4] P. J. Hrdlicka*, T. S. Kumar and J. Wengel, "Synthesis of a 2'-Amino-α-L-LNA-T Phosphoramidite", *Nucleosides Nucleotides Nucleic Acids* **2005**, *24*, 1101–1104.

[CP3] P. J. Hrdlicka*, J. S. Jepsen and J. Wengel, "Synthesis and Biological Evaluation of Conformationally Restricted and Nucleobase-modified Analogs of the Anticancer Compound 3'-*C*-Ethynylcytidine (ECyd)", *Nucleosides Nucleotides Nucleic Acids* **2005**, *24*, 397–400.

[CP2] B. R. Babu, Raunak, M. D. Sørensen, P. J. Hrdlicka, S Trikha, A. K. Prasad, V. S. Parmar and J. Wengel*, "Novel Nucleic Acid Architectures Involving LNA (Locked Nucleic Acid) and Pyrene Residues – Results from an Indo-Danish Collaboration", *Pure Appl. Chem.* **2005**, *77*, 319–326.

[CP1] P. J. Hrdlicka, B. R. Babu, M. D. Sørensen, N. Harrit and J. Wengel*, "Ångström-scale Chemical Engineering: Multilabeled 2'-Amino-LNA Probes for Nucleic Acid Detection in Homogenous Fluorescence Assays", In: *Collection Symposium Series* (M. Hocek, Ed.), *7 (Chemistry of Nucleic Acid Components)*, 27–28, Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic, Prague **2005**.

Published Book Review:

[BR1] P. J. Hrdlicka*, Book review on "Modified Nucleosides in Biochemistry, Biotechnology and Medicine" from Wiley, edited by Piet Herdewijn, *ChemBioChem,* **2009**, *10*, 378-379.

Presentations:

Delivered >10 invited presentations, six contributed talks and >25 posters at external venues, along with numerous internal contributions.

Invited Presentations:
2012: 67th Northwest Regional Meeting of the American Chemical Society (Boise, ID); University at Albany

2011: University of Aarhus (Denmark); Carnegie Mellon University; University of Copenhagen; University of Southern Denmark, NAC mini-symposium - Nucleic Acid Chemical Biology

2010: ISIS Pharmaceuticals (Carlsbad, CA); Minitube of America (Mt. Horeb, WI); Washington State University

2008: University Southern Denmark

2007: Washington State University; Gonzaga University; Gordon Conference on "Nucleosides, Nucleotides and Oligonucleotides" (Newport, RI)

Contributed Talks:
2012: American Chemical Society Conference (San Diego, CA) – two presentations

2010: 65th Northwest / 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA); American Chemical Society Conference (San Francisco, CA)

2008: American Chemical Society Conference (New Orleans, LA)

2007: AAAS Pacific Division, 88th Annual Meeting of the Pacific Division Meeting & 62nd Annual Meeting of the Northwest Region, American Chemical Society (Boise, ID)

Student Presentations:

2012: XX International Round Table on Nucleosides Nucleotides and Nucleic Acids (Montreal, Quebec, Canada) - students presented two posters; Idaho INBRE Research Conference (Moscow, ID) - student presented a poster (3rd place poster competition, faculty/staff choice category); Drug and Diagnostic

Development Conference (San Francisco, CA) – postdoc presented a poster; 67th Northwest Regional Meeting of the American Chemical Society (Boise, ID) - student delivered a contributed talk; American Chemical Society Conference (San Diego, CA) - student presented a poster.

2011: Idaho-INBRE Research Conference (Moscow, ID) - student presented a poster; TIDES – Oligonucleotide and Peptide: Research Technology and Product Development (Boston, MA) – PI presented a poster; NW Regional Conference of the Society for Developmental Biology, Friday Harbor Laboratories (San Juan Island, WA) - collaborators presented a poster.

2010: 6th Annual Oligonucleotide Therapeutics Society Meeting (Dana Point, CA) – PI presented two posters; Pacific Northwest Undergraduate Research Symposium on Organic Chemistry & Chemical Biology - students delivered a contributed talk and a poster (winner of poster award); Bio Nanotech Conference and Expo 2010 (Anaheim, CA) - students and collaborators gave four contributed talks; 65th Northwest / 22nd Rocky Mountain Regional Meeting of the American Chemical Society (Pullman, WA) - students presented three contributed talks and two posters; American Chemical Society Conference (San Francisco, CA) - students presented a contributed talk and three posters.

2009: Sigma XI, Annual Meeting and Student Research Conference (Houston, TX) - students presented two posters; Donald S. Matteson Symposium (Washington State University) - students presented two posters (winner of poster award); Idea Network for Biomedical Research Excellence (INBRE) Conference (Pocatello, ID) - student presented a poster (winner of poster award).

2008: Sigma XI, Annual Meeting and Student Research Conference (Washington, DC) - students presented a poster; 17th Regional Conference on Undergraduate Research of the Murdock College Science Research Program (University of Puget Sound) - student presented a poster; Idea Network for Biomedical Research Excellence (INBRE) Conference (Boise, ID) - student presented a poster; American Chemical Society Conference (New Orleans, LA) - student presented a poster.

2007: Sigma XI, Annual Meeting and Student Research Conference (Washington, DC) - students presented a poster.

2006: XVII International Round Table, "Nucleosides, Nucleotides and Nucleic Acids" (Berne, Switzerland). – students and collaborators presented five posters (winner of poster award).

Local PI/student presentations*:*
2012: Tenth Annual College of Science Student Research Exposition - students presented two posters.

2010: Eight Annual College of Science Student Research Exposition - students presented four posters; Dept. Chemistry – PI delivered an oral presentation; Dept. of Microbiology, Molecular Biology and Biochemistry – PI delivered an oral presentation.

2009: Fifth Annual College of Science Student Research Exposition - students presented five posters; External review board meeting (IBEST/COBRE center) – PI presented two posters; IBEST Center – PI delivered an oral presentation; Neuroscience REU Poster Presentations - students presented two posters; BANTech Center – PI delivered an oral presentation.

2008: Fourth Annual College of Science Student Research Exposition - students presented five posters; Neuroscience REU Poster Presentations - students presented a poster.

2007: BANTech Center – PI delivered an oral presentation; IBEST Center – PI delivered an oral presentation; CAMBR Center – PI delivered an oral presentation.

2006: BANTech Center – PI delivered an oral presentation.

Grants and Contracts Awarded
Four external grants (total > 1.5M$) and several internal grants (~110k$) have been secured. Three unrestricted gifts amounting to 30k$ have been received.

External Grants Awarded:

2012 Higher Education Research Council, Idaho State Board of Education (IF13-001): Development of diagnostic kits for gender determination of animal embryos ($50,000). Role: PI

2010 INBRE-WSU Spokane – Institute of Translational Health Sciences (ITHS) Collaborative Translational Seed Grant: Invader LNAs to treat autosomal dominant retinal dystrophies ($40,000; personal portion ~$10k). Role: PI; contact-PI: DR Stenkamp (Univ. Idaho); Fellow PI: M Neitz (Univ. Washington).

2010 Department of Defense, Office of Naval Research (N00014-10-1-0282): Functionalized Nanospring mats for detection of explosive materials (total $899,616; personal portion ~$225k). Role: PI of UI subcontract; PD: V Dobrohoktov (W. Kentucky Univ.), co-PI: DR McIlroy (Univ. Idaho).

2009 National Institute of Health, EUREKA (Exceptional, Unconventional Research Enabling Knowledge Acceleration), NIGMS (R01GM088697-01): Invader LNAs as novel Gene Specific Therapeutics ($523,940; personal portion ~$315k). Role: contact-PI; other PIs: RA Hill & MR Papasani (Univ. Idaho).

Internal Grants Awarded:

2011 Idaho INBRE Graduate Student Grant: Application to support Ms. Brooke Anderson (~$25.000). Role: PI; co-PI: DR Stenkamp (Univ. Idaho), 12 months.

2010 Idaho INBRE Graduate Student Grant: Application to support Ms. Brooke Anderson (~$25.000). Role: PI; co-PI: DR Stenkamp (Univ. Idaho), 12 months.

2010 Idaho INBRE Travel grant: Attendance to 6th Annual Meeting of Oligonucleotide Therapeutics Society ($1,500).

2008 Univ. Idaho Research Office and Research Council Seed Grant: Functionalized Locked Nucleic Acid Probes in Enzymatic Bio-Nanotransduction Systems for Ultrasensitive Biological Threat Detection Platforms ($9,000). Role: PI, co-PIs: AL Branen and JR Branen (Univ. Idaho), 12 months.

2008 Univ. Idaho, IBEST Pilot Grant Program: Intercalator-modified Nucleic Acid Probes for Targeting of Double Stranded DNA ($19,400). Role: PI, 12 months.

2007 Idaho NSF EPSCoR Research Infrastructure Improvement (RII) – Startup Augmentation: Synthesis of Isotopically Labeled Nucleotide Building Blocks for Characterization Studies ($11,585). Role: PI, 12 months.

2007 Idaho NSF EPSCoR Research Infrastructure Improvement (RII) – Instrumentation: Karl-Fischer Titrator for Water Content Determination in Moisture-Sensitive Reactions ($8,000). Role: PI, 12 months.

2007 Univ. of Idaho Research Office and Research Council Seed Grant: Easily accessible functionalized nucleic acids for targeting of dsDNA ($9,000). Role: PI, 12 months.

2007 Univ. of Idaho EPSCoR Travel Grant: Travel to AAAS Pacific Division/ACS NW Regional Meeting ($900).

Funded participant on USDA CSREES Federal Appropriations proposals (PIs: DN McIlroy, DE Aston).

Funded member of BANTech Center, Univ. of Idaho (PD: DN McIlroy).

Gifts/donations received:

2012-2013 Unrestricted gifts (3×$10,000) from an undisclosed US biotech company.

2012 Instruments (laminar flow hood, autoclave, thermal cyclers, incubators, -80 °C freezer, lyophilizer, microplate readers, centrifuges, etc) donated by Prof. Emeritus A. Larry Branen (Univ. Idaho).

Honors and Awards:

2013 Recipient, Excellence in Research and Creative Activity Award, Univ. Idaho

2012 Recipient, Presidents' Inaugural Mid-Career Faculty Award, Univ. Idaho

2012 Recipient, Innovation Award, Univ. Idaho

2012 Nomination, Jean'ne M. Shreeve NSF EPSCoR Research Excellence Award

2010 Recipient, College of Science, Early Career Faculty Award, Univ. Idaho

TEACHING ACCOMPLISHMENTS:

Areas of Specialization: organic chemistry, medicinal chemistry, nucleic acid chemistry, nanobioscience

Courses Taught and Developed (student evaluations for course/instructor (c/i); 0 = poor, 4 = excellent):

CHEM 277 Organic Chemistry I (Fall 2009/Fall 2010/Fall 2011/Fall 2012) – evaluation c/i: 3.1/3.4, 3.3/3.6, 3.3/3.5 and 3.2/3.5; 2010-2012 classes averaged 58^{th}/65^{th}/60^{th} national percentile, respectively on standardized 1^{st} term ACS exam

CHEM 372 Organic Chemistry II (Spring 2010) – evaluation c/i: 3.3/3.6; class averaged 79^{th} national percentile on standardized ACS exam

CHEM 472/572 Introduction to Medicinal Chemistry (Spring 2008/2009/2011/2013) – evaluation c/i: 3.5/3.6; 3.8/4.0; 4.0/3.8

CHEM 571 Nucleic Acids: Synthesis and Applications (Fall 2008/Spring 2012) – evaluation c/i: 3.9/4.0; 4.0/4.0

CHEM 414/514 Applications of Nanomaterials in Biomedical Engineering (team taught, ~15% effort: Spring 2007/2008/2009/2010 – formerly CHEM404/504)

Other Teaching Contributions:

CHEM 112H Principles of Chemistry II" (Spring 2007; guest lecturer), CHEM 299 Undergraduate Research (supervisor), CHEM 376 Organic Chemistry Lab II (Spring 2008; guest lecturer), CHEM 491 Undergraduate Research (supervisor), CHEM 500 Master's Research and Thesis (supervisor), CHEM 501Seminar (Spring 2007-Spring 2008, coordinator), CHEM 502 Synthetic Nucleic Acid Chemistry (Spring 2008, supervisor), CHEM 502 Comprehensive Exam Organic Chemistry (Spring 2008, coordinator), CHEM 502 Advanced Nucleic Acid Chemistry (Spring 2009/2010, directed study), CHEM 600 Doctoral Research and Dissertation (supervisor), MMBB 404 Summer Research Seminar - Research Topics and Professional Development (Summer 2008/2009/2010/2011, supervisor), NEUR 508 Topics in Neuroscience (Spring 2007; guest lecturer), Setting and grading organic chemistry cumulative exams (Fall 2007-Spring 2012)

Students Advised:

Undergraduate Students:

17 students have been supervised on research projects since 2006. UI students: Philip Vukelich [2013-present], Max Cowan [2013-present], Benjamin Denn [2011-present], Mason Frederickson [2009-2011], Matt Womeldorff [2010-2011], Mitchell Odom [2010], David Love [2009-2010], Jared Rigoli [2008], Kirsten Canady [2007], Michael Chavez [2007] and Sarah Doornbos [2007]; Visiting students: Grace Anderson [2012, Montana Tech. Univ.], Tyler Horrocks [2012 Brigham Young University - Idaho], Jared Onley [2009, Whitworth University], Laurant Palmatier [2009, Univ. California San Diego], Daniel Raible [2008, Whitworth University], Joanna Hawryluk [2007, Simmons College] and Johanna Root [Univ. Puget Sound].

Graduate Students:

Advised to completion of degree as major professor:
Fall 2011, Sujay P. Sau, Ph.D in Chemistry: "Chemically modified oligonucleotides for targeting of DNA and RNA". Current: post.doc with John Chaput, Arizona State University.

Fall 2010, Michael E Østergaard, PhD in Chemistry: "Functionalized Locked Nucleic Acid for Therapeutic and Diagnostic Purposes". Current: post.doc at ISIS Pharmaceuticals Inc.

Spring 2010, Bharat Baral, MS in Chemistry: "Part I: Biophysical Characterization of C5-Functionalized Locked Nucleic Acids and Part II: Optimized Synthesis of [3-15N]-Labeled Uridine Phosphoramidites". Current: Development Associate II at Geron Corporation.

Spring 2008, Todd Pankratz, MS in Chemistry (non-thesis option).

Visiting graduate students advised to completion of degree (as formal external supervisor):
Summer 2009, Sanne Iversen, M.Sc in Chemistry: "Intercalator modified RNA nucleosides", (internal supervisor: P Nielsen, Univ. Southern Denmark). Current: On maternal leave from a position as high-school teacher at Odense Tekniske Gymnasium, Denmark.

Summer 2009, Rie L. Rathje, M.Sc in Chemistry: "DNA-targeting using N2'-functionalized 2'-methylamino DNA", (internal supervisor: P Nielsen, Univ. Southern Denmark). Current: On maternal leave from a position as high-school teacher at VUC Fyn and HF Svendborg (Denmark).

Current advising of graduate students as major professor:
Brooke A. Anderson (summer 2008-present), Mamta Kaura (fall 2008-present), Saswata Karmakar (spring 2009-present), Dale C. Guenther (spring 2010-present), Jackson Davis (fall 2012-present).

Graduate committees:
Daniel Julien (MS, major professor: Rod Hill, spring 2010)
Pallavi Cheguru (Ph.D, major professor: Rod Hill, spring 2011)
Niels Bomholt (Ph.D, major professor: Erik B. Pedersen, Univ. Southern Denmark, summer 2011)
Parameswara Subramanian (MS, major professor: Aaron Thomas, fall 2011)
Andrew Markelonis (MS, major professor: Chien Wai, fall 2011)
GuanKui Wang (Ph.D, major professor: Rod Hill, summer 2012)
Jamie Haas (Ph.D, major professor: David McIlroy, fall 2012)
Temple C. Warwick (Ph.D, major professor: Tom Bitterwolf, spring 2013)

Andrew Aring (Ph.D, major professor: Richard Williams, fall 2008-present)
Dusty van Hofwegen (Ph.D, major professor: Sam Minnich, fall 2010-present)

Post-doctoral fellows:
V.V.R. Sai (Mar 2009- Mar 2011). Current: Assistant Prof. at Indian Institute of Technology, Madras.
Shiva Rastogi (Dec 2010-Sep 2012). Current: Research Scientist at Texas State University.

SERVICE:

Professional Memberships

2010-2011	Member, Oligonucleotide Therapeutics Society
2010-	Member, Institute of Translational Health Sciences (ITHS)
2008-	Member, American Chemical Society, Biological Chemistry

Professional Service

Ad hoc referee on > 70 manuscripts submitted to JACS; Journal of Organic Chemistry; Nucleic Acids Research; Chemistry – European Journal; Bioorganic and Medicinal Chemistry Letters; Chemical Communications; Organic and Biomolecular Chemistry; ACS Chemical Biology; Tetrahedron Letters; Molecular Therapeutics Nucleic Acids.

Member of Inaugural Scientific Advisory Council of the Oligonucleotide Therapeutics Society (2013-2014).

Ad hoc consultant for ISIS Pharmaceuticals Inc (2011-2012) and Minitube of America (2011-).

Co-organizer, Medicinal Chemistry Section, ACS NORM-RMRM Meeting 2010

Member, International Advisory Committee, International Conference on Recent Advances in Chemical Science (ICRACS-2013; Arya Post Graduate College, India).

Conducted and published book review for ChemBioChem.

Committee Service:

University level:	
2013-	Member, University's Faculty Experts Group
2008-2011	Member, Faculty Affairs Committee
College level:	
Fall 2012-Spring 2013	Member, Faculty and Staff Council
Fall 2012	Member, promotion committee
Spring/Fall 2012	Member, search committee, interim and permanent Dean (College of Science)
Spring 2010	Faculty Marshal, commencement
2008-2011	Member, LeTourneau committee
Fall 2008	Member, 3rd year review committee (Ytreberg/Dept. Physics)
Department level:	
2012	Member, 3rd year review committee (Magolan)
2011-2012	Member, computer committee
2010-2011	Member, chair's advisory committee
2009-present	Member, graduate admissions committee (chair 2011-2012)
2009-2010	Member, search committee, Assistant Professor (Chemistry - organic)
2008-2011	Chair, graduate recruitment committee
2007	Member, exploratory committee, establishment of BS forensic chemistry degree
2006-2007	Member, committee for student-faculty relations
2006-2008	Faculty Secretary, Department of Chemistry

Outreach:

2013	Served as a university representative in discussions with Chairman Earl Sullivan from the Idaho Coalition for Innovation (The CORE).
2012	Interview with University Communications and Marketing Department in connection with development of new fundraising brochure.

2010	Interview articles with undergraduate researcher Mason Frederickson and Dr. Hrdlicka published on UI homepage.
2010	Interview articles with undergraduate researcher Mason Frederickson and Dr. Hrdlicka published in local newspaper, electronic news sites and UI media on the occasion of 2010 INBRE Conference.
2010	Article entitled "Nanomaterials for Biosensor Platforms Toward Increasing Safety and Shelf Life of Agricultural Commodities" (DE Aston, DN McIlroy, L Branen, S Rastogi, J Branen, G Corti, PJ Hrdlicka, K Noren and JJ Nagler) published in The World of Food Science.
2010	Interview articles published in UI Argonaut, UI Friday Letter, and regional newspapers and electronic news sites on the occasion of procuring the DoD award "Functionalized Nanospring mats for detection of explosive materials".
2009	Interview articles published in Vandal Science and regional newspapers and electronic news sites on the occasion of procuring the NIH award "Invader LNAs as novel Gene Specific Therapeutics".

Other Service:

Summers 2008-2012	Mentor, visiting undergraduates, INBRE REU program
Summers 2008-2011	Member, "Beyond Baccalaureate Discussion Panel", Idaho INBRE Seminar Series
Summers 2007-2009	Mentor, visiting undergraduates, Neuroscience REU program
Fall 2007/2009/2010	Poster judge, Annual College of Science, Student Research Exposition, Univ. Idaho
Fall 2008	Co-host, ~15 potential transfer students from North Idaho College
Fall 2008	Participant, recruitment luncheon at Univ. Idaho for prospective graduate students from Brigham Young Univ.
Spring 2008	Judge, UI Student Research Expo
Fall 2007	Recruitment trip, Gonzaga University

Community Service:

2008-present	Academic advisor, Univ. of Idaho, Table Tennis Club

PROFESSIONAL DEVELOPMENT:

2010	Participant, on-line course Acuc101: Introduction to animal care and use, Univ. Idaho.
2010	Participant, "Write winning grants", Grant Writer's Seminar & Workshops, Idaho INBRE Program.
2010	Participant, annual retreat of Initiative for Bioinformatics and Evolutionary Studies (IBEST) Center.
2010	Participant, "So what ? who cares ? why you ?" workshop hosted by Idaho TechConnect at UI, which presented commercialization success tools.
2008	Participant, annual retreat of Initiative for Bioinformatics and Evolutionary Studies (IBEST) Center.
2007	Participant, "NSF Days at WSU Spokane Riverpoint" - two day workshop

2007	Participant in three workshops on “Finding Funding/Responding to a Program Announcement”, “Proposal Budget Development and Award Administration” and “Reviewer`s Perspective on Proposals” offered by Grant Development Specialists at UI.

CURRENT & PENDING SUPPORT

Name: Patrick J. Hrdlicka

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL $ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
	Active:				
PJ Hrdlicka (PI)	HERC – Idaho SBOE IF13-001	$50,000	070112-063013	5%	Development of diagnostic kits for gender determination of animal embryos
PJ Hrdlicka (PI & contact-PI); RA Hill (PI)	NIH EUREKA R01GM088697	$523,940	080109-073112	20%	Invader LNAs as novel gene specific therapeutics
V Dobrokhotov (PD); PJ Hrdlicka (PI) DN McIlroy (co-PI)	Office of Naval Research N00014-10-1-0282	$899,616	011209-113012	10%	Functionalized nanospring-mats for detection of explosive materials
	Pending:				
PJ Hrdlicka (PI)	HERC – Idaho SBOE	$50,000	070113-063014	5%	Production of gender-sorted semen for applicantions in the animal reproduction industry
DE Aston (PI) PJ Hrdlicka (co-PI)	USDA – National Institute of Food and Agriculture	$499,798	081413-081717	5%	Detection of genomic DNA from food pathogens using nano-Invaders and surface-enhanced Raman scattering (SERS) spectroscopy
RV Williams (PI) PJ Hrdlicka, J Magolan, JM Shreeve (co-PIs)	NSF - MRI	$773,766	060113-053114	0%	MRI: Acquisition of a 600 MHz Nuclear Magnetic Resonance Spectrometer

FACILITIES & OTHER RESOURCES

Laboratory: The PI's research group occupies two laboratories. The synthetic chemistry lab (1460 sq. ft., Renfrew Hall 326) was completely renovated in 2006 and is outfitted with four fume hoods (3x8 ft. and 1x6 ft), three long two-sided lab benches with drawers, and three vented cabinets for storage of flammable solvents. A large, closed cupboard for room temperature storage of chemicals is placed along one of the walls in the laboratory. The juxtaposed DNA synthesis lab (660 sq. ft., Renfrew Hall 314) is outfitted with four fume hoods (2x8 ft and 2x4 ft), six one-sided lab benches with drawers and elevated shelving, and one vented cabinet for storage of flammable solvents. Together, the labs accommodate up to ten full-time researchers. The PI is, furthermore, in the process of establishing a BSL1-level laboratory (422 sq. ft., Renfrew Hall 301+302; estimated completion ~June 2013) which will be utilized for cell culture studies and molecular biological experiments. This renovated laboratory will be outfitted with two fume hoods (2x4 ft), one free-standing laminar flow hood (4 ft), and three one-sided lab benches with drawers and elevated shelving. All laboratories are outfitted with multiple 120V/240V single phase outlets, compressed air, natural gas, deionized water, and ethernet/wireless access. All major instrumentation is protected from power surges by uninterruptible power supplies (UPS).

Computer: The PI has two laptops set up for local and remote office use (SciFinder; Microsoft Office; Adobe Photoshop; ChemDraw, etc…). In addition to their personal laptops, students have access to two desktop computers in the laboratory, which are equipped with standard word processing, graphical and scientific software (Chemdraw, Mestre NMR, ACD H/C NMR-predictors, etc…). ~10 computers are dedicated to controlling instrumentation.

Office: The PI has an office (165 sq. ft., Renfrew Hall 313W) located close to his laboratories, which allows for daily contact with the research team. Group members have access to an office (96 sq. ft., Renfrew Hall 329) immediately next to the large laboratory, along with office space in secluded parts of both laboratories. Weekly group meetings are held in the departmental conference room (Renfrew Hall 220). All office spaces have full ethernet/wireless access.

Support staff: The chemistry department employs a secretarial staff member, a financial services staff member, a departmental manager, a Ph.D-level NMR facility manager, and an electronics/network specialist. On-site chemical and biological stores - staffed by full-time managers who are partially supported by their departments - maintain a large assortment of laboratory supplies, chemicals and solvents available for purchase. The university maintains a two man professional machine shop, a mass spectrometry facility staffed with a full-time Ph.D-level manager, an optical imaging facility staffed with a full-time manager with >30 years of experience, and a glass blower.

Other resources: The Department of Chemistry at the University of Idaho consists of 12 research-active faculty and 3 instructors, including a recently hired full-time organic chemistry instructor, which has allowed for a reduction of the PI's teaching load. A broad range of research

topics are studied at the Department including graphene production from inexpensive materials, synthesis and detection of explosives, development of analytical instrumentation, synthesis and photochemistry of organometallic compounds, development of synthetic methodology toward molecular scaffolds of therapeutic value, identification of room temperature ionic liquids for nuclear waste reprocessing, and supercritical fluid extraction of metals and radioisotopes. Faculty members maintain cordial and supportive relationships and constitute a valuable resource for discussions on project-related matters.

EQUIPMENT

PI laboratory:

- 2 DNA synthesizers (Expedite 8909) for custom synthesis of chemically modified oligonucleotides
- 3 HPLC systems (Varian-Rainin and Shimadzu) equipped with autosamplers, detectors and fraction collectors for purification and quality control of materials. Systems are set up for reverse-phase and ion-exchange chromatography.
- 2 UV/VIS spectrophotometer (Cary Varian 100) and 1 fluorescence spectrophotometer (Cary Varian Eclipse) equipped with Peltier temperature controllers, software and numerous optical cells for high throughput for characterization of (fluorescent) oligonucleotides
- 25+ and 10+ optical quartz cells for UV/VIS and fluorescence spectroscopy, respectively
- 1 rapid mix accessory (Applied Physics RX2000) compatible with the Cary spectrometers for stop-flow kinetics experiments
- 2 UV/VIS spectrophotometers (Genesys 10UV and Shimadzu Pharmaspec UV-1700) without temperature control
- 1 fluorometer for quantification of small amounts of DNA/RNA/protein (Qubit 2.0)
- 1 refrigerated centrifugal concentrator (Labconco Centrivap Concentrator) connected to a high-vacuum pump (Boc Edwards XDS 5C)
- 1 microcentrifuge with temperature control (Tomy MTX-150)
- 3 microcentrifuges without temperature control (two Beckman Coulter 18 microfuges and one Galaxy 16DH)
- 2 digital constant-temperature incubators (Quincy Lab 10-140E)
- 2 heat blocks
- 3 small (10 x 10 cm) horizontal gel electrophoresis units
- 2 large (20 x 20 cm) horizontal gel electrophoresis units
- 1 large (adjustable) vertical electrophoresis unit
- 4 small (10 x 10 cm) vertical gel electrophoresis units
- 3 trans-blotters (Bio-Rad)
- 6 power supplies for electrophoresis (Beckman, E-C Apparatus Corp., Fisher Scientific, VWR Scientific Products)
- 1 UV-crosslinker (Agilent Stratalinker 2400)
- 1 UVP Multi Doc-it Digital Imaging system with UVP Benchtop 2UV Transilluminator, PC and software

- 2 pH meters (Denver)
- Numerous vortexers, orbital/vial/tube rotators, mini-spinners and pipettors
- 1 Class II biosafety cabinet (5ft, Labconco, Purifier Logic Delta series) with UV light and service fixture
- 1 CO_2 incubator (Thermo Scientific)
- 1 homogenizer (Seward Stomacher80 Biomaster)
- 1 IEC EXD explosion-proof floor model centrifuge (Damon/IEC division)
- 1 free-standing autoclave (Market Forge Sterilmatic)
- 1 -80˚ C 20' chest freezer (VWR)
- 1 microscope (Olympus BH-2)
- 1 water bath heater (Fisher Scientific)
- 1 96-well luminescence microplate reader (Molecular Devices Emax)
- 1 96-well fluorescence microplate reader (BioTek Flx800) with additional filters, pc and software (BioTek KC Junior microplate analysis)
- 2 thermal cyclers (Stratagene Robocycler Gradient 96 and Roche GeneAmp)
- 1 test strip reader DT2032
- 5 rotary evaporators (four Heidolph Laborota 4000 and one Buchi Rotavapor 200)
- 4 vacuum pumps (three KNF Laboport UN820.3FTP and one Welch Dry Fast Ultra 2032) and 1 oil pump (Welch Duo Seal) for rotary evaporators
- 2 large temperature-controlled circulating chillers (VWR)
- 4 stainless-steel vacuum manifolds linked to a high vacuum pump (Boc Edwards XDS 5) used in the drying of compounds
- 1 lyophylizer (Labconco Freeze Dry System Freezone 4.5) with rotary vane dual stage mechanical vacuum pump (Labconco model 117)
- 1 vacuum oven (VWR)
- 3 analytical balances (Metler Toledo AB204-S, Acculab AL-204 and VIC-3101)
- 1 large explosion-proof refrigerator with freezer top for storage of reagents
- 3 domestic freezers and refrigerators for storage of oligonucleotides, media and buffers
- 1 large oven (Lindberg/Blue M) for drying of glassware SW
- 7 temperature-controlled magnetic stirring hotplates (IKA RCT Basic and OptiChem)
- ~15 magnetic stirring hotplates without temperature-control
- 1 Karl-Fischer coulometer (Mettler Toledo DL32)
- 1 ultrasound sonicator (Fisher Scientific)
- laboratory glassware (flasks, condensers, etc.)

Department of Chemistry (general use):

- 300 MHz NMR spectrometer (Bruker Avance) for routine one-dimensional ^{1}H, ^{13}C and ^{19}F measurements
- 500 MHz NMR spectrometer (Bruker Avance) with solid and variable temperature probes; spectrometer has multinuclear and two-dimensional capabilities

- GC-MS composed of a Agilent Technologies 5975C VL Mass Selective Detector interfaced to a model 6850 gas chromatograph
- EPR spectrometer (Bruker EXM)
- FTIR spectrometer (Nicolet Avatar 370 DTGS)
- Fluorescence spectrophotometer (Hitachi F-2000)
- UV-VIS spectrophotometer (Shimadzu Pharmaspec UV-1700)
- Atomic absorption spectrometer (Thermo Fisher Scientific, S series)
- CHN elemental analyzer (Exeter CE-440)

Faculty members are generous with respect to sharing resources, which expands the pool of available specialized instrumentation even further if warranted by the project.

University of Idaho (general use):

- optical imaging facilities (http://www.uidaho.edu/sci/biology/imaging-center) offer access to high resolution imaging in phase, DIC, fluorescence and confocal microscopy. Fluorescent stereomicroscopy, laser microdissection, image processing and qualitative and quantitative image analysis are also offered, alongside with flow cytometry and cell sorting
- dark room with x-ray film developing equipment, UV-crosslinker and gel documentation station with quantification software (QuantOne) via Department of Food Science.
- mass spectrometry facilities with access to i) a Waters Q-Tof Premier quadrupole time-of-flight mass spectrometer that is equipped with electrospray ionization, nanoESI, MALDI, and Triazaic nanotile ion sources, and which is routinely interfaced to a Water nanoAcquity UPLC or an Acquity HPLC; ii) a Waters Xevo TQ tandem quadrupole mass spectrometer that is equipped with electrospray ionization, nanoESI, and Trizaic nanotile ion sources and interfaced to a nanoAcquity UPLC; iii) a GC-MS composed of a single quadrupole Hewlett-Packard 5973 Mass Selective Detector interfaced to a model 6890 gas chromatograph. Inductively coupled plasma mass spectrometry (ICP-MS) is available through reciprocal agreement with Washington State University (~7 miles away)
- nanofabrication class-1000 clean room with the Nanometer Pattern Generation System for electron-beam-lithography down to 25 nm
- nanomaterials characterization facilities: scanning electron microscopy (SEM); field-emission scanning electron microscopy (FE-SEM); transmission electron microscopy (TEM); scanning tunneling microscope (STM); atomic force microscope (AFM); energy dispersive spectroscopy (EDS); powder x-ray diffractometer (XRD); single-crystal x-ray diffractometer

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Wednesday, May 08, 2013

To: Patrick J. Hrdlicka, Ph.D
Associate Professor
Department of Chemistry
University of Idaho

Concern: Letter of support regarding your HERC grant application

Dear Dr. Hrdlicka,

Please accept this letter as an indication of Minitube's support for your HERC grant application and of our commitment to collaborate with your team in bringing the invader technology to a commercial stage. Based on our previous discussions and successful collaboration we will continue to invest research and financial resources into this project.

About Minitube of America: Our Company has been involved in research and development of advanced reproductive technologies and unique customer services since the 1980s. While there are more than 100 million head of pigs produced in the United States annually, more than 70 million of them are bred or produced with the aid of one or more Minitube products. Minitube holds the largest market share of semen extenders and AI equipment in the United States where 95% of the dairy cows and pigs are produced with artificial insemination (AI). While our core business was developed with the increased use of AI, Minitube products support as well the commercial livestock and bloodstock embryo transfer industry. We make products for sperm, eggs and embryos, to promote livestock reproduction and germplasm preservation.

In 2004, Minitube of America opened the International Center for Biotechnology (ICB), a state-of-the-art research facility, with world-class scientists including reproductive biologists, cell biologists, molecular biologists, endocrinologists supported by a multi-species farm with the entire required veterinary care infrastructure. Minitube scientists are performing advanced research to build the future technologies animal production and agriculture including development of methods to gender pre select in livestock offspring. At the same time, Minitube is active in the use and further development of advanced reproduction technologies such as, in vitro fertilization, in vivo embryo collection and transfer, genomic analysis and cloning. This significant research and development effort is supported by internal resources, amounting to over 10% of annual gross revenue, by outside funding from competitive grants (NIH/SBIR) and by monetary or in-kind contributions from academic and corporate collaborations including: Massachusetts General Hospital, Transplantation Biology Research Center; Harvard University; University of Minnesota; Mayo Clinic; Ludwig Maximillian University, Munich; University of Georgia; University of Wisconsin; Worcester Polytechnic Institute; CellThera; University of Kentucky Gluck Research Center; University of Florida Veterinary School; University of Alberta; Laval University, Quebec.

Facilities and Infrastructure: Minitube available facilities include 3,600 ft^2 of laboratory space located at the Minitube International Center for Biotechnology (ICB) in Mt. Horeb, WI. The facility is staffed by over 30 full time employees of whom 12 are PHD level. The space has separate clean rooms dedicated to oocyte and embryo production, in vivo embryo production, in vitro production and culture of cloned embryos, cell culture and molecular biology.

The Minitube ICB maintains a significant number of animals (cattle, pigs, horses, small ruminants and dogs) located at 4 different farms and used for clinical trials of our products and technologies. These farms have full time animal caretakers and facility technicians, 5 veterinarians on staff, as well as contract veterinary care by Lodi Veterinary Clinic, Lodi, WI. Written Standard Operating Procedures are in place to address animal handling and care, biosecurity, animal health, animal nutrition, and database management for information related to embryo transfer, health testing, vaccinations, animal movements and animal disposal.

Proposal: Minitube considers the collaboration with you and your University of Idaho team a top research and development priority. We are proud to align our forces with your team and we appreciate the continuous investment of your University and state in advancing this technology. The license agreement between Minitube and the University of Idaho confirms our common interest to commercialize the animal reproduction application of the invader. Minitube will continue to invest significant resources in this project and our strong commitment is evidenced by: 4 PhD level employees plus support staff fully dedicated to this project; financial investments in gender determination technology in excess of $5M till date; and a corresponding ongoing annual project budget in excess of $1M. As the technology approaches market launch, Minitube's investment will grow and resources will be dedicated to field trials and marketing.

We are looking forward to collaborating with you on this very innovative, timely, and important project. We are confident that - collectively - we can launch a commercial product and generate economic benefits for all the parties involved.

Sincerely,

Ludwig Simmet
CEO, Minitube of America, Inc.