Professional Enrichment Course

University of Pittsburgh School of Medicine
Office of Medical Education

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Course Name: Biomedical Innovation

Enrollment Period:	2023-2024
Course Dates:	Each seminar date will be sent out via email and Slack at least 1 month in advance. Seminars will be held within each corresponding organ block throughout the MS2 curriculum.
Student Max:	None
Class Year:	MS2
Course Director:	Dr. Neeraj Gandhi neg8@pitt.edu
Course Administrator:	Student administrators: Sara Cao (yuc238@pitt.edu), Chris Schumacher (chs375@pitt.edu), Sam Adida (saa412@pitt.edu), Nick D'Angelo (nvd7@pitt.edu)
Location:	Each seminar location will be sent out via email and Slack at least 1 month in advance.
Registration:	Registration is not needed for this course.
Course Description:	This lunch seminar series focuses on emerging technologies across various fields of medicine. The series will run in parallel with the Organ Systems blocks. Each seminar will focus on an example of biomedical innovation within the current organ block, presented by faculty/researchers involved in the development or use of the new technology. The course will guide students in learning how technology and medicine are interwoven, and provide examples of how clinicians can participate in innovation. In addition, students will gain knowledge of upcoming developments across various specialties of medicine.
Objectives:	● Show students how technology can impact patient care across all disciplines of medicine ● Help students conceptualize how they may incorporate innovation within their clinical career
Pre-Requisites:	None
Requirements:	Attend at least 4 scheduled course sessions out of 8
Texts:	None

Topics covered may vary based on speaker availability. Below are sample session topics.

Cardiology: Valvular heart disease represents a formidable disease burden, with the number of valve replacements expected to reach 850,000 globally by 2050. While a variety of solutions are currently utilized, these solutions all have considerable limitations in terms of their durability, ability to adjust to physiological changes, immunogenic/thromboembolic complications, and ease of implantation. In situ tissue engineering is a potential strategy that utilizes a substrate upon which endogenous cells can undergo tissue formation. This may be particularly impactful for pediatric patients, for whom durability and adaptability of valve prostheses are of great concern.

Suggested readings:
https://www.jtcvs.org/article/S0022-5223(18)33112-X/fulltext
https://www.nature.com/articles/s41569-020-0422-8

Renal: Renal replacement technology is vital for patients suffering from end stage renal disease. New innovations aim to not only achieve full kidney functionality, but also do so in a way that does not impede patient mobility or limit lifestyle, which have traditionally been challenges for current-generation devices. For example, implantable bioartificial kidneys aim to mimic natural glomerular filtration and take advantage of blood pressure to induce filtration, eliminating the need for an external power source.

Suggested reading:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9902727/

Pulmonology: Pulmonary function is a central and continuously essential aspect of human medical functioning. It is especially important in the field of critical care medicine, where patients' lung function is often compromised due to sepsis, shock, trauma, and preexisting conditions. The recent pandemic, which was marked by profound respiratory effects and resulting equipment shortages, highlighted the pressing need for technological advancement and innovation in the field of pulmonology. 3D cell culturing has allowed researchers to apply patient-derived lung tissue cultures to test potential novel drugs for lung repair and regeneration in an individualized manner. Additionally, the field of sleep medicine has experienced numerous breakthroughs in recent years with the advent of at-home sleep apnea test improvements for a previously underdiagnosed condition.

Kapoor, M., & Greenough, G. (2015). Home Sleep Tests for Obstructive Sleep Apnea (OSA). Journal of the American Board of Family Medicine : JABFM, 28(4), 504–509. https://doi.org/10.3122/jabfm.2015.04.140266

Honkoop, P., Usmani, O., & Bonini, M. (2022). The Current and Future Role of Technology in Respiratory Care. Pulmonary therapy, 8(2), 167–179. https://doi.org/10.1007/s41030-022-00191-y

GI: The fields of gastroenterology and hepatology are evolving rapidly. Recent breakthroughs in DNA sequencing have allowed for the development of in-home screening tests for colorectal cancer, making care accessible to a larger population with expected increases in demand and expansion into other realms of GI pathology in the coming years. In addition, minimally invasive, endoscopic procedures – the most common diagnostic procedure performed by the GI specialty, are continuing to disrupt the entire surgical world and the integration of AI into these procedures has the potential to continue to dramatically alter the field in the coming years. This is evident in both upper and lower GI tract pathologies as it has particularly shown value in determining neoplastic versus non-neoplastic lesions in less experienced endoscopists.

Sinonquel, P., & Bisschops, R. (2021). Striving for quality improvement: can artificial intelligence help?. Best practice & research. Clinical gastroenterology, 52-53, 101722. https://doi.org/10.1016/j.bpg.2020.101722

https://www.beckersasc.com/gastroenterology-and-endoscopy/gastroenterology-in-2030-what-the-specialty-will-look-like-in-10-years.html

Musculoskeletal/Dermatology: Total shoulder, hip, and knee arthroplasty are rapidly evolving surgical techniques in the past several decades, with innovative technological strategies being developed and implemented in order to achieve optimal hardware precision, joint alignment and stability, preserve implant longevity, and improve patient outcomes after surgery. Future advancements for this technique include robot-assisted surgeries, augmented and mixed reality, artificial intelligence and machine learning, patient-specific instrumentation, and preoperative planning tools. Robot-assisted arthroplasty is an emerging alternative to the conventional arthroplasty procedure in the shoulder, hip, and knee, and may be completely integrated into the practice of orthopedics within the next decade.

Suggested readings:
https://pubmed.ncbi.nlm.nih.gov/37263482/
https://pubmed.ncbi.nlm.nih.gov/37105324/
https://pubmed.ncbi.nlm.nih.gov/35491420/

Hematology: Gene therapy has become one of the most promising approaches to reducing or eliminating various diseases in recent years. A potentially curative process of integrating novel genetic material into target mutated cells via a vector, like recombinant adeno-associated virus, allows for transcription and translation of functional genes. Numerous inherited hematologic diseases are subjects of extensive research into potential gene therapy cures, such as hemophilia, sickle cell disease (SCD), and beta-thalassemia. Last August, a novel gene therapy for beta-thalassemia, Zynteglo, was approved by the FDA. Utilizing a patient's own hematopoietic stem cells, Zynteglo modifies the genes associated with faulty beta hemoglobin to produce a functional variant. A patient with beta-thalassemia often requires blood transfusions every 2-5 weeks. At least 89% of patients in clinical trials for Zynteglo saw transfusion independence.

Suggested readings:
https://pubmed.ncbi.nlm.nih.gov/31322165/
https://pubmed.ncbi.nlm.nih.gov/29669226/
https://www.fda.gov/news-events/press-announcements/fda-approves-first-cell-based-gene-therapy-treat-adult-and-pediatric-patients-beta-thalassemia-who

Endocrine: Applications of artificial intelligence and cognitive computing offer promise in diabetes care. Over the past ten years, diabetes management has been transformed due to the integration of new technologies such as continuous glucose monitoring devices and the development of the artificial pancreas, along with the exploitation of data acquired by applying these novel tools. However, despite the increasing adoption of insulin pumps and continuous glucose monitoring devices, most people with diabetes do not achieve their glycemic goals. This could be related to a lack of expertise or inadequate time for clinicians to analyze complex sensor-augmented pump data. Machine learning algorithms have been developed to identify dangerous insulin regimens. Additionally, models have been used to improve glycemic outcomes and prevent life-threatening complications in people with type 1 diabetes.

Suggested readings:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6000484/
https://pubmed.ncbi.nlm.nih.gov/32694787/
https://pubmed.ncbi.nlm.nih.gov/32908282/

Reproductive and Developmental Biology: 1 in 3 women seek treatment for Heavy Menstrual Bleeding (HMB), in the US. Recent innovation, Cryoablation, has introduced a novel way to treat HMB with minimal damage to reproductive organs. Cryoablation triggers cellular destruction, by subjecting the targeted endometrial tissue to freezing temperature, resulting in reduced menstrual bleeding in subsequent cycles. Over time, the treated tissue sheds, leading to a thinner endometrial lining and lighter periods. One of the notable benefits of cryoablation is its fertility-sparing nature, making it suitable for women who desire future pregnancies. Unlike certain surgical procedures or other methods that utilize heat, cryoablation does not result in scar formation within the endometrium, nor does it typically interfere with a woman's ability to conceive and carry a pregnancy.

Suggested readings:
https://pubmed.ncbi.nlm.nih.gov/29128205/
https://pubmed.ncbi.nlm.nih.gov/22360696/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9379116/