UNMC Center for Intelligent Health Care

1. <u>Purpose and Context of the Center.</u>

Rationale and Significance: Following his defeat in chess to Deep Blue, Grandmaster Gary Kasparov declared the future was not human versus computer, nor computer versus computer, but human and computer working together. That concept has been well articulated in Terry Sejnowski's recent book "The Deep Learning Revolution". Our vision is to intelligently bring technology onto the healthcare team to optimize the synergy between the clinician, the patient, and the computer.

Artificial Intelligence (AI) has generated tremendous interest in all segments of our society. A recent review in the Harvard Business Review states that this is a 5 trillion dollar business and rapidly growing. Worldwide there are only 22,000 AI experts with many fewer who have expertise in healthcare. Thus, there is a great need to scientists to be experts in AI and a need to train clinicians that can translate AI into clinical care. It is an opportunity for UNMC and the University of Nebraska to become an international leader in AI-related science and solutions for healthcare. We will develop brilliant ideas then pursue the best ideas into viable products that help clinicians and patients. Becoming a world-leader takes focus. We will be a national leader in good data, one of the foundations of successful AI solutions, we will be national leaders in optimizing human and computer cognition, we will partner with other University of Nebraska schools to be leaders in algorithms and analysis with the goal of bringing about more precision in medicine (intelligently supporting clinicians and patients).

UNMC is in a unique position: We have access to world-class faculty in clinical informatics, we have a strong, supportive clinical partner with Nebraska Medicine, we have strong collaboration with our academic partners at UNO, UNL and UNK to bring in the best techniques of algorithms and analytics in artificial intelligence, and we have the Interprofessional Experiential Center for Enduring Learning (iExcel) as a research and development partner for optimizing human and computer cognition. Through the creation of the Center for Intelligent Health Care we will recruit and retain faculty to build and test great ideas and we will build the infrastructure that moves great ideas into great solutions.

Center Goal: To create healthcare solutions that intelligently supports clinicians to become more efficient and effective, and to improve the health of our patients.

Mission Statement:
The Center for Intelligent Health Care will:

1. Provide a springboard for clinical informaticists, data scientists, and artificial intelligence researchers to interact, publish, and compete for extramural funding.

2. Attract and retain the best students in Science, Technology, Engineering, and Mathematics (STEM) as well as students in healthcare with an interest in clinical informatics and artificial intelligence. This will include undergraduate, graduate and post-doctoral students.

3. Create good data that connects the DNA to diseases, seamlessly.

4. The Center will partner with iExcel to research and optimize human cognition partnering with health information technology, especially artificial intelligence.

5. Serve as a usability and prototyping lab, and clinical incubator for innovation that improves patient safety, quality and cost.

6. Serve as an economic driver for the State of Nebraska through the creation of new businesses that spin off from the Center.

Tagline: CIHC: Intelligently simplifying healthcare.

Vision: Nebraska will be a world-leader in linking human cognition and artificial intelligence, development of algorithm and analytics, and creation of good data to deliver precision in medicine. We will create innovative solutions that improve the efficiency and effectiveness of clinicians and the health of our patients. We will train the next generation of clinicians and scientists in clinical informatics, data science, and artificial intelligence.

2. Need and Demand for the Center.

At the outset it is critical to understand the difference between healthcare and health care. Healthcare is the environment where we practice medicine, health care is what we deliver to our patients.

The US healthcare system is in crisis. It is complex, expensive, and inefficient. There is an explosion in information ranging from DNA to individual disease management. The amount of information and the rate of change are too great for any individual to keep up. Further, as implemented, health information technology has led to clinician burn-out and escalating costs.

To understand the problems with the US healthcare system it is important to understand that the current healthcare system has its roots in the late 1800's when the patient's history and physical examination were the two cornerstones of patient care; an assumption that underpins care today. Add to that two events from the 1960s: Medicare, and the moon landing, and you have the triad of co-conspirators that have led to our disrupted healthcare system.

This Center will be a leader in healthcare transformation by linking brilliant, innovative scientists in clinical medicine and clinical informatics with leaders in health information technology and artificial intelligence to create a world-class clinical incubator and a unique whole-health system solutions that will facilitate the metamorphosis of the best concepts into great solutions.

We are at the beginning of the artificial intelligence revolution. There are currently no centers within the University of Nebraska System (and only a few fledgling efforts at other universities) that focuses on artificial intelligence, big data, and precision in medicine in healthcare. The Center is needed to create a critical mass that can stimulate and sustain innovation, and synergize research efforts that can then create pathways for great concepts to become great solutions that improve the quality and efficiency of clinical care and improve the health of Nebraskans. It is equally important to realize the opportunity costs lost to Nebraska if we are on the sideline artificial intelligence revolution.

The Center will be very well positioned to connect UNMC with UNO, UNL, and UNK to train the next generation of clinical informaticists, data scientists, and AI experts; not just in the theory, but in the practical application of clinical informatics, big data, and artificial intelligence through our cores in good data, precision medicine, and artificial intelligence through our prototyping laboratory and clinical incubator with the ultimate goal of bringing more precision to health care.

3. Resources. We have a strong core of clinicians, clinical informatics, health information technologists, and artificial intelligence experts across our four campuses, however there is no strategic direction or coordination. The Center will create an entrepreneurial culture that creates and sustains innovation. The Center will work with leaders and faculty across the four campuses to provide strategic focus to grow into a world-class center. The Center has been labelled as a priority "Big Idea" for the Nebraska Foundation.

The Chancellor and the Dean of the College of Medicine at UNMC have pledged support for the initial start-up of $500,000 per year for fiscal years 2020, 2021, and 2022. Subsequent funding will be based on grants, contractual work, royalties, and foundation support. Additionally UNO, UNL, and UNK will support in kind contributions for their faculty and students.

Physical Facilities. We anticipate needing lab space to house 20 faculty, students and researcher staff in the first three years. A core of the Center will be collaboration, therefore we will need conference space that can bring together faculty and students across the three campuses.

Instructional Equipment and Informational Resources. We outfit a conference room configured for interaction with computer and audiovisual equipment to support live, distributed conferences.

4. Budget Projection and Plan for Sustainability.
Initial funding support will come from the UNMC with contributions from UNO, UNL and UNK for their faculty and students. This proposal includes start-up funding for the first two years. We expect significant income to the Center start in year two. After the initial two years of funding budget support will be approved by the oversight committee based the Center's demonstrated value to the University of Nebraska and Nebraska Medicine. Funding will come from extramural government and non-government grants, consultative practice, contracted work, philanthropy, venture/angel investment, and royalties.

Please see **Appendix 1** for budget details.

5. Director Qualifications.

Dr. John Windle is uniquely qualified to lead the Center for Intelligent Health Care. He is the Richard and Mary Holland Distinguished Chair of Cardiovascular Science and Professor of Cardiovascular Medicine. In 1985 Dr. Windle set-up the first clinical electrophysiology laboratory in Nebraska. In 1995 he became the Assistant Dean for Continuing Medical Education, in 1998 become the inaugural Director of the Health Informatics Program at UNMC and in 2000 became the Division Chief of Cardiovascular Medicine until he stepped down in 2016. In the early 1990s as a consultant to Bard Electrophysiology he developed the first database to support the Electrophysiology Laboratory. In the late 1990s he partnered with Bob Throne and Lori Olson to develop a novel cardiac mapping system and they received National Science Foundation funding for that work. Over the subsequent 20 years Dr. Windle has received extramural funding from the National Institute of Standards and Technology, the National Library of Medicine, the National Science Foundation, the Agency for Healthcare Quality and Research and The Pew Charitable Trust Foundation. He has served as the President of the Heartland Affiliate of the American Heart Association and as the Chair of the Informatics and Health Information Technology Taskforce of the American College of Cardiology. Since 2008 he has been recognized as one of the "Best Doctors" in America for his clinical care.

Dr. Windle's biosketch is listed in **Appendix 2**.

We have also listed the biosketches of Drs. James Tcheng who will be a key faculty recruit for the Center in **Appendix 3**.

6. <u>Reporting and Organizational Structure.</u>
The Center Director will report to the Chancellor of the University of Nebraska Medical Center.

Appendix 4 lists the proposed members of the Oversight Committee.

Appendix 5 lists initial faculty members and key collaborators across the three University of Nebraska campuses.

7. <u>Participating Faculty and Partnerships.</u>
The academic administrative home of the Center will the University of Nebraska Medical Center but the Center will extend to UNL and UNO.

Collaborations with Higher Education Institutions External to the University. We already have strong working partnerships across UNMC, UNO and UNL. At the outset we intend to partner with Duke University and the University of Utah for additional clinical informatics expertise. We anticipate finding consultants in cognitive science and behavioral economics.

Partnership with Business. A core function of the Center will be to translate great concepts into great solutions. We are already working with multiple health information technology companies including IBM Watson Health, Google, Apple, Epic, and Nuance but will look at opportunities with specialty medical societies, standards organizations, government, and organizations such as Haven Healthcare.

Constituencies Served. Our Center serves the citizens of Nebraska.

8. <u>Strategic Plan</u>
We are witnessing two of the "most important one-time events on our history. The emergence of real, useful artificial intelligence and the connection of most of the people on the planet via a common digital network" according to authors Brynjolfsson and McAfee. There is an opening for a well-coordinated effort to bring AI effectively into healthcare,

Artificial intelligence is the ability of computers to reason and solve problems. Good AI depends on four layers working together: Algorithms, Data, Analytics, and Grounded Truth.

-The **Algorithm** is the foundational element on which AI is built. It is the mathematics and processing necessary to drive the engine.
-**Data** is how the engine gets trained. Data can come from any number of sources: genetic data, the electronic health record, or your Apple watch. The challenges are having secure data sets, and defining, building and collecting "good" data.
-The **Analytics** layer is the application of the best tools, such as machine learning, natural language processing, computer vision, robotics, etc. to solve the specific problem.
-**Grounded Truth** is the ability to know what is correct from what is erroneous. It requires content experts to make sure that right question is being asked the correct way.

UNMC has world-class expertise in data and grounded truth. UNO and UNL have strengths in AI algorithms and the analytics prove the concepts. To capitalize on the unique strengths of the

University of Nebraska these three layers will be integrated and made operational through three core areas:

Core for Good Data: Healthcare suffers because computers don't talk to one another. Good data is computable/machine readable and maintains its original semantic meaning (i.e., interoperability). To date, neither the government nor standards organizations have been able to solve this issue; current electronic health record systems only compound the problem. The Center will be a world leader in good data. We will address foundational issues related to good data to provide secure, high quality, reusable data for biomedical and AI researchers, clinicians and patients.

Core for Computational Intelligence (Algorithms and Analytics): Data is useful only if transformed into information, knowledge, and decision. This core involves data interpretation, modeling, fusion, integration, warehousing, application development and deployment powered by sound software engineering; both big data and small data research areas ranging from machine learning to simulation. UNMC will partner with our academic partners at UNO, UNL and UNK to work on optimizing computer intelligence.

Core for Human Cognition and Artificial Intelligence: Our research in human-computer interaction has allowed us to build a robust usability and prototyping lab. Work within that lab allowed us to create and validate the Nebraska Clinical Encounter Framework. This framework deconstructs the clinical encounter into dataflow, workflow and human cognition then reconstructs the clinician encounter using the framework to optimize the human-human (clinician-patient) interaction and human-computer interaction to support the encounter. The framework is will simplify health care to reduce clinician burn-out by making care more efficient and effective. The framework acknowledges that humans have limited memory and are susceptible to cognitive errors (mistakes), but computers have their own limitations – and that both need to be optimized and synchronized. The Center will be one of the first in the country to concentrate on the optimization of artificial intelligence, and human cognition in the clinical domain using our novel framework, robust usability lab, and rapid prototyping technology.
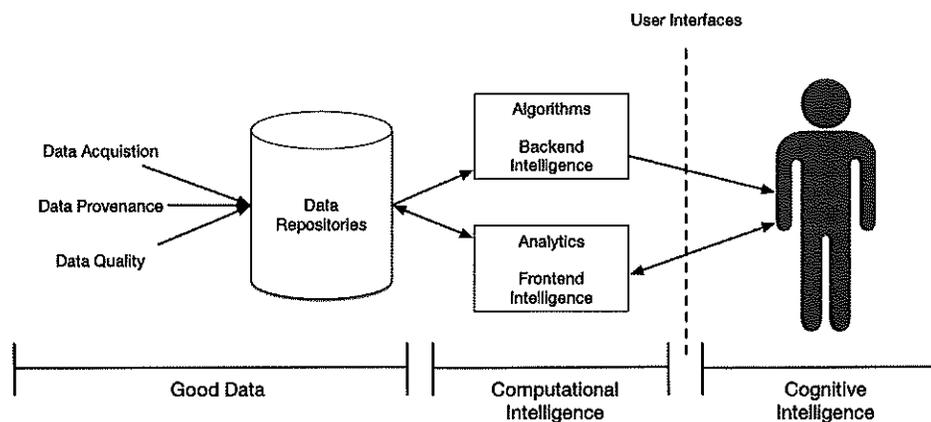

Figure 1 gives a visual representation of how we propose to link algorithms, data, analytics, and grounded truth into functional cores within the Center. It starts with the Core for Good Data (far left), utilizes analytics and artificial intelligence (middle), then designs and tests interfaces that optimize human cognition (right)

Precision in Medicine: Precision Medicine is a term developed by oncologists that link a patient's genetics and the patient's tumor to create a unique therapy. Forty years ago cancer

treatments were designed to kill rapidly dividing cells taking advantage of the knowledge that cancer cells grow faster than normal cells. However, they didn't do a very good job discriminating between cancer and normal cells, further many of the tumor cells didn't respond to chemotherapy at all and overwhelmed the body. Today we are at the cusp of a major revolution: Therapies that target specific characteristics of tumor cells versus normal cells and termed precision medicine.

This initiative is expanding the definition of precision medicine to be more inclusive. We are calling this Precision in Medicine. The powerful ability of integrating disease, the human genome, and clinical outcomes of an individual patient will transform healthcare beyond cancer therapy. We will be able to move beyond clinical guidelines to understand and build on the individual patient response.

Precision in medicine has a second definition; it means the delivery of the right information at the right time and in the right format to clinicians. Linking human cognition and artificial intelligence with good data, and the right algorithms and analytics will help us achieve that precision.

Prototyping Laboratory and Clinical Incubator: We will create the world's foremost prototyping laboratory and clinical incubator for optimizing human and computer cognition in healthcare. The prototyping lab is the functional test bed that links good data, computational and human intelligence to clinicians and patients. The prototyping team will test and validate innovative concepts created by our clinical informatics and artificial intelligence scientists and move them forward from proof of value to scalable, useful solutions. The Lab will take full advantage of our unique partnerships to link the Center with iExcel, Nebraska Medicine, and potentially Children's Hospital to facilitate investigator-initiated, industry and government-supported research and quality improvement initiatives. The Center will work closely with the Center Oversight Committee and Scientific Advisory Board to facilitate the creation of new, Nebraska-based businesses to bring great ideas to life.

The Business Model:

There is a substantial gap between the goals of traditional academic units to test and publish new concepts and the ability to transform great concepts into clinical solutions. To accomplish this goal we must create a new business model for UNMC. The origin of this model is founded on the work of two Arizona Professors, Nunamaker and Briggs who published the three levels of proof for information technology adoption: Proof of Concept, Proof of Value, and Proof of Use.

Proof of Concept is the core of the traditional academic model - the funding research through grants predicated by innovation, good methodology and original concepts. Our clinical informatics and artificial intelligence faculty will seek grant support from government and non-government sources to develop and validate proof of concept work.

Proof of Value comes from validation of the concept in a controlled population such as the patients, students, residents, and faculty who practice at Nebraska Medicine. Our prototyping team will translate proof of concept work into functional, testable prototypes that can be evaluated within the iExcel system and validated at Nebraska Medicine and other clinical research partners. Besides grants, the prototyping team will support the Center's growth through consulting and contractual work.

Proof of Use is the ultimate goal. It is when our technology solutions are adopted and used by clinicians and patients across the country and throughout the world.

The Center for Human and Computer Cognition intends to support the full range of proofs. To accomplish this we will not only support the traditional proof of concept work but also have the explicit goal and means to take the best concepts and build them into solutions that benefit our clinicians and patients. The Center will work with our clinical partners to produce good actionable data and through our incubator create value for that good data. We will work on the licensing and patenting of inventions in conjunction with UNeMed, UNeTech and work with the Nebraska Business Development Center to fully realize the business case for individual projects and create a clear return on investment strategy that will create strategic partnerships with industry. It is anticipated that the Center will spawn an LLC serve as the commercial arm of the Center and partner with start-ups and established high tech companies. The Center will help create jobs in Nebraska.

Governance:

Center Oversight Committee: The Center will report to the Chancellor of the University of Nebraska Medical Center. The Oversight Committee will be composed of senior leaders from Nebraska Medicine, the University of Nebraska System, and key business and community leaders. The Oversight Committee will be responsible for the approval of the strategic plan and the annual budget, and the evaluation of the Center's Director.

Scientific Advisory Board: We will bring together national thought leaders in artificial intelligence and biomedical informatics along with academic and community leaders in Nebraska to vet Big Ideas. Artificial intelligence development will be very competitive and fraught with dead-ends. Vigorous vetting will allow the best ideas to float to the top and create a culture of success.

Center Executive Team: The Center Executive Team will consist of the Center and Core Directors, the Administrative Director and two members of the oversight committee. This group will be responsible for the day-to-day operations of the Center including building business cases for projects and negotiation of contracts.

The Projects:

The raison d'être for the Center is take great concepts (projects) and create solutions that fundamentally transform how clinicians and patients interact with health information technology. To quote Edwin Land, "Don't undertake a project unless it is manifestly important and nearly impossible".

The exemplar foundational projects are noted in **Appendices A, B, and C.** The common theme is that these projects have been validated but they require unique expertise, substantial energy, and persistence to achieve "proof of use." This will require sustained funding and some risk, but these projects have very high ceilings that can help transform health care. Perhaps the strongest statement that can be made is that world-renowned experts in clinical informatics and intelligent health care are willing to relocate to Nebraska for the opportunity that we present. Appendix A is a demonstration project within the Good Data Core, Appendix B within the Human and Computer Cognition Core and Appendix C within the Computational Intelligence

Core. The first two years will also be used to create a strategic plan to coordinate the researchers on the three campuses into larger, sustainable functional focused units; to move from scattered individual investigators into a world-class center focused factory.

It should be noted that The Center will interface with intercampus efforts in Bioinformatics and other Big Data projects, but at the outset, we are concentrating on Clinical Informatics and artificial intelligence to optimize human and computer cognition.

9. <u>Expected Outcomes.</u>

The expectation is that the Center for Intelligent Health Care will be a world leader in optimizing human and computer cognition for the benefit of clinicians and patients. It starts with partnering with iExcel and Nebraska Medicine. It will require the creation of a new business model for the University of Nebraska. It is a center that relies on not only grants, contracts and philanthropy, but also the creation of new businesses and business relationships that create a self-sustaining Center and new job development for Nebraska.

10. <u>Metrics of Success.</u>
The metrics of success will be measured by manuscripts, grants, and contracts. It will be measured by the matriculation of undergraduate, graduate and post-docs into careers in clinical informatics and artificial intelligence. It will be measured by the success of transforming great concepts into solutions that improves the lives of clinicians and health of their patients, and the creation of new businesses in Nebraska.

Appendix 1

Budget Justification:

The Center for Intelligent Health Care is creating a completely new model for the University. We are proposing to create solutions that will fundamentally alter healthcare. Solutions that have eluded other Universities, Corporations, and the Government.

It starts with a faculty and staff with unique skills and experience. They will require substantial protected time to build out, validate, and produce viable solutions. While not represented on the above spreadsheets both UNO and UNL will contribute researcher and student time for the Center.

The Good Data Core will build off the work of Drs. Tcheng, Bray, Campbell, Campbell, and McClay to create data that has the liquidity that can be captured in the electronic health record in the course of daily work and move seamlessly to quality organizations and payers. Drs. Tcheng and Bray have strong ties to two of the best programs in the Country, Duke and Utah respectively. We anticipate using the teams at these two programs as consultants as we slowly build permanent positions within the Center.

The Algorithm and Analytics Core will pair UNO and UNL faculty with clinical and research faculty at UNMC and Nebraska Medicine to create the best solutions. We expect the Core Director for Algorithms and Analytics be a joint appointment with one of the undergraduate campuses. We expect to provide salary support so that the Director will be on a 12 month contract.

The Core for Artificial Intelligence and Human Cognition will extend the usability and prototyping lab that Dr. Windle's has established. We will make full use of the iExcel building to test and validate our solutions. The prototyping lab will allow us to test various solutions that try to optimize human and computer cognition. We expect to partner with Dr. Ash and his team to accelerate the adoption of best practices to Nebraska Medicine, this will include our faculty and staff becoming Epic-certified so that we can extend the resources of Nebraska Medicine.

A key hire will be the Administrative Director for the Center. This will require someone with a unique set of skills and will require commensurate compensation. The Administrative Director needs to have direct experience in the healthcare system, can speak to scientists and researchers, can negotiate the hierarches of the University of Nebraska and Nebraska Medicine. This person will need to work with the Nebraska Business Development Center to build business proformas, work with the NU Foundation for donors, and needs to be able to negotiate and execute on grants and contracts with industry.

There will be substantial travel involved in the development of business opportunities (contracts and consultation) through the Center. We will need to create one or two conferences annually where we bring in leaders in AI to the campus to work with our faculty.

We anticipate by year 3 we will have created revenue streams from philanthropy, grants, contracts, consultation, and royalties to reduce personnel expenses and allow growth. The oversight committee will approve budgets and new positions.

TABLE 1: PROJECTED EXPENSES
UNMC Center for Intelligent Health Care

Personnel	(FY2020-21) Year 1		(FY2021-22) Year 2		(FY2022-23) Year 3		(FY2023-24) Year 4		(FY2024-25) Year 5		Total
	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost	FTE	Cost	Cost
Director		$0		$0		$0		$0		$0	$0
Faculty (see operating line below)[1]	-	$0	1.00	$0	1.00	$0	0.50	$0	0.50	$0	$0
Non-teaching staff: Professional	1.33	$113,269	4.25	$430,000	4.25	$442,900	4.25	$456,315	4.25	$469,872	$1,912,356
Graduate Assistants[2]	1.00	$40,000	3.00	$80,000	8.00	$300,000	13.00	$597,400	18.00	$912,374	$1,929,774
Subtotal	2.33	$153,269	8.25	$510,000	13.25	$742,900	17.75	$1,053,715	22.75	$1,382,246	$3,842,130
Benefits (21%)		$32,186		$107,100		$156,009		$221,280		$290,272	$806,847
Total Personnel	2.33	$185,455	8.25	$617,100	13.25	$898,909	17.75	$1,274,995	22.75	$1,672,518	$4,648,977
Operating											
General Operating[3]		$0		$25,000		$25,000		$100,000		$125,000	$275,000
Equipment for Center		$35,000		$25,000		$25,000		$75,000		$75,000	$235,000
Consultants[4]		$0		$25,000		$25,000		$25,000		$25,000	$100,000
Travel[5]		$30,000		$25,000		$25,000		$50,000		$50,000	$180,000
Facilities[6]		$0		$25,000		$25,000		$100,000		$100,000	$250,000
Start-up Grants[7]		$0		$0		$0		$400,000		$500,000	$900,000
Subcontracts[8]		$0		$0		$0		$500,000		$1,000,000	$1,500,000
Subtotal		$65,000		$125,000		$125,000		$1,250,000		$1,875,000	$3,440,000
Total Expenses		$250,455		$742,100		$1,023,909		$2,524,995		$3,547,518	$8,088,977

[1] Expenses will be adusted to match contract/grant support.

[2] The first two years are covered by start-up funds; Years 3- 5 are contingent on obtaining grants.

[3] Funds for computer software and hardware, and website maintenance.

[4] The Center will rely on consultants with limited employees until secure independent funding is obtained.

[5] Funds for travel are necessary for business and national presentations.

[6] There is no new space identified for the Center; funds will support facility upgrades.

[7] Pilot grants are dependent on the Center's financial sustainability.

[8] We anticipate to support faculty at other institutions through subcontracts.

TABLE 2: PROJECTED REVENUES
UNMC Center for Intelligent Health Care

	(FY2020-21) Year 1	(FY2021-22) Year 2	(FY2022-23) Year 3	(FY2023-24) Year 4	(FY2024-25) Year 5	Total
DDIF Admin[1]	$500,000	$500,000	$0	$0	$0	$1,000,000
Philanthropy[2]	$0	$0	$500,000	$2,000,000	$2,000,000	$4,500,000
Grants[3]	$0	$0	$200,000	$500,000	$750,000	$1,450,000
Contracts[4]	$100,000	$250,000	$500,000	$2,250,000	$3,000,000	$6,100,000
Royalties[5]	$0	$0	$0	$250,000	$500,000	$750,000
Total Revenue	$600,000	$750,000	$1,200,000	$5,000,000	$6,250,000	$13,800,000

[1] The College of Medicine (COM) will provide these funds. Funding originates from the Nebraska Medicine Academic Program Funding Agreement and the COM Department of Cellular and Integrative Physiology. (DDIF = Deans Development Investment Funds.)

[2] The UNMC Capital Campaign Initiative will be harnessed to provide philanthropic funding to support the Center.

[3] The Center will take 18-24 months to gain extramural research funding.

[4] The Center will build products that have commercial value either through consultation or contracts.

[5] This anticipates royalties will be produced through product development and partnerships with industry.