Imaging Biomarker Roadmap for Cancer Studies

1. Basic Research
   - Chemistry, Physics, Engineering, Computing
   - Putative Pharmacologic BM
     - Establish biological validation for tumour-therapy pairings
   - Putative Screening BM
     - Identify BM method/technique & parameter
     - Biological Validation
       - Does the BM address an unmet clinical need?
       - Does suitable data exist to evaluate the BM?
         - Yes = Use existing data
         - No = Acquire new data
         - Technical Validation
           - Precision
             - Reproducibility
           - Accuracy
           - Availability
             - Hardware
             - Software
             - Ethical approval
             - Regulation
             - IP & Licensing
         - Relationship to Intervention
         - Biological Validation
           - Graded Evidence ‘Fit for Purpose’
             - Strength
             - Specificity
             - Effect gradient
             - Temporality
             - Consistency
         - Accuracy
   - Putative Diagnostic BM
     - Establish BM sensitivity, specificity and effect on diagnostic accuracy
     - Establish BM-outcome relationship for tumour-therapy pairings
   - Putative Outcome BM
     - Establish if BM identifies cancer before clinical symptoms and signs
     - Establish BM precision, multicentre reproducibility
   - Refine BM and establish SOPs for clinical use

2. BM Validation
   - Economic Viability
     - Scan Cost
     - Study Design
     - Phantom, Pre-clinical AND/OR Clinical Datasets

3. BM Qualification
   - Translational Gap 1
   - Translational Gap 2
   - Achieve objective 1: BM improves trial design
     - Multicentre
     - Healthcare Systems
   - Achieve objective 2: BM improves patient care
     - Improve BM/Study design
     - Screen Cost
     - Statistical Power
     - Comparison with Biospecimen BMs
     - Prospective Studies OR Analyse Existing Data
     - Health Benefit
     - Cost Effective
     - Prospective Large RCT
   - Relate BM with incidence & Estimate reduction in cancer mortality in RCT
   - Does BM improve clinical diagnosis?
   - Use BM to define randomisation in RCT and demonstrate improved outcome
   - Achieve objective 1: BM improves trial design
   - Achieve objective 2: BM improves patient care
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Key to Schematic Diagram:

- **Settings**: Place where BM discovery, validation, development and qualification occurs
- **Roadmap Stage**: How far has the BM progressed from discovery to qualification?
- **Research Disciplines**: Which science community or study design tests each Roadmap Stage?
- **Roadmap Question**: Key question to be addressed in order to proceed along Roadmap
- **Sub-study or Activity**: Aim of each science sub-study
- **Research Application**: Potential clinical application for putative BM

↓ Continue down Roadmap

↓ Continue down Roadmap and cross into new Roadmap Stage

--- Boundaries of Roadmap Stage

← Go back to re-examine previous steps

Notes:

1. The Imaging Biomarker Roadmap must be read in conjunction with existing Cancer Research UK generic roadmaps for biomarker research.
2. Imaging Biomarkers differ from non-imaging biomarkers in several key ways. These differences are highlighted in the online table entitled ‘Important factors to consider when validating and qualifying imaging biomarkers’ and are emphasised in the Imaging Biomarker Roadmap.