

Mayo Clinic Comprehensive Cancer Center and Cancer Research Karolinska Institutet Cancer Research Collaborations

Possible Areas of Research Topics for Large Synergistic Grants 2027-2031 Special Focus on REDI (Risk assessment, Early Detection and Interception) and artificial Intelligence (AI) and Data Driven Life Science (DDLs)

Funding of Larger Synergistic Grants for Cancer Research Collaborations between Mayo Clinic Comprehensive Cancer Center (MCCCC) and Cancer Research Karolinska Institutet (CRKI) will be announced for 2026-2028. This RFA will focus on REDI (Risk assessment, Early Detection and Interception), with a special emphasis on breast and hematologic malignancies.

Breast Cancer and Other Solid Tumors Hematological Malignancies, and Advanced Emerging Tools and Technologies

As uniquely strong areas of research at both institutions where synergies are likely to arise in collaborative research areas, while other areas may also be considered. Projects utilizing and/or developing novel algorithms and methodologies in **Artificial Intelligence (AI) and Data Driven Life Science (DDLs)** are especially encouraged, provided that adherence to current legislation in Sweden and USA as well as protection of patient integrity is fully guaranteed and explained in the RFA.

For examples of research topics identified to have synergistic potential in collaborations between MCCCC and CRKI, see below. These areas of potential synergy have been identified with the help of three Task Forces with the following experts:

Breast Cancer Task Force:

MCCCC

Celine Vachon – Co-Chair
John Hawse – Co-Chair
Matthew Goetz
Jim Ingle
Amy Degnim
Mark Sherman
Rick Bold

CRKI

Linda Lindström – Co-Chair
Renske Altena – Co-Chair
Jonas Bergh
Jana de Boniface
Ioannis Zerdes
Yvonne Wengström
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Fredrik Strand

Hematologic Malignancies Task Force:

MCCCC

Tom Witzig – Co-Chair
Greg Nowakowski
Sameer Parikh
Jim Cerhan
Shaji Kumar
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CRKI

Co-chair: Martin Jädersten
Päivi Östling
Martin Jädersten
Tom Erkers
Kristina Sonnevi
Mattias Carlsten

Tools & Technologies Task Force:

MCCCC

Tufia Haddad – Co-Chair
Akhilesh Pandey – Co-Chair
Aadel Chaudhuri
Peter Lucas

CRKI

Co-Chair: Thuy Tran
Ola Larsson
Janne Lehtiö
Brinton Seashore-Ludlow
Avlant Nilsson

Breast Cancer and Other Solid Tumors

The Breast Cancer Task Force identified key areas within REDI, emphasizing the following needs:

- ****Prevention:****
 - Strategies to prevent breast cancer through early identification of benign disease and interventions in high-risk individuals
 - Preventing recurrence post-diagnosis via (neo)adjuvant treatments
- ****Longitudinal Studies and Early Lesion Evaluation:****
 - Studying benign disease development in patients with previous invasive cancer
 - Exploring immune and humoral responses, including circulating antibodies
 - Drug prevention trials using repeated FNAs and omics analysis of single cells
 - Long-term risk tracking, especially in ER-positive cases
- ****Research in Young Women:****
 - Biological and phenotypic profiling of breast cancer in younger women, including pregnancy-associated cases

Challenges Addressed Through Collaboration:

- Limited tissue availability for biomarker studies in benign lesions can now be mitigated through advanced mass spectrometry
- Broader lesion spectrum studies are needed due to heterogeneous progression
- Cross-institutional datasets are available and can be merged for robust analyses

Institutional Resources Needed:

- Legal and GDPR expertise for dataset integration
- AI and data science personnel

Top 3 Priority Areas:

1. Breast cancer in young women – spanning tumor biology, genetics, exposome, and immune profiling
2. Immune-tumor interactions and treatment response in neoadjuvant settings
3. AI-driven dynamic risk prediction using imaging and exposome data

Key Resources:

- ***Mayo:** BEAUTY trial, ER+ registry, Mayo Biobank, Olmsted screening cohort
- ***Karolinska:** STO trials, KARMA, Libro 1, TEX/PROMIX studies, PREDIX trials, SENOMAC, OptiTrain, SBG studies

Hematological Malignancies

The Hematologic Task Force identified several critical areas under REDI:

- ****Risk Assessment:****
 - TP53 mutation profiling
 - AI-based digitized sample analysis
 - Epigenetic age studies (EpiAge)

- Nutritional impacts on immune function
- Inflammatory markers (OHI Index).
- ****Early Detection:****
 - Monitoring precursors like MBL and CHIP
 - Liquid biopsy usage
- ****Interception:****
 - Trials of p53-targeting agents
 - Combating drug resistance in AML
 - Interventions for high OHI index patients

Collaboration Potential:

These topics involve overlapping expertise and available resources, including large biobanks, digitized samples, and registries. Cross-validation, pooled data, and rare subgroup analysis are viable with Mayo and KI collaboration.

Institutional Resources Needed:

- Dedicated AI development for hematology
- Resource allocation to support implementation

Top 3 Priority Areas:

1. High-priority clinical trials targeting TP53 and OHI-defined subgroups
2. Validation of digital and epigenetic biomarkers
3. Nutritional modulation and immune function trials

Key Resources:

- ***Mayo:** Large annotated biobank, p53 and OHI data, access to ECOG trials
- ***Karolinska:** EWAS trials, Vitamin D/C studies, HLH expertise, large liquid biopsy cohorts

Advanced Emerging Tools and Technologies

The Tools & Technologies Task Force highlighted two unique platforms:

- ***Karolinska's Molecular Tumor Board (MTB):** Integrates multi-modal data to support personalized treatment planning
- ***Mayo's Cancer Care Beyond Walls:** Enables remote risk assessment and biospecimen collection

Identified Needs:

- Standardization of scoring systems and cut-offs across technologies
- Rigorous case selection methodologies
- Expanded use of non-genomic technologies
- AI integration with structured multi-modal data

Scope and Collaboration Opportunities:

Develop a harmonized framework to showcase cross-technology case studies, standardize MTB guidelines, and organize integrated datasets for AI-driven applications.

Institutional Resources Needed:

- Access to core technologies and dedicated personnel
- Administrative support to secure institutional backing and ensure GDPR compliance

Top 3 Priority Areas:

1. Standardized and harmonized MTB frameworks
2. Integration of emerging tech for comprehensive case understanding
3. Robust data infrastructure for AI-driven interpretation

Key Resources (Selection):

- *Karolinska:* Spatial transcriptomics, proteomics, CRISPR, imaging, molecular pathology, biobanking, Pixelgen spatial proteomics, AI in histopathology
- *Mayo:* Single-cell proteomics, spatial multi-omics, metabolomics, long-read sequencing, iPSC/organoid development, advanced imaging and AI platforms

Detailed Descriptions of Identified Areas of Synergistic Potential as Identified by the Three Task Forces Follow this Page

Breast Cancer and Other Solid Tumors

What needs did your task force identify in the area of REDI (Risk assessment, Early Detection and Interception)?

1. Primary, secondary and tertiary prevention of breast cancer:
 - Prevention of breast cancer using early benign disease and risk for development of invasive cancers
 - Prevention of breast cancer in high-risk individuals based on interventions such as tamoxifen
 - Prevention of recurrence following diagnosis of breast cancer, e.g. through (neo-) adjuvant treatment
2. Longitudinal evaluation of benign vs disease status (and vice versa):
 - Diagnosis/biopsy findings of benign disease following previous diagnosis with invasive cancer
 - Immune and humoral responses in early lesions, circulating antibodies for detection of breast cancer
 - Trial of drug prevention using FNA to repeatedly sample tissue over time and use these single cells for transcriptomics/proteomics etc.
 - For example, high risk patients put on an intervention such as TAM or exercise and perform repeated FNAs, comparing effects of two drugs over a shorter time, two interventions etc.
 - Long-term follow-up studies of breast cancer patients to understand late risk (for ER-positive cancer).
3. Understanding the biology and phenotypes of breast cancer in young women (pre- vs post-menopausal; pregnancy-associated breast cancer).

What is the scope of the problem areas, and can these be addressed through collaborative research?

- Tissue based biomarkers (RNA, protein) is very difficult in the benign setting due to small amounts of tissue. To date, these types of studies have failed to improve risk stratification.
 - Opportunity here based on improvements in mass spec technology and can use 10's-100's of cells now.
- Scale is an issue. Focusing only on the benign lesion may be problematic as frequently cancer develops in the other breast or in a different quadrant.
- Such studies need to span all types of lesions in the benign setting that represent the entire spectrum of progression.
 - Accessible datasets that can be pooled - interacted - merged: see pages below for overview of trials at Mayo and at KI.
- Late recurrence that is difficult to predict currently and of great concern for patients especially premenopausal with many years at risk. At twenty years after diagnosis - closing gap of risk between low and higher risk patients.

What level of funding do you anticipate is required to address the stated problems?

- KI Team: The current funding allocation by the Executive Committee (3 x 1 MSEK per PI) may not be sufficient to coordinate projects as proposed. Integrating various methods and coordinating efforts will require substantial resources, time, and collaboration among multiple PIs from both KI and Mayo.
- Additionally, restrictions on sharing or shipping human samples between the U.S. and Sweden could further complicate projects.
- To address these challenges, funding should range from 3 x 3–8 MSEK per PI annually. However, the current lower funding level could serve as a proof-of-concept, with the potential for additional allocations in future calls.

In addition to your recommendation for funding, what additional institutional resources are needed?

- Assistance and coordination in integration and merging of datasets is needed, also in terms of legal and GDPR issues.
- Access to AI resources and personnel with expertise.
- These resources should provide earmarked access or dedicated support, potentially secured through the Executive Board or similar channels.

Please provide the top 3 problems that your task force recommends addressing.

1. Breast cancer in young women (multiple areas to be explored, including tumorigenesis, exposome, epigenetics, genetics, proteomics).
2. Influence of tumor-immune microenvironment on response to therapy: neoadjuvant setting with serial samples.
3. AI/machine learning of radiology images and pathology images to improve short and long-term risk –dynamic risk using multiple images--could specifically focus on younger women with dense breast given recommendations for all to have MRI or imaging integrated with exposome to inform risk.

Resources:

Mayo (with a focus on young women):

1. Dr. Ingle adjuvant clinical trials in premenopausal women (we are determining what clinical tissues/blocks are available).
2. BEAUTY (neoadjuvant trial of standard chemotherapy for locally advanced breast cancer) (2/3 of the population were premenopausal).
3. Mayo Clinic ER+ registry. This is currently being developed/abstracted but will include >2000 patients with early-stage ER+/HER2- breast cancer, and about 800 will be premenopausal.
4. 2000+ premenopausal BC patients with blood, genetic sequence/genotyping data and follow-up (epidemiologic study).
5. P1 and P2 clinical trials.
6. Mayo Biobank, consisting of a 2D mammography cohort of 12,000 with median 11 years follow-up/ WES, GWAS and images all available; deep questionnaire and EHR data.
7. Olmsted population-based screening cohort with f-up; 2D, 3D images of over 40,000 women.

Karolinska:

1. Linda Lindström PI for the STO-trials including approximately 2500 breast cancer patients with detailed clinical information and at least 25 years of follow-up as well as whole tumor IHC information med images for the breast cancer markers and whole-genome gene expression data. The STO-5 trial only includes premenopausal patients (see Johansson and Lindström et al, JCO 2022).
2. KARMA prevention study with PIs Per Hall and Kamila Czene.
3. Libro 1 - well annotated breast cancer cohort within the KARMA cohort. PI Kamila Czene.
4. For epidemiological studies to understand incidence and risk trends we also have both regional and national registers in Sweden including all Swedish citizens using the personal number to merge different types of data.
5. Translational clinical trials TEX and PROMIX studies including primary tumor and metastatic sampling with Thomas Hatcheck as PI.
6. ScreenTrustCAD and other studies headed with Fredrik Strand as PI including screening mammogram images.
7. PI Jana de Boniface – clinical data and long-term outcomes SENOMAC trial, Stockholm DCIS trial.
8. Yvonne Wengström – longterm FU OptiTrain trial on physical exercise.
9. Neoadjuvant:
 - PREDIX HER2: Randomized phase II clinical trial, comparing neoadjuvant Trastuzumab, Pertuzumab, and Docetaxel (DHP) with Trastuzumab Emtansine (T-DM1) in Patients With HER2-positive Breast Cancer. (Study Chair: Associate Professor Thomas Hatschek; Study Director: Professor Jonas Bergh) (longitudinal multi-omics data available).
<https://pubmed.ncbi.nlm.nih.gov/34165503/>

- PREDIX Luminal B: Prospective randomized phase II Swedish trial for patients with HR-positive/HER2-negative breast cancer (more than 20 mm and/or with lymph node metastasis), randomized 1:1 to receive either paclitaxel weekly for 12 weeks followed by palbociclib and endocrine therapy for 12 weeks (Arm A), or the reverse sequence (Arm B). All patients received three cycles of adjuvant epirubicin and cyclophosphamide. Primary endpoint was rates of objective radiologic response at 12 weeks (ORR12). Secondary endpoints included pathologic complete response (pCR), event-free survival (EFS), safety, and health related quality of life (HRQoL). (Principal Investigator: Associate Professor Thomas Hatschek). [https://www.esmooopen.com/article/S2059-7029\(24\)00878-0/fulltext](https://www.esmooopen.com/article/S2059-7029(24)00878-0/fulltext)
- PROMIX: A Phase II Study. Preoperative Treatment of Breast Cancer with a combination of Epirubicin, Docetaxel and Bevacizumab. A Translational Trial on Molecular Markers and Functional Imaging to Predict Response Early (Principal Investigator: Associate Professor Thomas Hatschek). <https://pubmed.ncbi.nlm.nih.gov/38714665/>
- EORTC 10994/BIG 1-00: A randomized phase III trial. First Prospective Intergroup Translational Research Trial Assessing the Potential Predictive Value of p53 Using a Functional Assay in Yeast in Patients With Locally Advanced/Inflammatory or Large Operable Breast Cancer Prospectively Randomized to a Taxane Versus a Non-Taxane Regimen (Study Chair: Professor Herve Bonnefoi) [PI Sweden: Professor Jonas Bergh]. <https://pubmed.ncbi.nlm.nih.gov/21570352/>
[https://www.annalsofoncology.org/article/S0923-7534\(23\)01341-8/fulltext](https://www.annalsofoncology.org/article/S0923-7534(23)01341-8/fulltext)

10. Adjuvant:

- PANTHER: A Randomized Phase III Study Comparing Biweekly and Tailored Epirubicin + Cyclophosphamide Followed by Biweekly Tailored Docetaxel (dtEC→dtT) Versus Three Weekly Epirubicin + Cyclophosphamide + 5-fluorouracil Followed by Docetaxel (FEC→T) in Lymph Node Positive or High-Risk Lymph Node Negative Breast Cancer Patients (Principal Investigator: Professor Jonas Bergh). <https://pubmed.ncbi.nlm.nih.gov/27825007/>
<https://pubmed.ncbi.nlm.nih.gov/39018515/>
- SBG 2004-1: A randomised feasibility/phase II study with dose-dense/tailored epirubicin, cyclophosphamide (EC) followed by docetaxel (T) or fixed dosed dose-dense EC/T versus T, doxorubicin and C (TAC) in node-positive breast cancer (Principal Investigator: Professor Jonas Bergh). <https://pubmed.ncbi.nlm.nih.gov/29190004/>
- Retrospective early breast cancer patient cohorts, with available multi-omics data, tissue and plasma collection (>1000 patients).

Hematological Malignancies

What needs did your task force identify in the area of REDI (Risk assessment, Early Detection and Interception)?

Risk Assessment:

- TP53 mutations (including small subclones) important in most blood cancers – CLL, mantle cell lymphoma, myeloma (MGUS – SMM – MM – Relapsed), and MDS/AML. Several areas of common interest/ongoing projects.
- Digitization of tumor samples – DLMP ongoing project with goal of AI approach to prediction; also being done in KI.
- Epigenome-wide association studies (EWAS) for epigenetic age –predict outcomes, toxicity? Serial studies? Diet manipulations and effect on EpiAge. KI is planning a trial (Ungerstedt et al) to doing of

EpiAge pre-transplant and co-morbidities. Potential synergy there.

- Nutritional Immune Function – Mg Vitamins C and D - Need large validation cohort. Vitamin C –oral at ASH increased with Nordic MDS –Aza with oral Vitamin C.
 - Vitamin D – KI has Vitamin D and immune function.
 - Magnesium and T-cell function –CAR-T and Lymphoma.
- Inflammation - Predicting inferior outcomes in blood cancers using the Optimized Hemophagocytosis Inflammatory Index (OHI Index). Two easy blood biomarkers – ferritin and sIL2R predict high morbidity. Could validate this at KI and Mayo and seek intervention.
 - HLH review by KI team (Henter, NEJM Feb 2025). Much expertise at KI
- Valuable resources available at both sites
 - Liquid biopsies database – large cohorts at both sites (BioLymph at KI/Ekström-Smedby et al)
 - Large cell biobanks for various hematological disorders
 - Different analyses depending on local expertise could be performed at each site (e.g. high-throughput drug ex vivo screening at KI)
 - Large databases; Mayo has huge databases of many disease including rare types. KI/Sweden has access to multiple connectable registries (cancer, other diseases, prescribed drugs, generational/hereditary, socio-economy etc.)
 - Could be used to explore a number of issues, including long-term complications/adverse events, risk factors, hereditary factors
 - Rapidly assess emerging therapies by pooling data (BiTEs, targeted drugs, novel myeloma drugs just in AL amyloidosis etc.)
 - Possible to focus on rare subgroups by pooling data
 - Cross validation across both cohorts

Early Detection:

- MBL as a precursor state for CLL; also increases risk of infections and skin cancer –potential chemoprevention trial to prevent (Parikh at Mayo, Rosenqvist/Österborg and others at KI)
- MCED tests – as a monitor for FU and emerging second cancers – future maybe –too long a timeline
- CHIP assessment prior or during PARP inhibitors or Lutetium treatment of prostate or any radionuclide therapy – potential KI several groups working on it. Potential collaboration. The advantage of this would cross-cancer (not just blood cancers) – maybe tied to CAR-T

Interception:

- Trial of oral agents for p53 mutated blood cancers – any ready for MCL or CLL? Or a small trial that would take any p53 mutated cancer? KI would be interested in trial – maybe do separate trials to avoid regulatory hurdles. Huge interest in all blood cancers. KI has groups developing new drugs targeting p53 (Wiman et al)
- Targeting Cytarabine resistance with novel agents –for AML; Lymphoma – trials in progress at KI
- Targeting high OHI (optimized HLH inflammatory index) with novel agents; serial studies – do the markers normalize and if not does it signal relapse? This would be inflammatory idea – Gamifent/emapulumab trial in Israel –may be coming. Other agents may be of interest (anakinra, ruxolitinib, other novel drugs).

[What is the scope of the problem areas, and can these be addressed through collaborative research?](#)

Risk Assessment:

- TP53 mutations – likely 10-15% of newly diagnosed blood cancers
- Digital signal and AI approach for analysis – analysis of flow cytometry
- Epigenetic Age – all patients would qualify; pre transplantation, induction chemo, CAR-T –might be a relevant patient population to focus on
- OHI Index – about 15-20% of patients are considered high risk

Early Detection:

- Would require screening – OR use our large existing biobank to perform testing

- MCED tests – no need to do population screening – that is ongoing with GRAIL and EXACT; rather – take treated DLBCL etc. and monitor as a marker for relapse or new diseases. Likely not a good pilot because of duration of FU needed.
- CHIP assessment prior or during PARP inhibitors or Lutetium treatment of prostate or any radionuclide therapy – if we include ONC we could get enough patients

What level of funding do you anticipate is required to address the stated problems?

- Too soon – until we know what project – we can then come up with a budget
- We are interested in small pilot trials phase I/(II) - KI has exceptional drug development pipelines making trials with correlatives attractive, Mayo may have better access to pharma developed novel drugs. However, we would need to assess regulatory hurdles. Rather than do the exact same trial we could do companion pilots.
- We could leverage the Mayo/KI Collaboration in concert with company funding or other philanthropy to accelerate the research.

In addition to your recommendation for funding, what additional institutional resources are needed?

- We both seem to have the cores including AI groups – may need KI Heme specific AI expertise. We have one person specifically working with us in Hematology; plus our HemePath AI group (focusing on samples)
- Probably the biggest additional institutional resource need is funding to make it happen.

Please provide the top 3 problems that your task force recommends addressing.

- We have no lack of ideas. We (TEW and MJ) will circulate to our committee at the same time as the Executive Group meeting Monday March 3. Once we learn of scope...narrow our priorities.

Resources:

Mayo (with a focus on lymphoma – myeloma – and CLL):

1. Large biobank with samples that have been collected and outcome annotated
2. Digitized slides on thousands of cases but no AI outcomes analysis
3. P53 status known for sure on CLL and Myeloma
4. Good preliminary data on OHI in Lymphoma – need an intervention\
5. EpiAge analysis pre and post as a predictor of tox
6. Access to ECOG trials for samples – Myeloma – CLL and Lymphoma

Emerging Advanced Tools and Technologies

What needs did your task force identify in the area of REDI?

The task force group at KI has identified a key platform/area at KI: the Molecular Tumor Board (MTB), i.e. a process in which we integrate data from various technologies, such as global genomic databases, molecular profiling data to provide clinicians with state-of-the-art information facilitating design of personalized treatment plans. Its implementation has streamlined the process by reducing time required for complex evaluations, thereby expediting initiation of tailored treatments.

Although the approach seems to work well, there are several challenges that can be addressed:

1. Despite vast amounts of data, there is **no standardized or consensus** regarding cut-offs and scoring systems.
2. Many cases are handled **ad hoc**, with inconsistent case selection and limited systemic validation.
3. **Technologies beyond genomics** (see methods in the table) that could provide a more complete understanding of the patient/cases are essentially not used.

At Mayo Clinic, the Cancer Care Beyond Walls platform, is being developed to enable risk assessment and screening to occur via digital health technologies and biospecimen collection at home or in the local community. While initially serving Mayo Clinic investigators and patients regardless of their site of care, the aim is to make this platform available globally for research teams and patients/participants. The aforementioned MTB could be expanded to incorporate remote multi-modal data collection and AI-generated care plan recommendations to be validated/modified by the tumor board.

What is the scope of the problem areas, and can these be addressed through collaborative research?

- How can co-develop a “proof-of-concept” framework, where we at a high scientific level address and identify cancer cases that will give us N1 elucidation (moving away from ad hoc studies).
- How can we standardize and increase readiness with a showcase of cross-technology case studies (such as showing for example 10 patient cases in a certain cancer type)
- How can we establish scientific rigor in case selection: establish criteria
- How do we build and organize a data series structure? (Design and links molecular, clinical, imaging data? And AI?)

Consensus was for the KI and Mayo Clinic to develop a RFA to enable co-development of similar or complementary emerging tools/technologies that would provide a competitive advantage for this collaboration. It is recommended that this not be limited in scope by disease or tech. The scoring guidelines for proposals could prioritize those that build upon established synergy of emerging tools and tech and/or those that would advance prioritized initiatives by focused disease groups. The end product(s) would become a shared resource to accelerate collaborative research within or beyond the breast cancer and hematologic malignancies focus groups.

What level of funding do you anticipate is required to address the stated problems?

The allocated funding by Executive Committee in this current call (3 x 1 MSEK) per PI will not suffice as it is insufficient to even fund one FTE (even more so in Sweden). The integration of different methods and the coordination would require heavy resources but also time, and very likely several PIs on each side (KI or Mayo) working together. The recommended funding to the stated problems should be in the range of 3x 3-8 MSEK(3 x \$280,000-750,000)/year per PI, which will allow our teams to accomplish something substantial instead of suboptimal results from a pilot study.

The problem of not being able to share/ship human samples and/or multi-modal data, if needed in the projects, between USA/Sweden might complicate the projects. Thus, the KI and Mayo Clinic teams should be free to work on their local samples to address the biomedical application/technology development goals (see below).

In addition to your recommendation for funding, what additional institutional resources are needed?

Several methodologies available at core facilities or local companies originating from KI and Mayo Clinic researchers could be required. These resources will need to allow ear-marked access or dedicated resources (of course by for example approach from the executive board).

Please provide the top 3 problems that your task force recommends addressing.

1. Standardize MTB Guidelines in harmonizing the approach and interpretation
2. Integration of emerging technologies (see example of technologies in appended table)
3. Building and organizing a data series structure that links together these data and make them readily accessible for AI/Machine-learning

SUMMARY RECOMMENDATIONS

- Technology developments for cancer research that can be applied on samples: we should be open and **push for technology developments.**
- Prioritize proposals that **advance current technologies**, build on the strong technologies for clinical translation, rather than create new technologies or tools.

Given the challenge associated with exchanging/shipping patient samples and/or sharing data, the team proposes to consider applications that use:

1. **Parallel data generation with shared methodology:** KI/Mayo uses the same methods, but work with their own patient samples. This still fosters synergy, as collectively generated data strengthens the overall findings.
2. **Stepwise technology transfer from preclinical to clinical use:** One partner focuses on in vitro/ex vivo materials while the other implements the technology in human patient samples. This allows for technology validation and seamless translation into clinical applications.
3. **Different technology, converging results:** Different technological approaches are used to address the same research question. This demonstrates that multiple methodologies can yield comparable and reproducible results, enhancing robustness.

Inventory of the key tools and technologies at KI	
Technologies	Possible PIs/researchers including core facilities
Spatial and single cell transcriptomics	Anja Mezger (core facility)
Proteomics/proteogenomics	Janne Lehtiö
Crispr Gene editing	(SciLifeLab KI facility)
Mass Spectrometry	Janne Lehtiö, Roman Zubarev
NGS	SciLifeLab facility is legally under KTH and Uppsala Univ.
Genomics	Microbiota, Lars Engstrand/ Panelseq Johan Lindberg, WGS: Richard Rosenquist Brandell; Ann Nordgren; Anna Wedell
Molecular Imaging (PET imaging) In vitro, in vivo, human Radiopharmacy, Theranostics	Thuy Tran, Rimma Axelsson
Molecular pathology	MTB-portal David Tamborero
Biobanking	Childhood cancer biobank, Johanna Sandgren
Drug screening small molecules, drug/probe synthesis (CBCS core facility)	Brinton
Transcriptomics	Also NGI?
Machine-learning	Histo pathology, Johan Hartmann/Mattias Rantalainen Avlant Nilsson
Cell barcoding	Kasper Karlsson
Spatial proteomics (Pixelgen)	The importance of Spatial Proteomics - Pixelgen Technologies
Digital long read sequencing (Basic genomics)	Basic Genomics
Liquid biopsies	Eva Tham Oscar Wiklander Samir El Andaloussi? Claudia Fredolini
Patient cohorts and PDX/organoids	Young BC patient cohorts, prog ER+, increasing incidence (both prevention and detection) PDX, organoids

Inventory of the key tools and technologies at Mayo Clinic	
Research Core/Lab	Technologies
Proteomics Core and Pandey Lab	Laser capture microdissection FFPE samples for mass spectrometry (LC-MS/MS) Single cell proteomics Imaging mass spectrometry (MALDI-based glycan and lipid imaging) Post-translational modification Immunopeptidome Olink HT Platform (~5,0000 cytokines/proteins) Human Proteome Microarray Peptide synthesis
Immune Monitoring Core	Hyperion and CyTOF platforms for mass spectrometry imaging, Phenocycler Fusion
Spatial Multi-Omics Core	NanoString GeoMx and CosMx platforms, 10X Genomics Visium HD with CytAssist, Vizgen MERSCOPE
Metabolomics Core	NMR and LC-MS based measurements of metabolites/lipids including amino acids, neuromodulators, fatty acids, lipids, and TCA cycle metabolites
Genome Analysis Core	WGS, WES, Whole transcriptome sequencing, miRNA sequencing, ChIP-seq, Methyl-seq, and single cell sequencing. Long-read sequencing (Oxford Nanopore and PacBio)
Stem Cell & Organoid Core	Skin fibroblast isolation, generation of human induced pluripotent stem cells (iPSCs), isolation and expansion of human tissue-derived adult stem cells
Cytogenetics Core	Karyotyping, FISH
Flow Cytometry Core	Multiple types of flow cytometers
Pathology Research Core	Histological staining, immunohistochemistry and IHC quantitation, tissue microarray construction, high-throughput digital imaging, and RNA in situ hybridization using RNAscope
Microscopy & Cell Analysis Core	Transmission, scanning, and serial block face 3D electron microscopy. Confocal and super resolution microscopy.
Biospecimens Accessioning and Processing Core	Specimen accessioning, specimen processing, RNA and DNA extraction, PBMC isolation and cryopreservation, biofluid processing, aliquoting, and cryopreservation, and long-term storage of samples in a dedicated cryostorage facility with robotic sample access.
Patient Cohorts, PDX and Organoids	<i>List of tools in development. Examples include</i>
Patient cohorts	-Mayo Clinic Biobank -Breast cancer registry -Metastatic breast cancer registry
PDX/Organoids	-Early stage and metastatic breast cancer PDX and organoids
Mayo Clinic Platform	
MCP_Discover	Solution for data discovery, big queries, AI model development, post-market surveillance
MCP_Validate	Solution to evaluate quality, bias, and accuracy of AI models in an IP secure environment

MCP_Deploy	Solution to integrate AI solutions into clinical workflows through EHR integration
Cancer Care Beyond Walls	(In development) – product to support cancer care delivery at home or the local community across the cancer continuum
Clinical Trials Beyond Walls	(In development) – product to support clinical trials and research conduct at home or the local community