**Table 1: Nutrients/phytochemicals of interest and putative biomarkers for bioavailability & bioactivity endpoints**

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| **Nutrient** | **Biomarker for bioavailability** | **Molecules/Mechanism disturbed with deficiency** | **Health impact** | **Biomarkers of Health and Disease** | **Model Systems** |
| Calcium | Ca levelsCa kineticsBone mineral turnover | PTH hormone levelsLoss of boneShifts in microbiota | Osteoporosis | Bone densityMicroCT (bone architecture)\* translational work in humans | RodentHuman |
| Potassium | K kinetics | Rise in blood pressure, Lower BMDHigher NAE | HypertensionOsteoporosis | Blood pressureBone density | RodentHuman |
| Iron | Hemoglobin levels, Caco-2 model | HemoglobinFerritinSoluble transferrin receptor | NA | NA | RodentChickenHuman |
| Vitamin A | Vitamin A levels | Night visionImmune function | NA | NA | RodentChicken |
| Zinc | Zinc levels | Immune functionDNA integritymicrobiome | Infection susceptibilityInflammationCancer | Inflammatory markers/cytokinesOxidative stressDNA damage\*studies done in cell culture, animals and translation work in humans | *In vitro*RodentZebrafishHuman |
| Vitamin D | Vitamin D3 levels25(OH) vitamin D3 | Ca homeostasisLoss of bone | Osteoporosis | Bone densityMicroCT (bone architecture)\* translational work in humans | RodentHuman |
| Vitamin E | Vitamin E isomers & metabolite levels | Oxidative stress, inflammation, and systemic vitamin E trafficking | Nonalcoholic Steatohepatitis CancerVascular Dysfunction | Oxidative stressInflammation markersFatty liver pathologyPharmacokinetics\*studies done in animals and translational work in humans | *In vitro* digestion systemRodentsHumans |
| Folate | C-14-folate & metabolitesPolymorphismsHomocysteineMethyl PoolPlasma and RBC folate | Epigenetic alterationsMethylation changesDNA damage | CancerHeart DiseaseNTDAnemia | Homocysteine accumulationMethyl-pool alterationsDNA damageIncreased cancer risk\*studies done in cells, animals and translational work in humans | Human |
| B12 | B12 levelsTCII saturationMethylmalonic acid | Epigenetic alterationsMethylation changesDNA damage | CancerHeart DiseaseCognitionAnemiaDemyelination disease | Homocysteine accumulationMethyl-pool alterationsDNA damageIncreased cancer riskMemory tests\*studies done in cells, animals and translational work in humans | Human |
| Bioactive lipids | Lipid oxidative products, Bioaccessibility | Oxidative stress, inflammation, adipogenesis | Inflammatory diseases, obesity | Inflammatory markers, total fat accumulation | *In vitro*, *C. elegans,* Drosophila |
| Essential Amino Acids | Lysine, Methionine | Protein Biosynthesis  | Protein deficiency | Cognition, disease resistance,  | Animal feeding for protein efficiency |
| Dietary exosomes and their RNA and protein cargos | foreign RNAs (bovine, chicken, microbial) in plasma; plasma and urine metabolites (purines); mixed lymphocyte reaction; activation of Toll-like receptors | Loss of bovine- and chicken-specific microRNAs in plasma | Loss of antiviral response, loss of fecundity, aberrant metabolism of purines, impaired spatial learning and memory, increased susceptibility to seizures | plasma cytokines, plasma microRNAs, gut microbiome, cognitive performance, aberrant plasma and urine levels of purine metabolites | Humans (milk and egg feeding studies), mice (feeding AIN-93G-based diets, defined by their contents of bovine milk or chick egg exosomes and their RNA cargos |
| Soy isoflavones | Isoflavone metabolite levels | Estrogen metabolismAnti-inflammatory perturbationsmicrobiota | Bone healthCancerHeart Disease | Bone densityMicroCT (bone architecture)Inflammatory markers\*studies done in animals and translational work in humans | RodentsHumans |
| Green tea catechins | Catechins and host- and microbiota-derived metabolites | Gut-liver inflammatory and oxidative stress responses; adipogenesis | Heart DiseaseNonalcoholic SteatohepatitisObesityCancerCognition | Inflammatory markersOxidative stressFatty liver pathologyCancer riskLipid accumulation\*studies done in animals and translational work in humans | Ex vivo fermentation, *C. elegans,*RodentsHumans |
| Isothiocyanates | Isothiocyanate & metabolite levels | Epigenetic alterationsAltered detoxificationOxidative stressmicrobiota | Cancer | Epigenetic changesDetoxification pathwaysCancer risk/incidenceOxidative stress\*studies done in cells, animals and translational work in humans | *In vitro*RodentHuman |
| Indole-3-carbinol | Metabolite | adipogenesis | obesity | Total fat accumulation | *C. elegans,* Drosophila |
| Stilbenoids | Resveratrol, piceatannol | Adipogenesis, aging, antioxidative responses | Obesity, aging | Total fat accumulation, lifespan | *C. elegans* |
| Anthocyanins | Levels of anthocyanins and metabolites | Inflammation, Oxidative Stress, insulin signaling pathways, adipocyte differentiation | Obesity InflammationCVDcancerBone health | Inflammatory markersOxidative stressCardiovascular perturbationsAdipocyte growth/differentiationInsulin resistanceImpaired glucose toleranceBone Ca retention, BMD | RodentPigsRabbits |
| Nitrate and nitrite | Nitric oxide, nitrosothiols, nitroalkenes. nitroamines | Vascular function, blood pressure, efficiency of muscle contraction | CVD risk, chronic kidney disease risk, cognition | Endothelial dysfunction, increased blood pressure, reduced endurance upon physical exertion | RodentsZebrafish |
| Ellagitannins and ellagic acid  | Urolithins via gut microbial hydrolysis | Inflammation, oxidative stress, vascular function, blood pressure, efficiency of muscle contraction | CVD, obesity and cancer risk,cognition | Inflammatory markers,oxidative stress | Zebrafish |
| Egg and Dairy Proteins | N/A | Inflammation, oxidative stress, vascular function, blood pressure | CVD, diabetes, metabolic syndrome | Brachial artery flow-mediated dilation, oxidative stress, inflammation, cardiometabolic indices | Humans |

***Table 2: Active and Planned Collaborative Studies***

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| **Collaborative Studies** | **Participants** |
| Absorption and metabolism modeling | MA, NE, OH, OR, IA, IN |
| Biomarker discovery, assessment measurements and validation | IL, NE, OR, OH, OR, CA-B, IA |
| Development of novel technological approaches and their applications | IL, KS, MA, NE, OR, MT, NJ, MO, IA, PA, IN |
| Model organisms | MA, KS, NE, OR, CAB, AZ |
| Animal models | IL, MA, KS, NE, OR, OH, CA-B, CT, CA-D, PA, AZ, IN |
| Human and population-based studies | IL, KS, NE, OR, OH, CA-B, OK, MT, IA, IN |
| Microbiome studies/gut health | MA, NE, OR, OH, IN, AZ, IN |
| Susceptibility factors (age, sex, race, disease, environment, gene interactions) | MA, OR, OH, CA-B, OK, IA, IN |
| Obesity | MA, CT, ME, AZ |
| Malnutrition | IL, KS, OK, MT, IA |
| Neurological/brain function | NE, OR, CA-B, CA-D, AZ |
| Metabolic disease/diabetes, fatty liver | MA, NE, OR, OH, CT, ME, IL, AZ |
| Cardiovascular disease | MA, NE, OR, OH, IN, CT, ME, IL |
| Cancer | MA, NE, OR, PA, IL |
| Bone health | IN, OK |

***Table 3. Resources***

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| **Station** | **PI** | **Special Research Capability** |
| AZ | Teske, JenniferDuca, Frank | Animal models, body composition, behavioral measures of sleep, physical activity, energy expenditure, feeding, brain site-specific microinfusion, molecular biology, qPCR. Environmental and genetic interactions in altering the gut microbiota and nutrient-sensing pathways of the intestine in obesity and diabetes. |
| CA-B | Shane, Barry | molecular biology, genomics, genetic variation, animal models, cellular and *in vitro* systems, human studies |
| CA-D | Clifford, AndrewLiu, YanhongJi, Peng | Chemistry, isotope modeling, metabolomics, vitamins and phytonutrients, bioinformatics, human studies, LC/MSAntimicrobial resistance of food-borne bacteria, alternatives to antibiotics, feed-based health technologies to improve animal health.Nutritional factors in modulating neuronal resilience to early-life adverse events (e.g. infection and stress). |
| PA | Vanamala, Jairam | Animal models, flavonoids, anthocyanin, food processing, oxidative stress, inflammation, bioavailability, colon cancer prevention |
| OH | Bruno, Richard | *In vitro* and animal models, flavonoids, vitamin E (alpha- and gamma-tocopherol) and metabolites, oxidative stress, inflammation, metabolic syndrome, nonalcoholic steatohepatitis, vascular endothelial function, human studies |
| IL | Andrade, JuanDeMejia, Elvira | Sensors for biological and food matrices, nutrient and bioactive analysis, bioavailability and bioefficacy of nutrients, food product development, food fortification, encapsulation technologies, global food and nutrition security Bioactive peptides and proteins in foods, inflammation, markers of type 2 diabetes, cancer, and cardiovascular disease risk |
| IN | Weaver, Connie | Human and animal studies, mineral balance and kinetic modeling, bone turnover, bone densitometry, and bone micro-CT, bioavailability, mineral analysis, microbiota, cardiovascular measures |
| KS | Lindshield, Brian | Micronutrient bioavailability, protein quality, food aid development and assessment, international agricultural development nutrition and health assessment |
| MA | Park, YeonhwaXiao, Hang | Animal (including non-vertebrates) and cell culture models, behavioral and physical activity measurements, obesity, aging, diabetes, molecular biologyAnimal and cell culture models, cancer, inflammation, microbiome, metabolisms, molecular biology |
| NE | Zempleni, Janos | Bioavailability studies in animals and humans, exosome biology, molecular biology, RNA biology, transgenic models, human studies |
| OK | Stoecker, BarbaraLin, DingboLucas, Edralin | Animal models, bone quality, zinc homeostasis, human studiesFood biochemistry, egg lutein, egg xanthophylls, food bioactive compounds and chronic disease prevention - inflammation, diabetes, obesity and cancerAnimal models, body composition, human studies, inflammation, cell culture, bone quality, oxidative stress |
| OR | Ho, EmilyDallas, DavidHord, Norman | Molecular biology, epigenetics, signal transduction, chemoprevention studies in cell culture, animal models (mouse, zebrafish), and humans; mineral metabolism and gene regulation (humans), nutrient/gene/epigene interactions, nutrient/environment interactionsExamine survival of pathogen-specific human milk immunoglobulins in the infant gut, toxic metabolites and gut inflammation, digestion and putrefaction via peptidomics, metabolomics, microbial sequencing and inflammatory protein analysisAnimal models, physical performance, signal transduction, diet-microbiome interactions, dietary factors affecting nitric oxide homeostasis |
| MT | Sands, David | Selection of more nutritious crops, based on the input of this nutrition group. The new crops include oil crops cultivars selected for, high omega-3/low glucosinolate content, low glycemic cereal grains and potatoes, and high lysine wheats, and very high protein cereal grains, and development of plasmid curing agents from plants to be used in animal feeds to reduce the spread of antibiotic resistance. |
| ME | Klimis-Zacas, Dorothy | Nutritional Physiology and Biochemistry, Nutrition and Vascular Function and Metabolism, Berry bioactives and their role on chronic disease (Cardiovascular, Hypertension, Metabolic Syndrome) |
| CT | Lee, Ji-youngKoo, Sung I  | Dysregulation of energy metabolism, chronic inflammation and dyslipidemia, lipid metabolism and inflammatory signaling pathways, molecular targets that critically impact on the process of liver fibrosis and fibrogenic pathway.Mechanisms of intestinal absorption of lipids and lipid-soluble vitamins, dietary phytochemicals and lipid metabolism |
| NJ | Rogers, Michael A | Nanostructuring fiber morphology, food engineering, protein/polysaccharide induced structural heterogeneity |
| IA | White, Wendy S  | Bioavailability and metabolism of carotenoids, including beta-carotene and lutein, use of stable isotropic tracers to measure to bioefficacy of beta-carotene in humans, nutritional genomics, biofortification to combat vitamin A malnutrition. |
| MO | Gruen, Ingolf U | Analytical chemistry with applications in food composition, flavor chemistry and the influence of food ingredients on quality attributes of foods |