CLINICAL METAPROTEOMICS WORKFLOW TO STUDY HOST-MICROBIOME DYNAMICS

Pratik Jagtap

University of Minnesota

Google Scholar: z.umn.edu/pjgs
PubMed: z.umn.edu/pjagtapreferences

Email: pjagtap@umn.edu
X: pratikomics or usegalaxyp
Bluesky: pratikomics
Threads: pratikomics

*Learn more at **galaxyp.org***
z.umn.edu/itcrgalaxyvideo

CLINICAL METAPROTEOMICS WORKFLOW TO STUDY HOST-MICROBIOME DYNAMICS

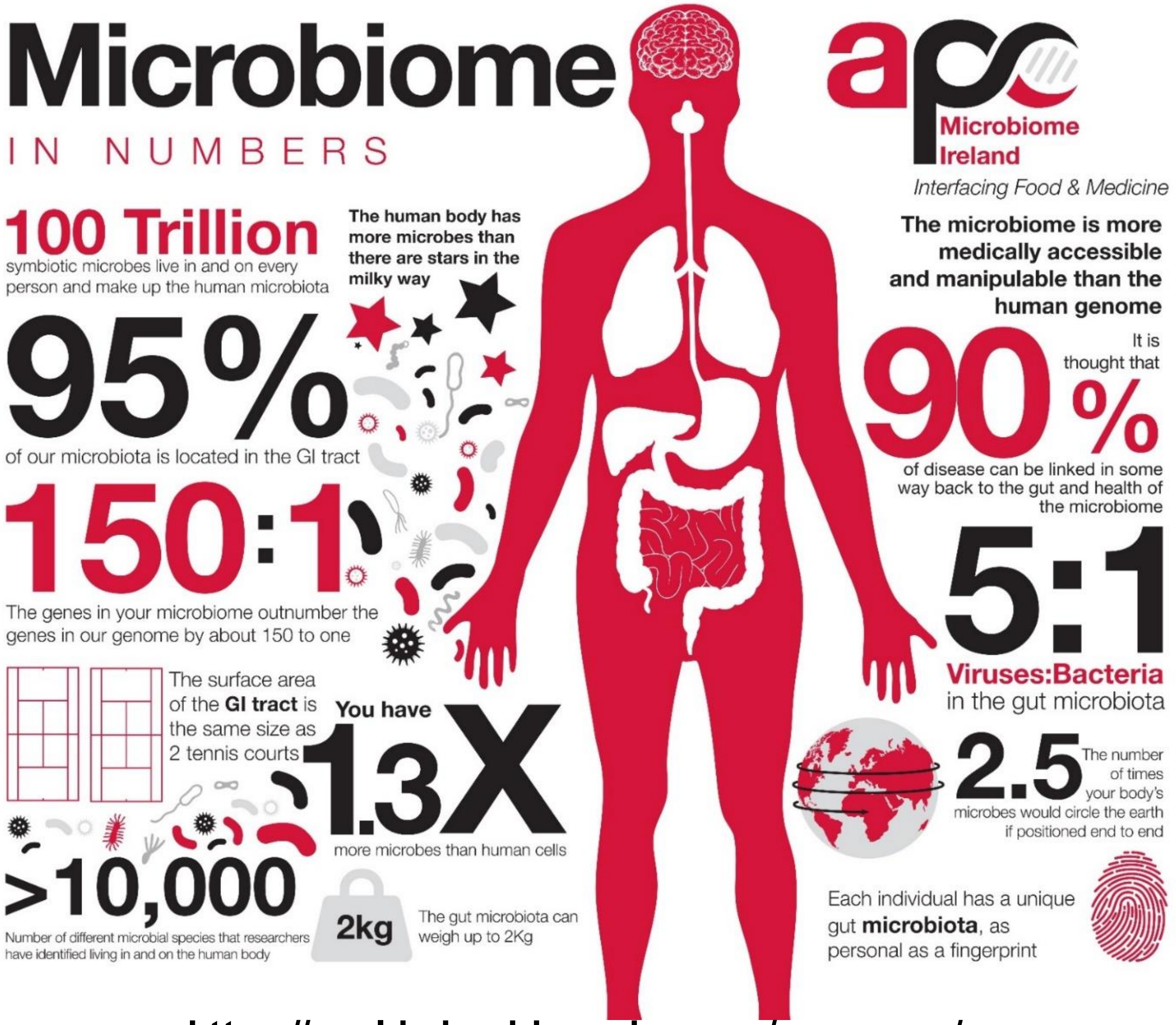
- *MICROBIOME RESEARCH*
- *MASS SPECTROMETRY DATA ANAYSIS*
- *METAPROTEOMICS RESEARCH*

- *GALAXY BIOINFORMATICS PLATFORM*

- *CLINICAL METAPROTEOMICS WORKFLOW*
- *CLINICAL METAPROTEOMICS:COVID-19 PANDEMIC*
- *CLINICAL METAPROTEOMICS:CYSTIC FIBROSIS*
- *CLINICAL METAPROTEOMICS: ORAL CANCER*

- *METAPROTEOMICS EDUCATION*

MICROBIOME RESEARCH



Microbiome

IN NUMBERS

Microbiome Ireland

Interfacing Food & Medicine

100 Trillion symbiotic microbes live in and on every person and make up the human microbiota

The human body has more microbes than there are stars in the milky way

95% of our microbiota is located in the GI tract

150:1 The genes in your microbiome outnumber the genes in our genome by about 150 to one

The surface area of the **GI tract** is the same size as 2 tennis courts

You have 1.3X more microbes than human cells

>10,000 Number of different microbial species that researchers have identified living in and on the human body

2kg The gut microbiota can weigh up to 2Kg

The microbiome is more medically accessible and manipulable than the human genome

It is thought that **90%** of disease can be linked in some way back to the gut and health of the microbiome

5:1 Viruses:Bacteria in the gut microbiota

2.5 The number of times your body's microbes would circle the earth if positioned end to end

Each individual has a unique gut **microbiota**, as personal as a fingerprint

https://worldmicrobiomeday.com/resources/

https://www.nature.com/articles/d41586-020-00193-3

MICROBIOME

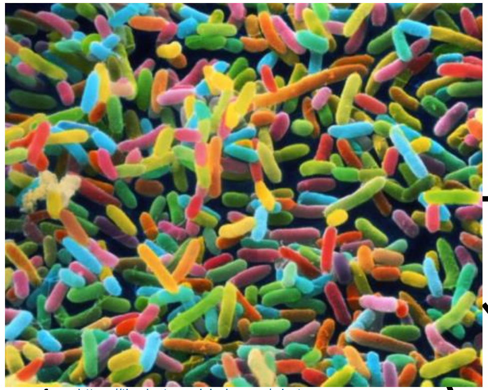
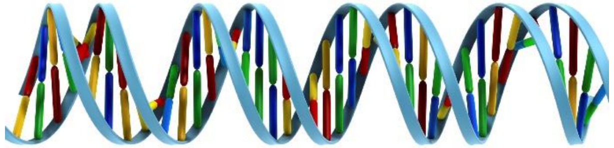


Image from https://thedoctorweighsin.com/what-everyone-should-know-about-the-infant-microbiome/

Potential to unravel the **mechanistic details of microbial interactions with host / environment** by analyzing the **functional dynamics of the microbiome.**



METAGENOMICS

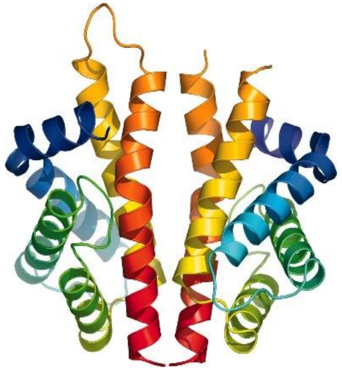
TAXONOMY

function

METATRANSCRIPTOMICS

TAXONOMY

function

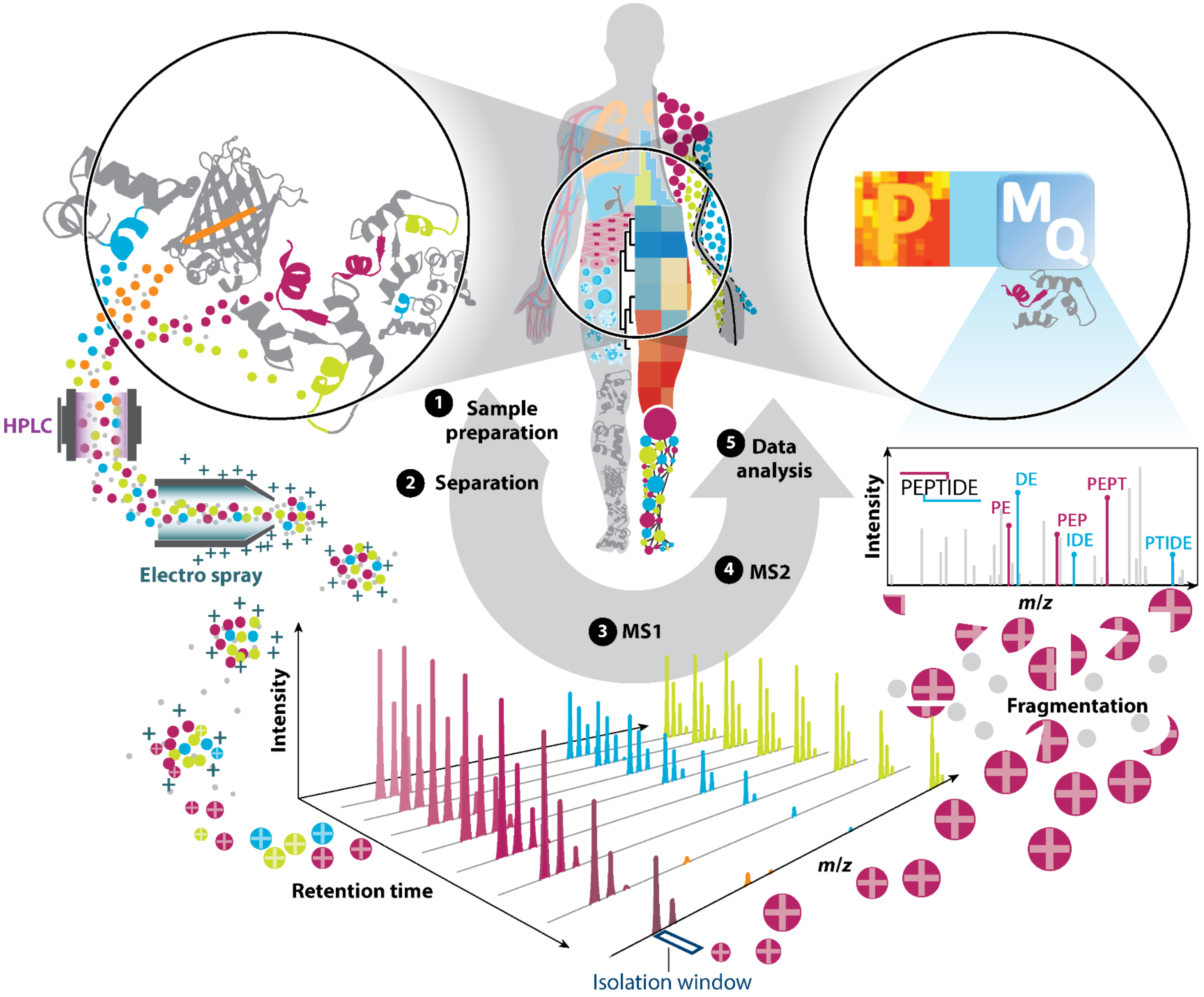


METAPROTEOMICS

TAXONOMY

FUNCTION

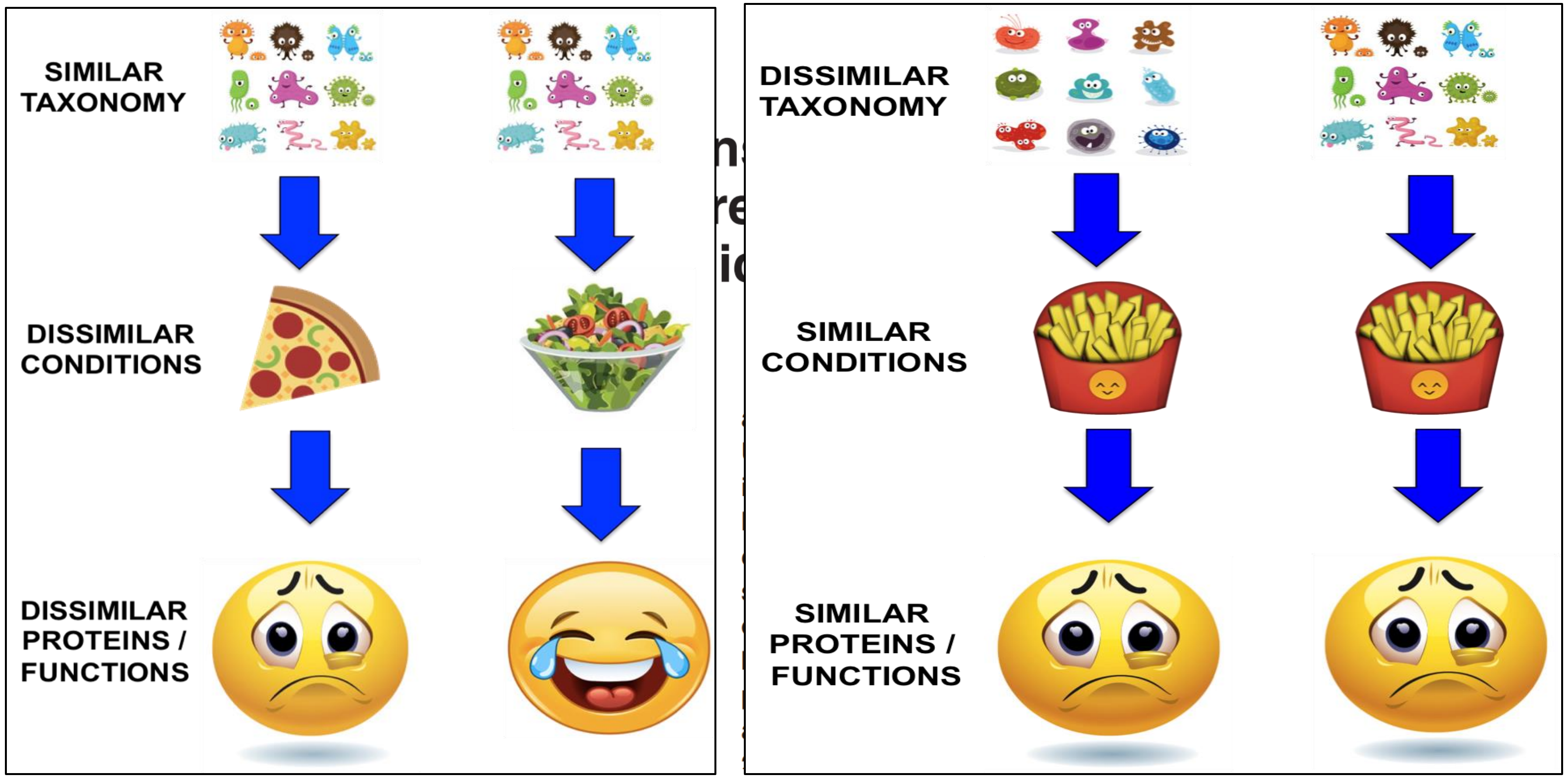
MASS SPECTROMETRY AND PROTEOMICS



Sinitcyn P, et al. 2018.
Annu. Rev. Biomed. Data Sci. 1:207–34

METAPROTEOMICS

<u>Bond and Wilmes 2004</u>
“The large-scale characterization of the entire protein complement of environmental microbiota at a given point in time”
Environ. Microbiol. 6, 911–920.

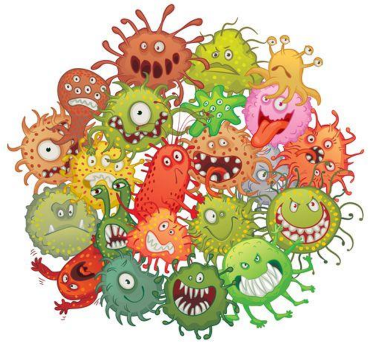


<u>Bond and Wilmes 2015</u>
“Through the application of metaproteomics to different microbial consortia over the past decade, we have learnt much <u>about key functional traits in the various environmental settings where they occur</u>.”
Proteomics. doi:10.1002/pmic.201500183.

METAPROTEOMICS ANALYTICAL CHALLENGES

SINGLE-ORGANISM PROTEOMICS

METAPROTEOMICS



SEARCH DATABASE

SIZE	SMALL TO MEDIUM SIZE (10 K TO 100K SEQUENCES)	LARGE (1 MILLION AND ABOVE)
COMPLEXITY	SINGLE + CONTAMINANTS	MULTI-ORGANISM DATABASE WITH HOMOLOGOUS PROTEINS

Disparate tools and multiple processing steps.

- SEARCH ALGORITHMS BEING DEVELOPED TO ADDRESS LARGE AND COMPLEX DATABASE SEARCHES
- PROTEIN GROUPING AT MULTI-ORGANISM LEVEL
- IDENTIFICATION STATISTICS AFFECTED BY LARGE DATABASES
- TAXONOMY BASED ON UNIQUE PEPTIDE IDENTIFICATIONS
- FUNCTIONAL ANALYSIS BASED ON PROTEINS IDENTIFIED

MICROBIAL TAXA VARY WHILE METABOLIC PATHWAYS REMAIN STABLE WITHIN A HEALTHY POPULATION

Human Microbiome Project Consortium (2012). Nature. 486(7402):207-214. doi: 10.1038/nature11234.

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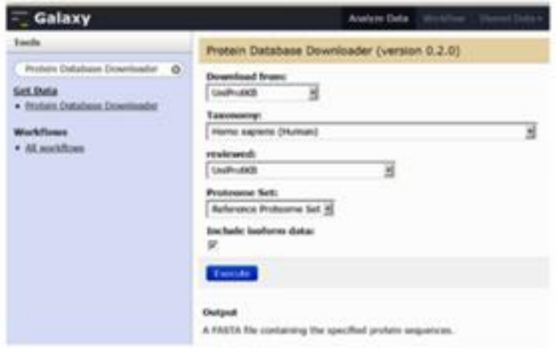
Defining Workflows and Histories

Workflows: Multiple software tools used in a sequential manner for an analysis



Protein Database Downloader (version 0.2.0)

Download from: UniProtKB

Taxonomy: Homo sapiens (Human)

reviewed: UniProtKB

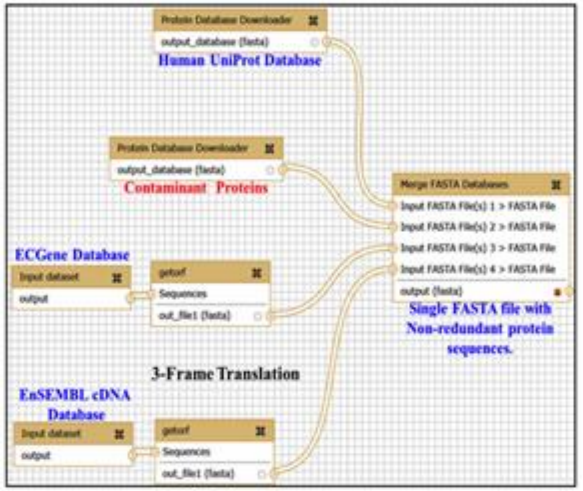
Proteome Set: Reference Proteome Set

Include isoform data: ☑

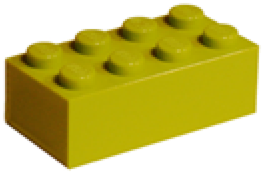
Output

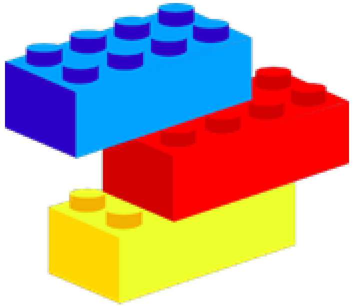
A FASTA file containing the specified protein sequences.

Single software tool in Galaxy

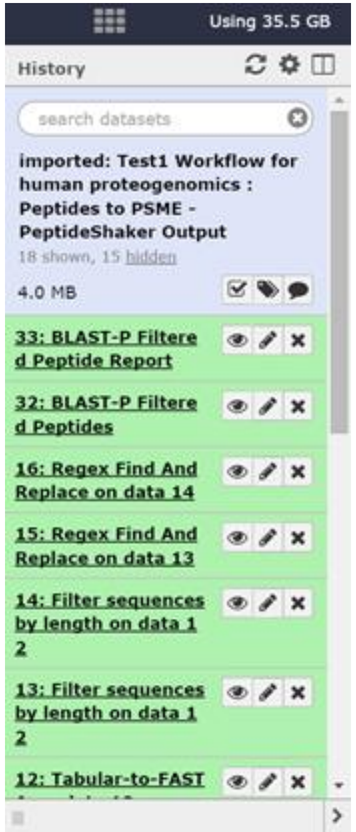


Integrated workflow using multiple, connected tools





History: recorded, complete analysis (workflow + all data and results)



imported: Test1 Workflow for human proteogenomics : Peptides to PSME - PeptideShaker Output

18 shown, 15 hidden

4.0 MB

33: BLAST-P Filtered Peptide Report

32: BLAST-P Filtered Peptides

16: Regex Find And Replace on data 14

15: Regex Find And Replace on data 13

14: Filter sequences by length on data 12

13: Filter sequences by length on data 12

12: Tabular-to-FAST

GalaxyP
galaxyp.org

The Galaxy Interface

Main viewing window
(workflow development, results visualization etc)

Tools

History

Welcome to GalaxyP

GalaxyP is a multiple 'omics' data analysis platform with particular emphasis on mass spectrometry based proteomics. GalaxyP is developed at the University of Minnesota, deployed at the Minnesota Supercomputing Institute, and is an extension of the popular Galaxy project. The GalaxyP project is supported by a grant from NSF.

This public Galaxy instance is meant for testing with small-scale data sets, and sharing workflows and tools. Users with larger data analysis needs are encouraged to install a local instance of Galaxy and access GalaxyP tools via the Tool Shed.

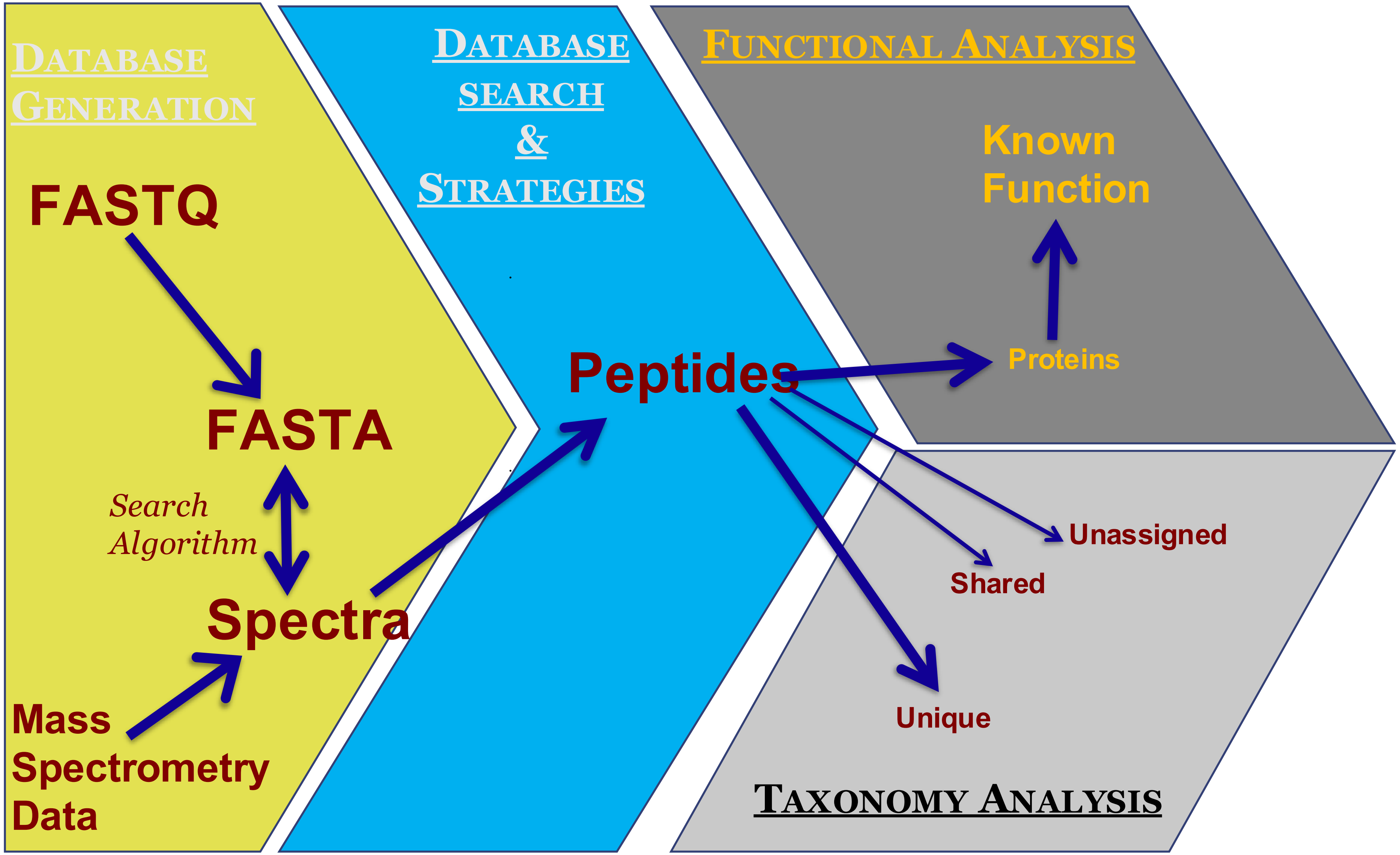
Updates

Febuary 13, 2015
All Galaxy Tools running nominally

Febuary 12, 2015
All Galaxy Tools running nominally

GalaxyP
galaxyp.org

METAPROTEOMICS WORKFLOW



DATABASE GENERATION

FASTQ

FASTA

Search Algorithm

Spectra

Mass Spectrometry Data

DATABASE SEARCH & STRATEGIES

Peptides

FUNCTIONAL ANALYSIS

Known Function

Proteins

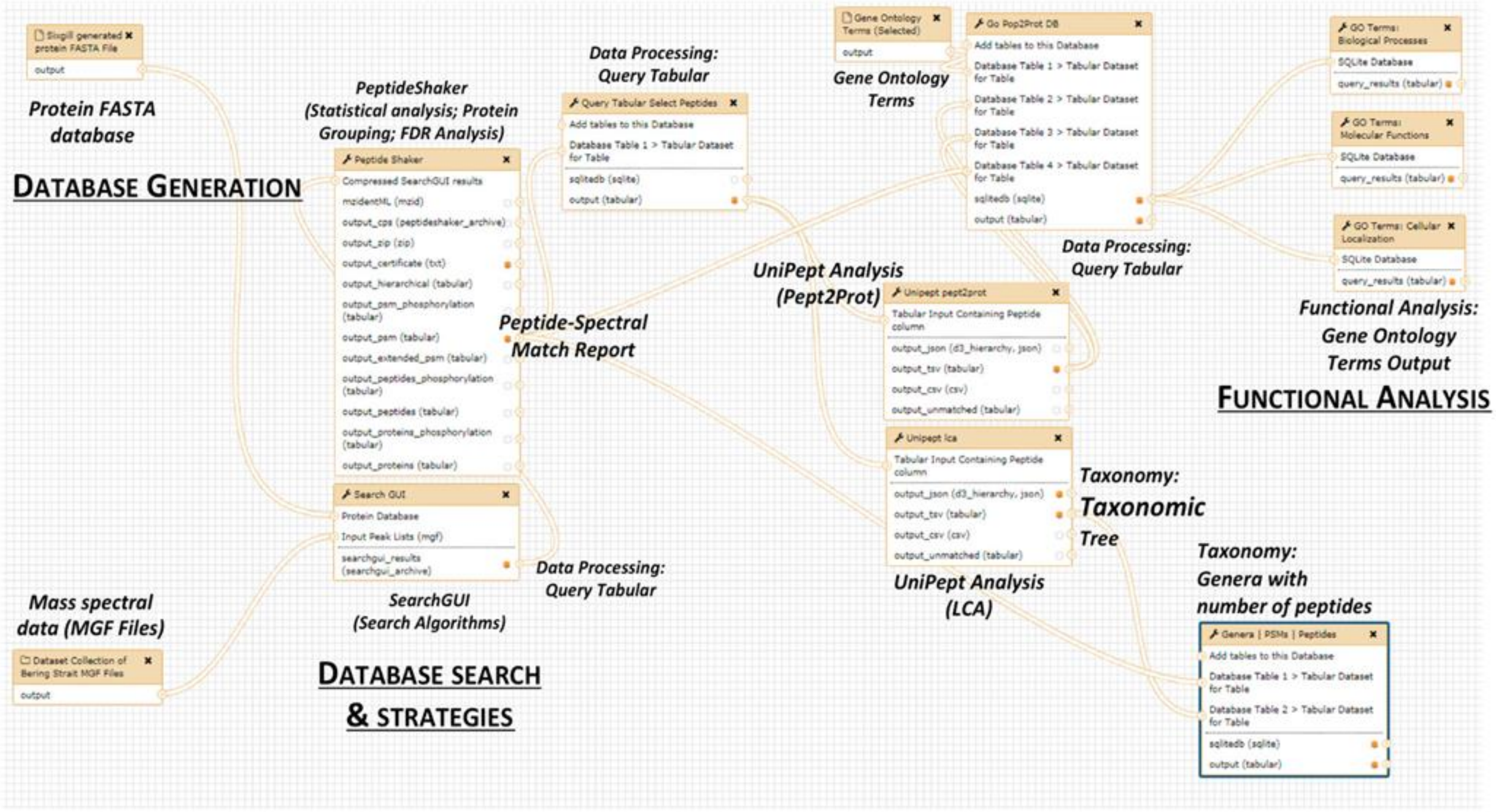
Unassigned

Shared

Unique

TAXONOMY ANALYSIS

SOLUTION: GALAXY BIOINFORMATICS PLATFORM



Blank *et al* Proteomes 2018, 6(1), 7; https://doi.org/10.3390/proteomes6010007

Software tools can be used in a sequential manner to generate analytical workflows that can be reused, shared and creatively modified.

Metaproteomics Publications

PROTEOMICS

Jagtap P *et al* (2012) Deep metaproteomic analysis of **human salivary supernatant**. Proteomics. 12(7):992-1001. doi: 10.1002/ pmic.201100503.

Microbiome

Rudney JD *et al* (2015) Protein relative abundance patterns associated with **sucrose-induced dysbiosis** are conserved across taxonomically diverse oral microcosm **biofilm models of dental caries.** Microbiome. 3:69. doi: 10.1186/s40168-015-0136-z.

SCIENTIFIC REPORTS
natureresearch

Afiuni-Zadeh S *et al* (2018) Evaluating the potential of residual Pap test fluid as a resource for the metaproteomic analysis of the **cervical-vaginal microbiome**. Sci Rep. ;8(1):10868. doi: 10.1038/s41598-018-29092-4.

ATS ATSJournals
AJRCMB

Jagtap PD et al (2018) **BAL Fluid Metaproteome** in Acute Respiratory Failure. Am J Respir Cell Mol Biol. 59(5):648-652. doi: 10.1165/rcmb.2018-0068LE.

ACS Publications
Most Trusted. Most Cited. Most Read.
Journal of proteome research

Thuy-Boun PS *et al* (2021). Metaproteomics Analysis of **SARS-CoV-2-Infected Patient Samples** Reveals Presence of Potential Coinfecting Microorganisms. J Proteome Res. 20(2):1451-1454.doi: 10.1021/acs.jproteome.0c00822

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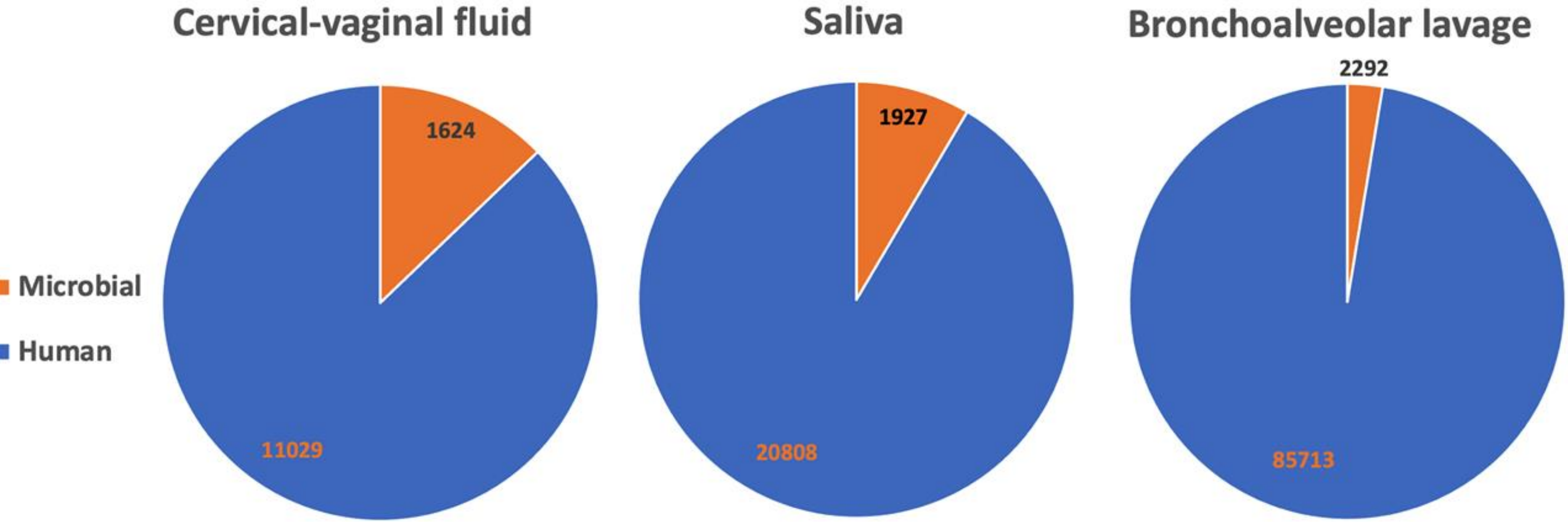
CLINICAL METAPROTEOMICS WORKFLOW TO STUDY HOST-MICROBIOME DYNAMICS

Katherine Do[1], Subina Mehta[1], Surbhi Bihani[2], Monica E. Kruk[1], Aryan Gupta[2],
Kevin Murray[1], Andrew Rajczewski[1], Reid Wagner[3], Dechen Bhuming[1], Kristin Boylan[4],
***Amy Skubitz[4], Theresa Laguna[5,6], Sanjeeva Srivastava[2]*, Timothy Griffin[1], Pratik Jagtap[1]**

[1] *Biochemistry, Mol. Biology and Biophysics, University of Minnesota, Minneapolis, USA*
[2] *Indian Institute of Technology Bombay, Mumbai, India*
[3] *Minnesota Supercomputing Institute, University of Minnesota, Minneapolis, USA*
[4] *Department of Laboratory Medicine and Pathology, University of Minnesota, Minneapolis, MN, USA*
[5] *Department of Pediatrics, University of Washington School of Medicine, Seattle, WA, USA*
[6] *Department of Pediatrics, Division of Pulmonary and Sleep Medicine, Seattle Children's Hospital, Seattle, WA, USA*

Do K *et al* (2024). A novel clinical metaproteomics workflow enables bioinformatic analysis of host-microbe dynamics in disease. mSphere https://doi.org/10.1128/msphere.00793-23

CLINICAL METAPROTEOMIC STUDIES DETECT LIMITED NUMBER OF MICROBIAL PEPTIDES

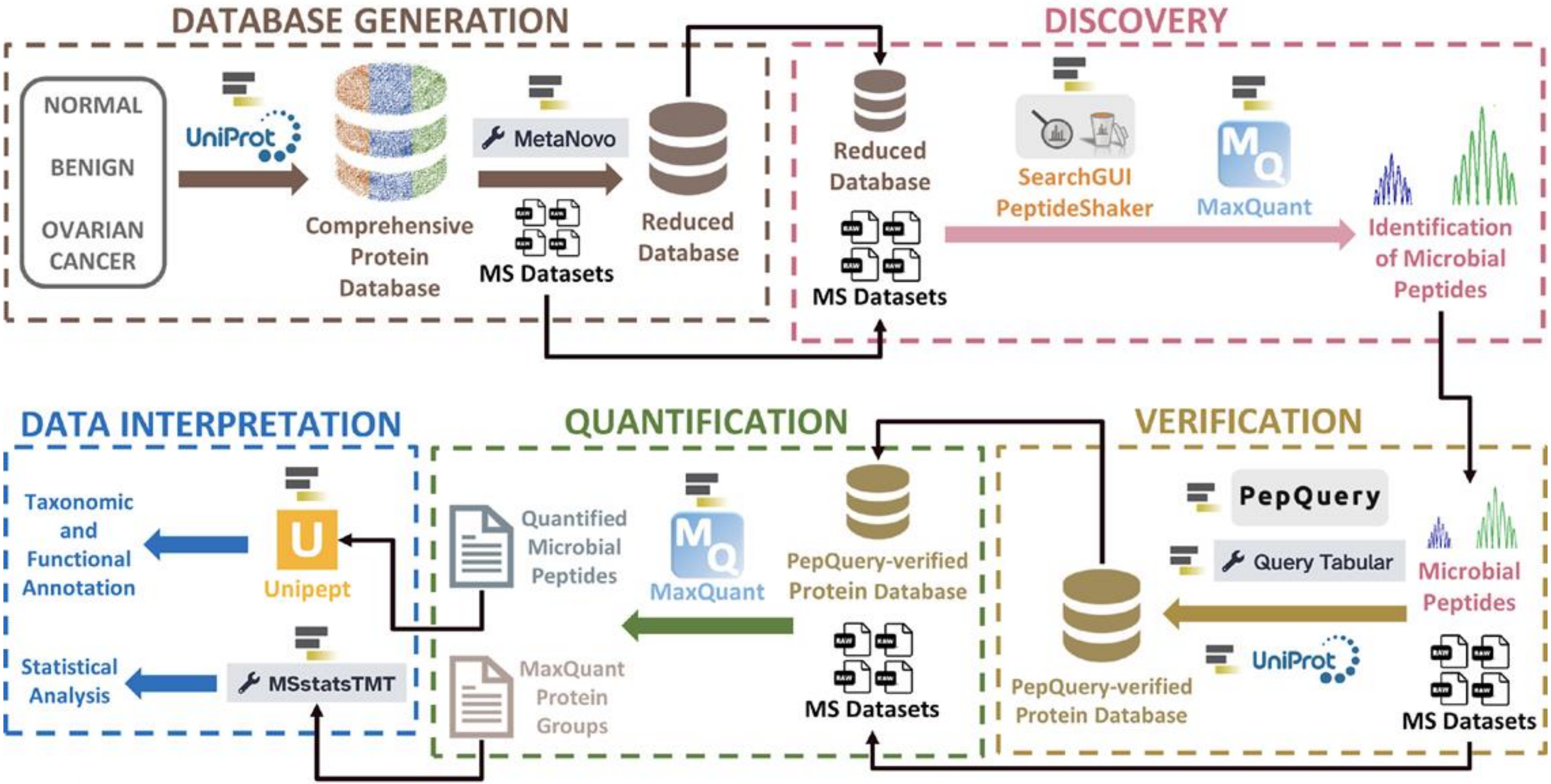


Afiuni-Zadeh *et al* (2018) Sci Rep . 8(1):10868.
doi: 10.1038/s41598-018-29092-4.

Jagtap *et al* (2012) Proteomics 12(7): 992–1001.
doi: 10.1002/pmic.201100503

Kruk *et al* (2024) mSystems
doi: 10.1128/msystems.00929-23

OVERVIEW OF CLINICAL METAPROTEOMICS WORKFLOW



DATABASE GENERATION

NORMAL

BENIGN

OVARIAN CANCER

UniProt

Comprehensive Protein Database

MetaNovo

MS Datasets

Reduced Database

DISCOVERY

Reduced Database

MS Datasets

SearchGUI PeptideShaker

MaxQuant

Identification of Microbial Peptides

VERIFICATION

PepQuery

Query Tabular

Microbial Peptides

MS Datasets

UniProt

PepQuery-verified Protein Database

QUANTIFICATION

PepQuery-verified Protein Database

MS Datasets

MaxQuant

Quantified Microbial Peptides

MaxQuant Protein Groups

DATA INTERPRETATION

Unipept

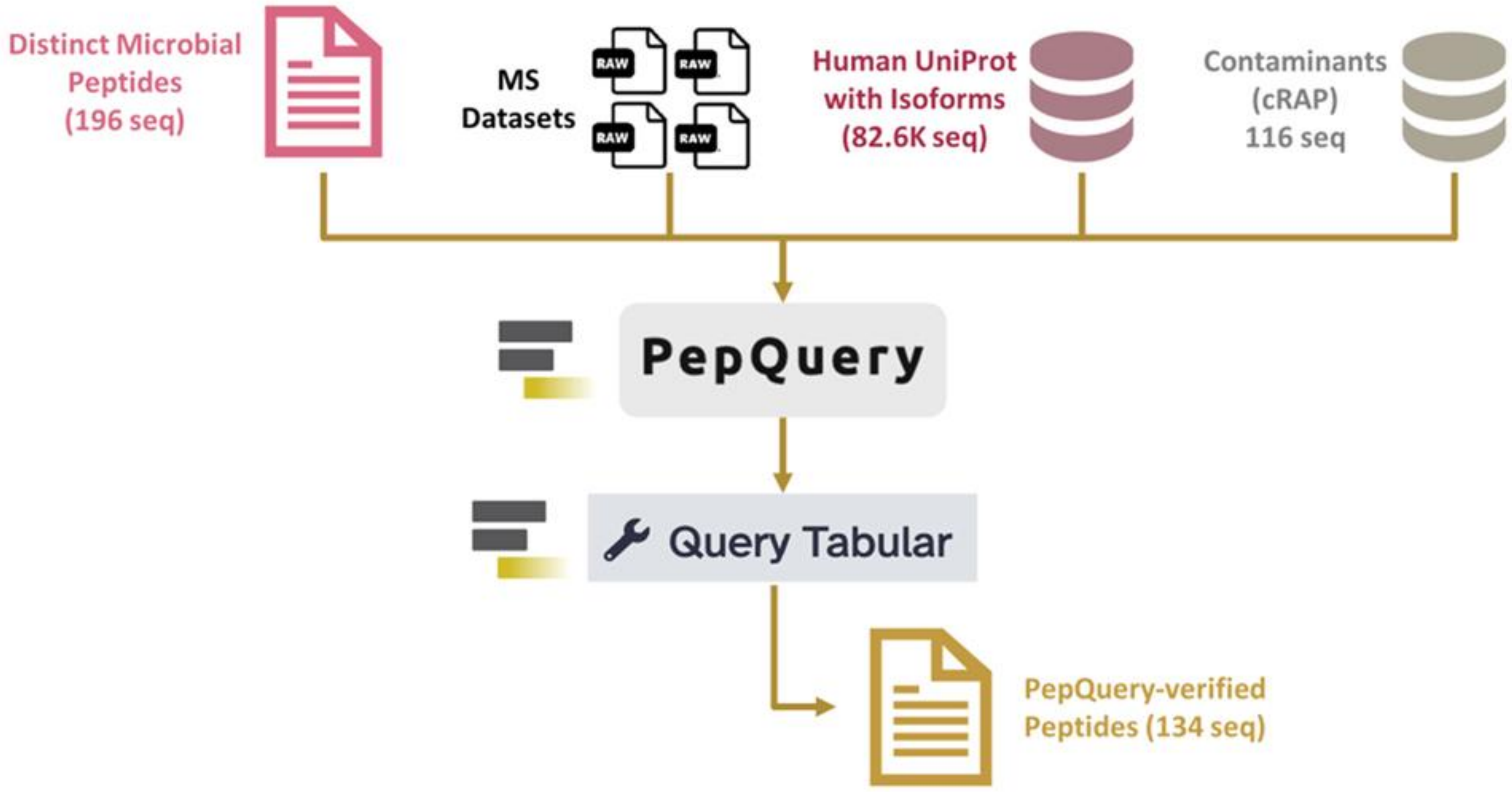
Taxonomic and Functional Annotation

MSstatsTMT

Statistical Analysis

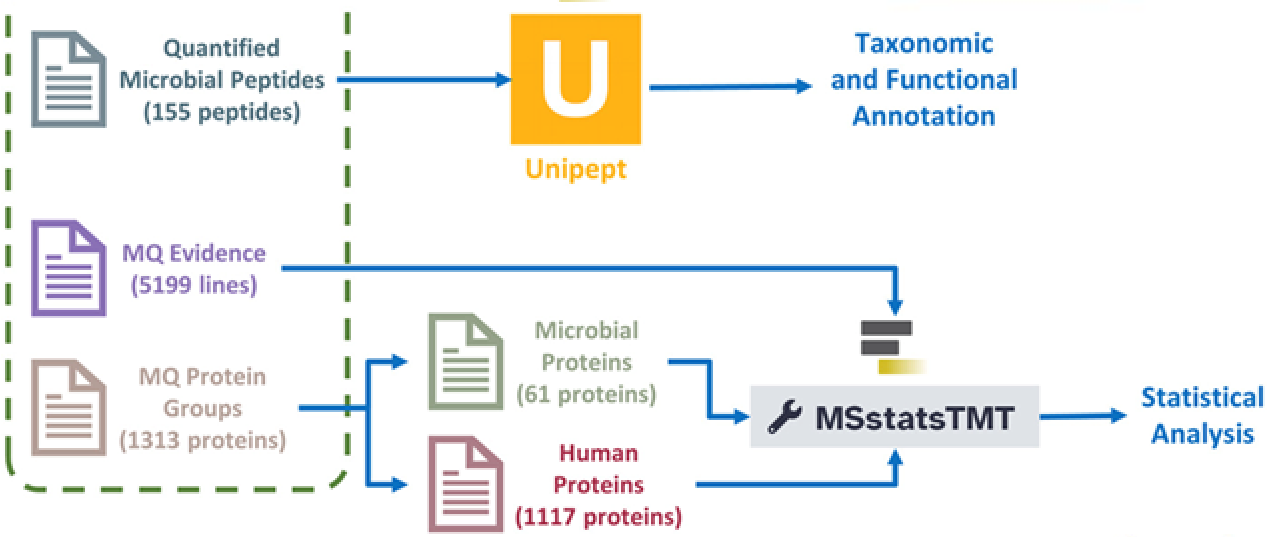
Do K *et al* (2024). mSphere https://doi.org/10.1128/msphere.00793-23

VERIFICATION AND VERIFIED DATABASE GENERATION MODULE



Do K *et al* (2024) mSphere https://doi.org/10.1128/msphere.00793-23

DATA INTERPRETATION MODULE



Quantification Module

Quantified Microbial Peptides (155 peptides)

MQ Evidence (5199 lines)

MQ Protein Groups (1313 proteins)

Unipept

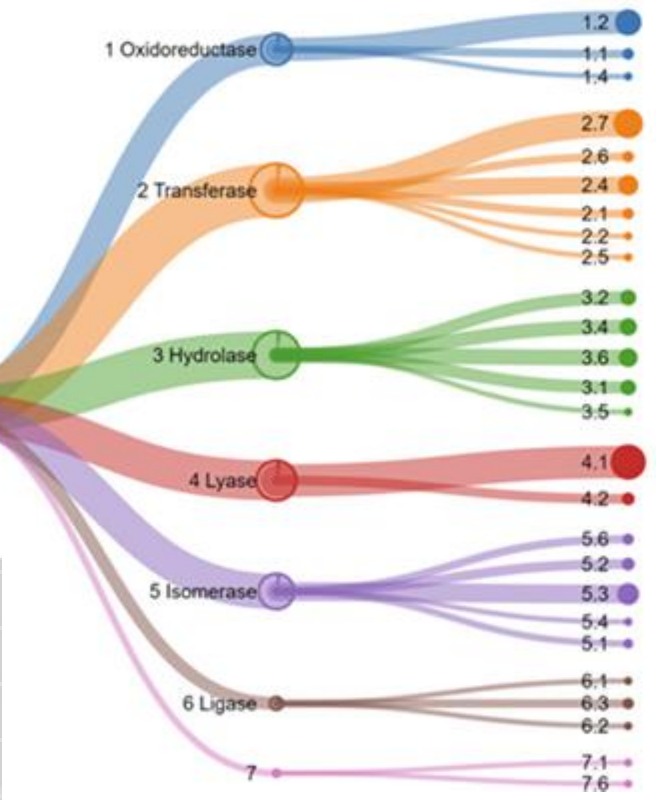
Taxonomic and Functional Annotation

Microbial Proteins (61 proteins)

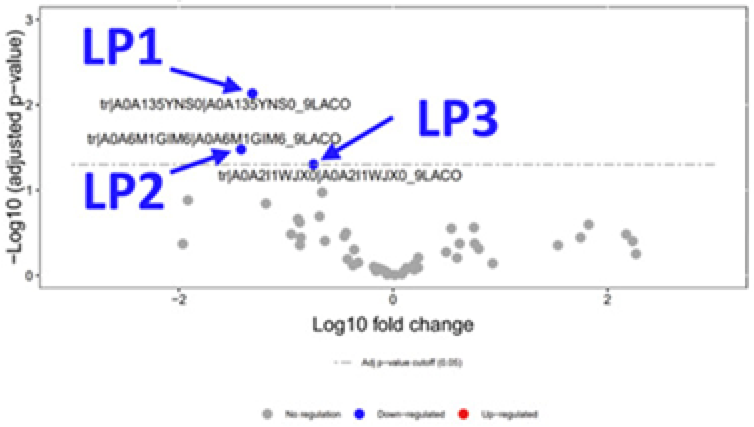
Human Proteins (1117 proteins)

MSstatsTMT

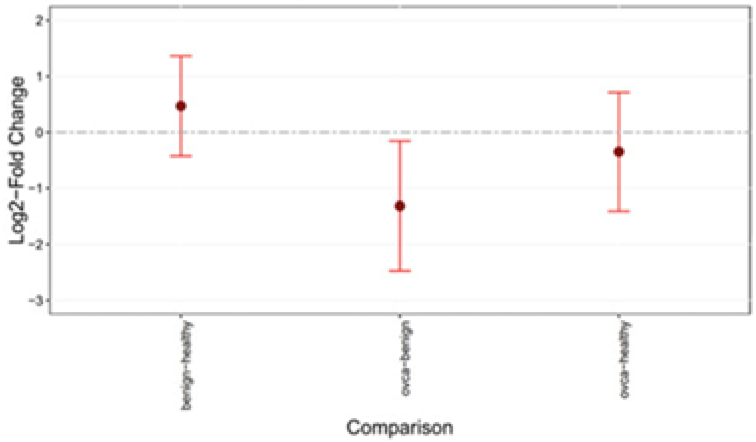
Statistical Analysis



ovca−benign



***Lactobacillus* protein 1 (LP1)**



Do K *et al* (2024) mSphere https://doi.org/10.1128/msphere.00793-23

The workflow modules, training data and documentation are available via the Galaxy Training Network.
https://training.galaxyproject.org/training-material/learning-pathways/clinical-metaproteomics.html

Galaxy Training Network

https://galaxyproject.org/events/gcc2021/training/

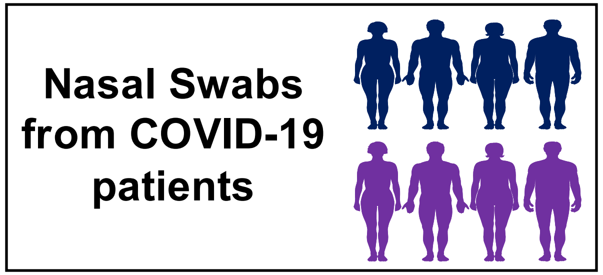
https://training.galaxyproject.org/training-material/topics/proteomics/

CLINICAL METAPROTEOMICS: COVID-19 PANDEMIC

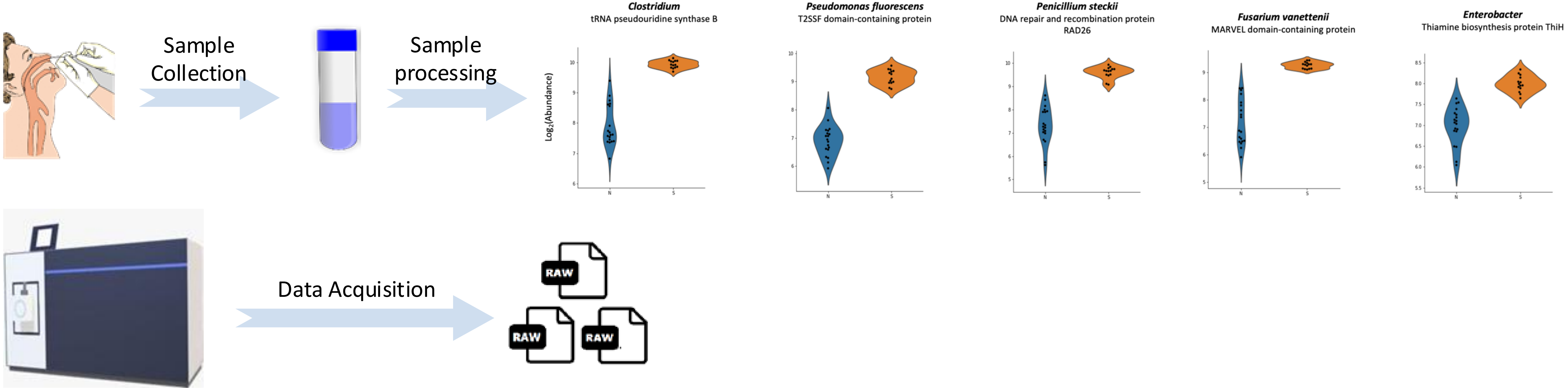
Bihani S *et al* (2023) Metaproteomic Analysis of Nasopharyngeal Swab Samples to Identify Microbial Peptides in COVID-19 Patients. J Proteome Res 22(8):2608-2619. doi: 10.1021/acs.jproteome.3c00040.

Surbhi Bihani

IIT BOMBAY



Nasal Swabs from COVID-19 patients



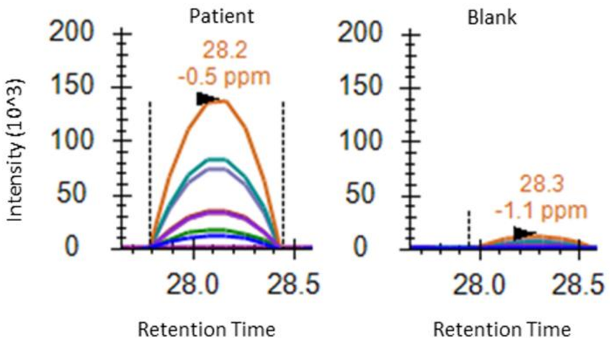
Sample Collection

Sample processing

Data Acquisition

TARGETED ANALYSIS OF POTENTIAL PATHOGENS IN COVID PATIENTS

QGIQNIPVVSQTGK (*Streptococcus parasanguinis*)

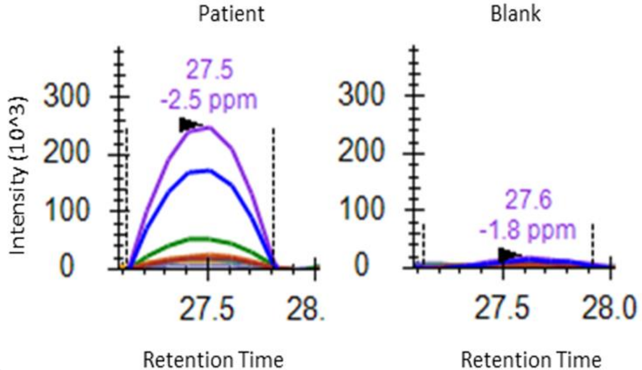


Streptococcus parasanguinis

Dominant isolate of dental plaque

Opportunistic pathogen associated with subacute endocarditis

GLFGDELCK (*Burkholderia cenocepacia*)

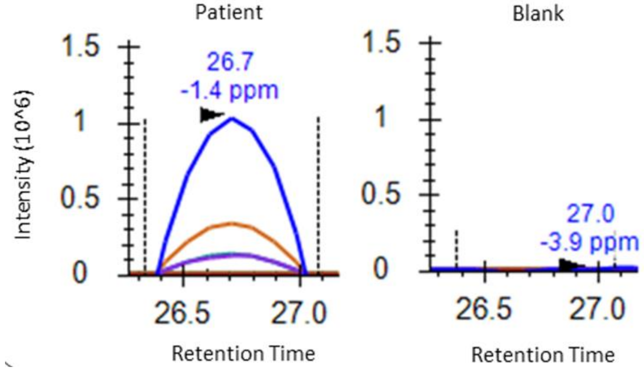


Burkholderia cenocepacia

Opportunistic pathogen

Cause systemic infections in immunocompromised individuals including cystic fibrosis patients.

IVDQEGAIVPK (*Cryptococcus floricola*)

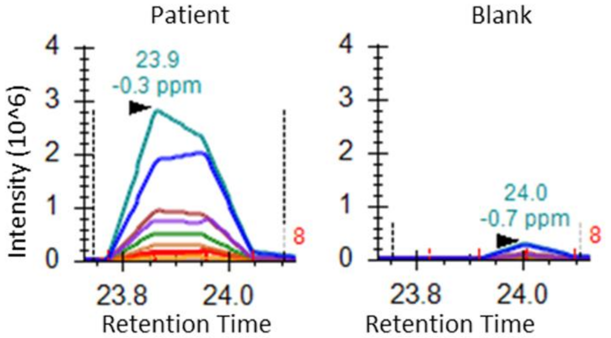


Cryptococcus floricola

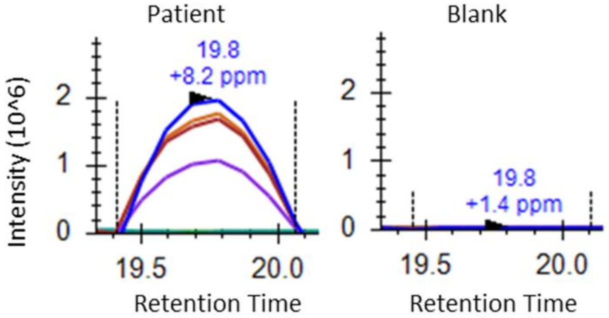
Infect immunocompromised hosts

Infection initiates in the lungs.

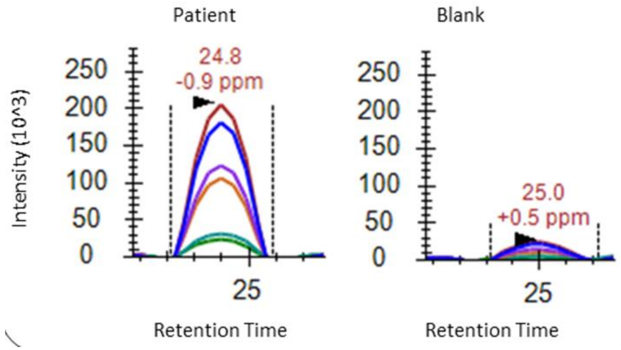
ICVLHGDK (*Clostridium sp.*)



DETDDQFEK (*Staphylococcus sp.*)



TPTLVSDLR (*Pseudomonas sp.*)



CLINICAL METAPROTEOMICS: CYSTIC FIBROSIS

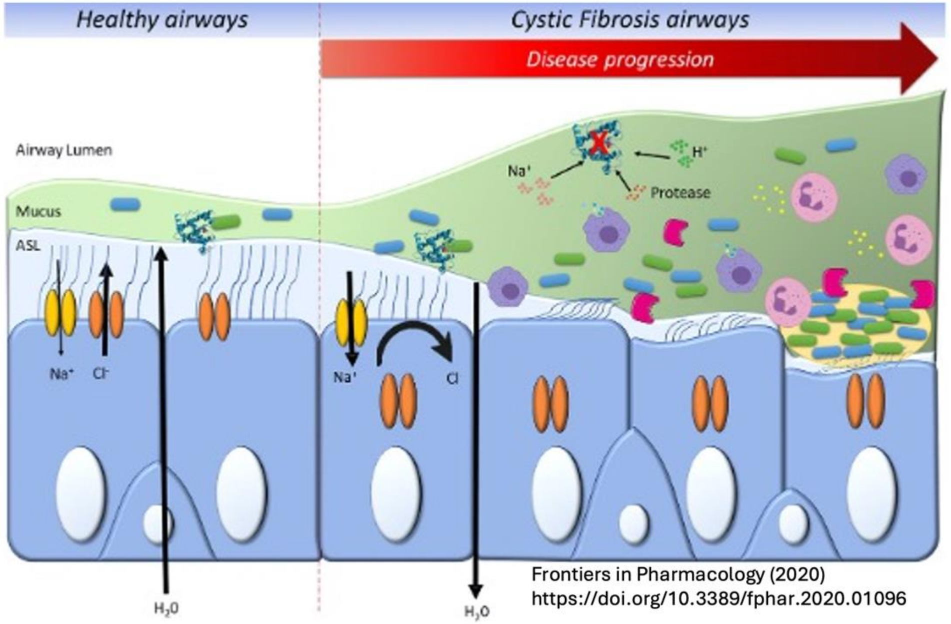
Kruk M *et al* (2024) An integrated metaproteomics workflow for studying host-microbe dynamics in bronchoalveolar lavage samples applied to cystic fibrosis disease. mSystems (https://doi.org/10.1128/msystems.00929-23).

Cystic Fibrosis and the Microbiome

- **Life-shortening Mendelian disease.**
- **Mutations in the CF transmembrane conductance regulator (CFTR) gene, which encodes an epithelial anion channel.**
- **Abnormal anion transport across epithelia of secretory glands including lung.**

↓

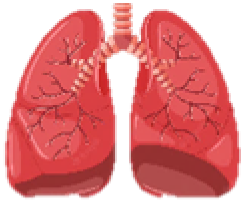
- **Thick mucus which predisposes patients to chronic bacterial infections and airway inflammation.**
- **Progressive and irreversible airway damage.**
- **Reduced quality and length of life in CF.**

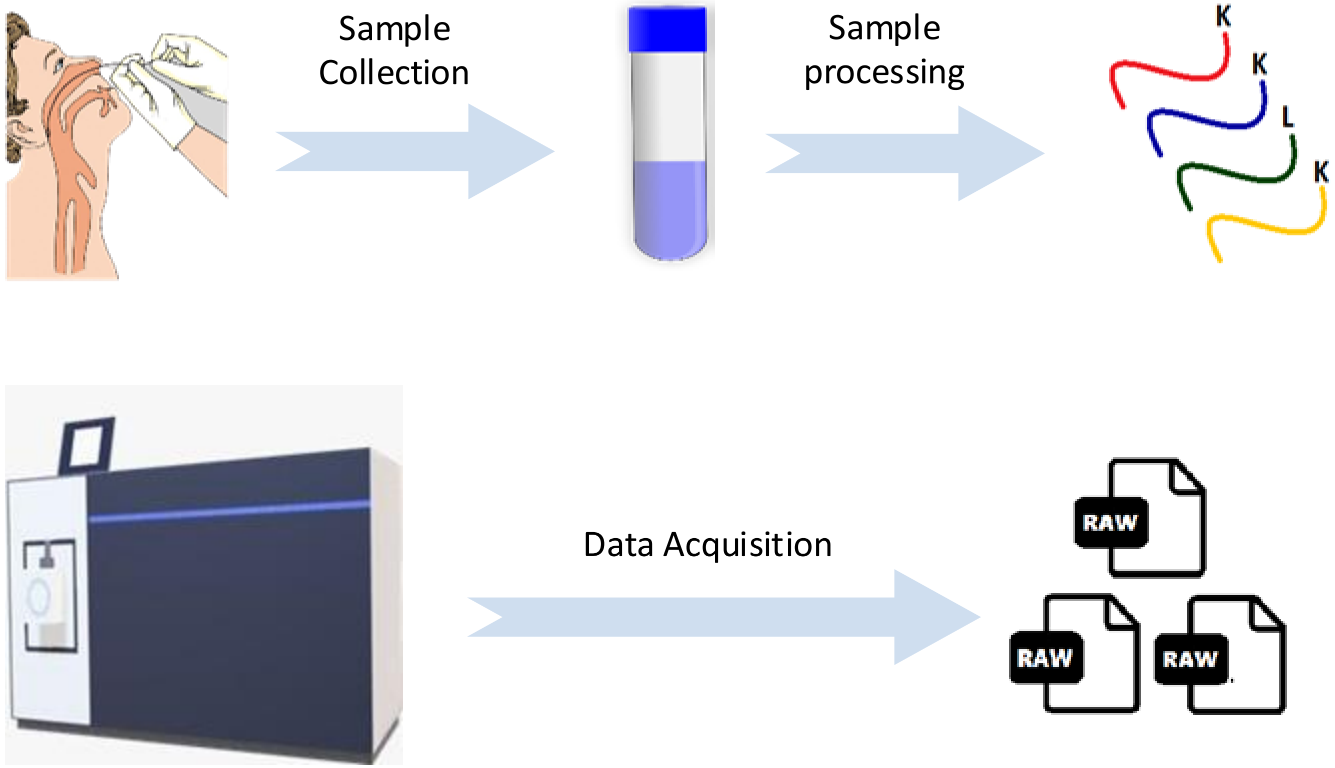


Frontiers in Pharmacology (2020)
https://doi.org/10.3389/fphar.2020.01096

CYSTIC FIBROSIS DATASETS

**BALF from
Cystic Fibrosis
or
Disease Control
Samples**





Sample
Collection

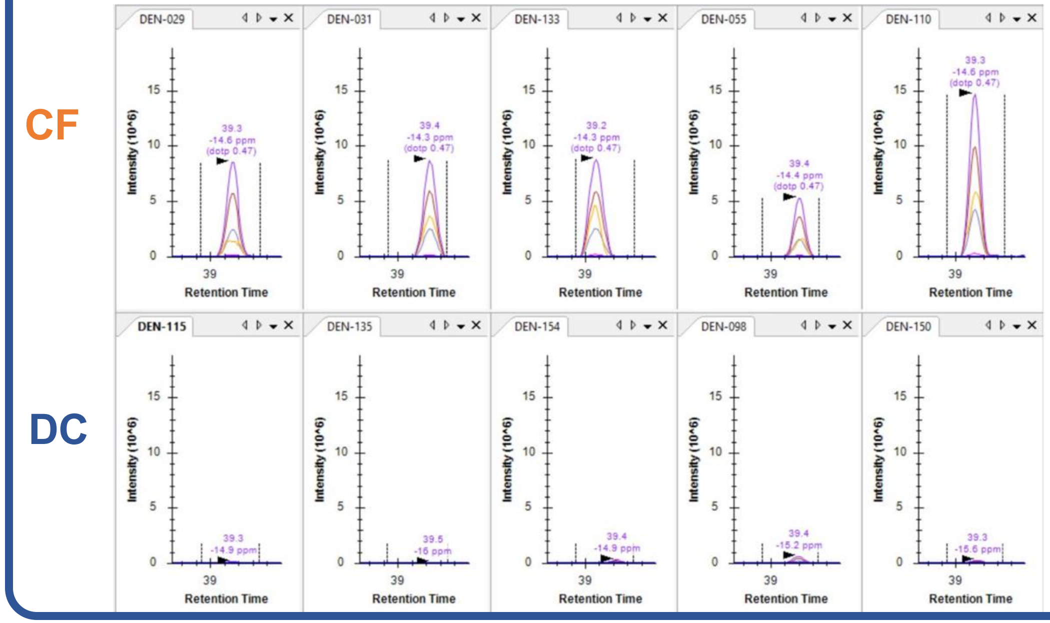
Sample
processing

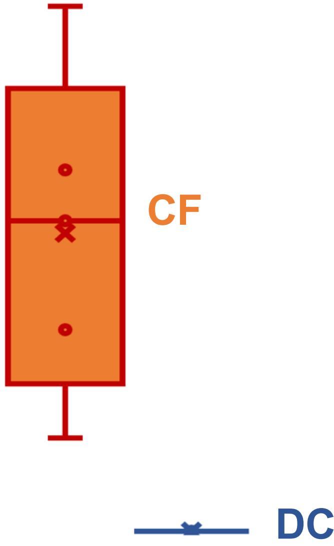
Data Acquisition

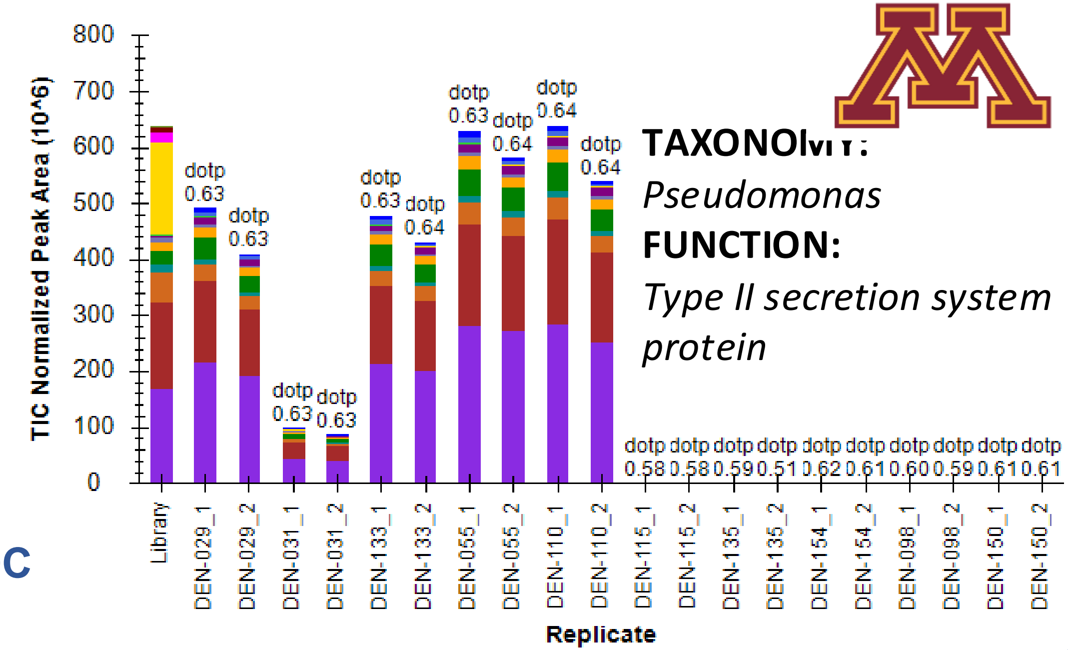
Monica E. Kruk

MICROBIAL PEPTIDES FROM CYSTIC FIBROSIS PATIENTS

DWLDSLLQR

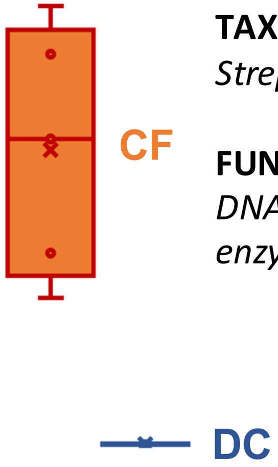






TAXONOMY:
Pseudomonas
FUNCTION:
Type II secretion system protein

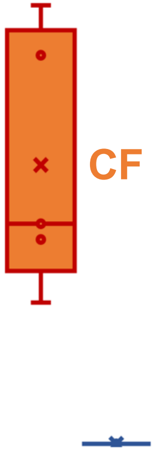
MKIGNLGGAYR



TAXONOMY:
Streptococcus agalactiae

FUNCTION:
DNA recombination enzyme

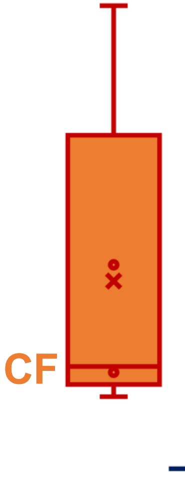
VLGARGHR



TAXONOMY:
Bacteria *(UniPept)*

FUNCTION:
Membrane kinase activity
Nucleoside triphosphate hydrolase
(A0A119BW38)

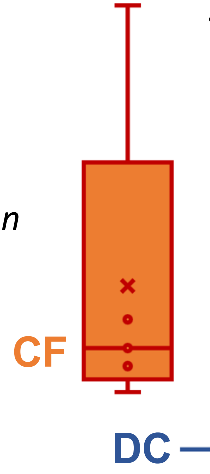
AALGAYDLR



TAXONOMY:
Unassigned (UniPept)

FUNCTION:
Uncharacterized protein
(A0A1A2YS21)

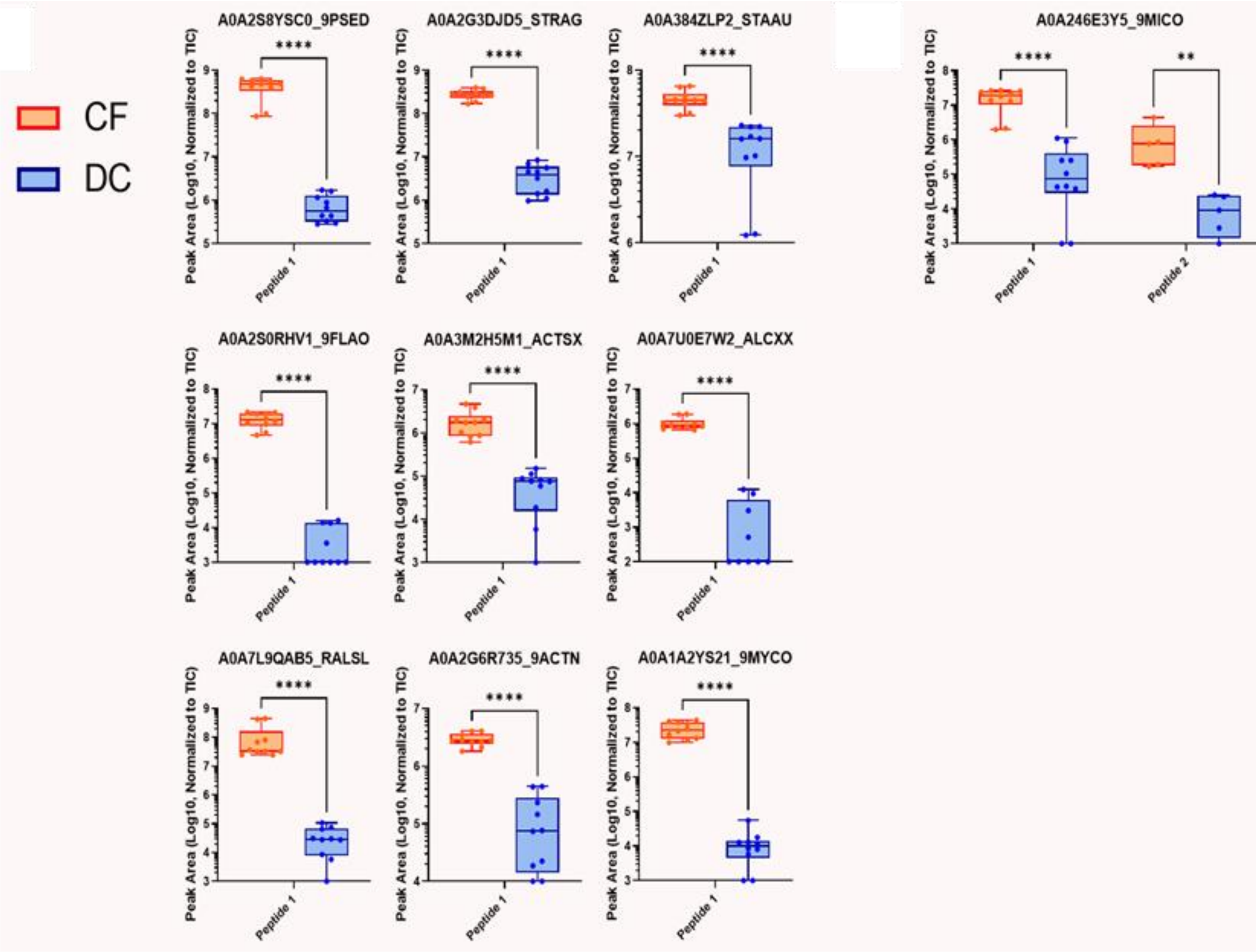
ATVEELHLEGI



TAXONOMY:
Unassigned (UniPept)

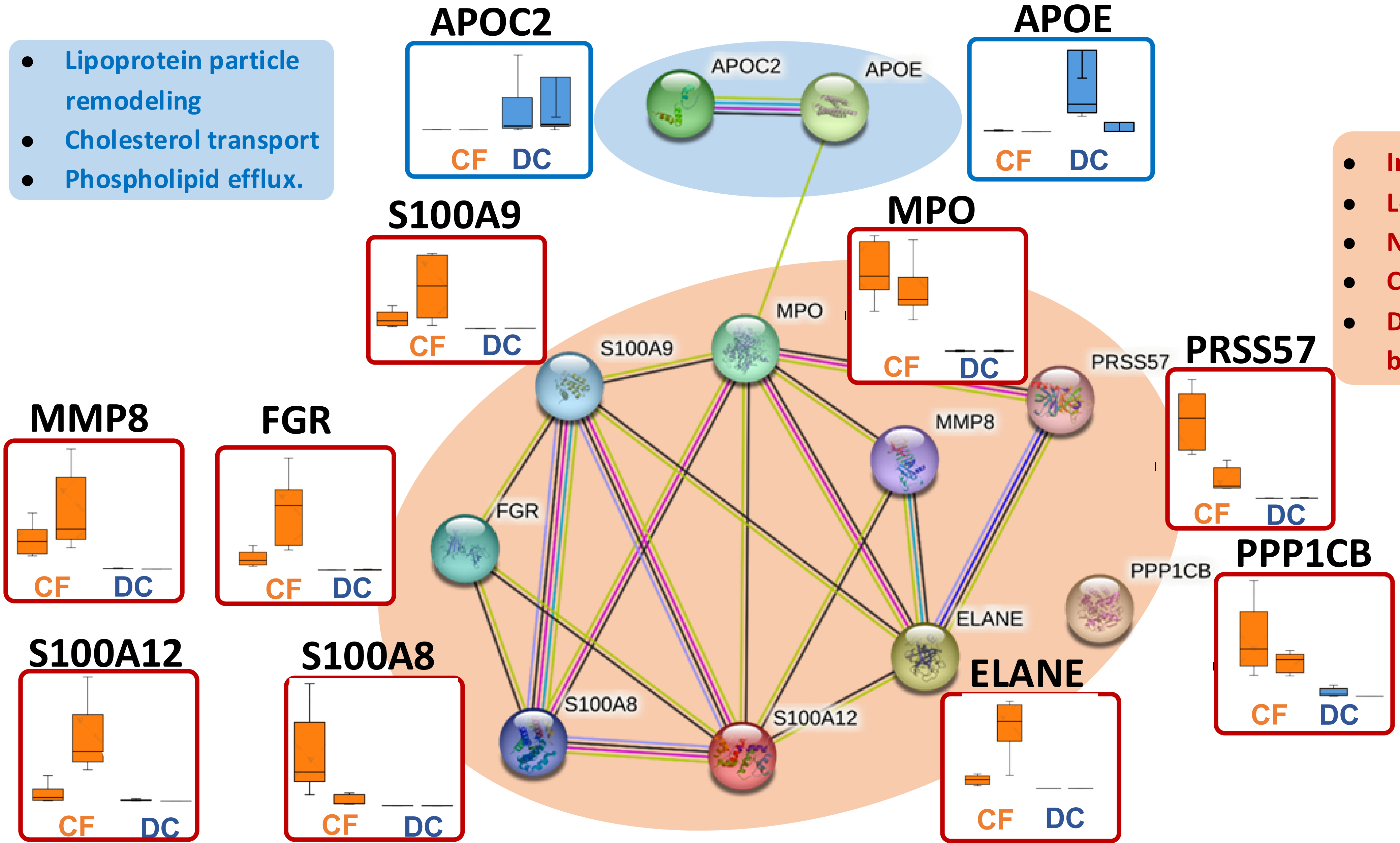
FUNCTION:
Uncharacterized
(A0A1H9MU03)

MICROBIAL PEPTIDES FROM CYSTIC FIBROSIS PATIENTS



TARGETED ASSAY FOR HOST-MICROBIAL PROTEIN DYNAMICS IN CLINICAL CF SAMPLES

- Lipoprotein particle remodeling
- Cholesterol transport
- Phospholipid efflux.



- Inflammatory response
- Leukocyte migration
- Neutrophil degranulation
- Cytokine production
- Defense response to bacteria

CLINICAL METAPROTEOMICS

- **We have developed a MS-based Galaxy-driven bioinformatics workflow for processing of microbial and host proteins, generating verified microbial peptide candidates suitable for targeted analysis within individual patient samples.**
- **We have utilized this workflow to detect and validate microbial peptides during co-infection during the COVID-19 pandemic.**
- **The workflow was also used to generate a promising microbial and host peptide panel for application to CF disease progression studies by comparing it with disease control (DC).**
- **We intend to use this workflow in other clinical metaproteomic studies to detect differentially expressed host and microbial proteins in disease state.**

CLINICAL METAPROTEOMICS WORKFLOW TO STUDY HOST-MICROBIOME DYNAMICS

- *MICROBIOME RESEARCH*
- *MASS SPECTROMETRY DATA ANAYSIS*
- *METAPROTEOMICS RESEARCH*

- *GALAXY BIOINFORMATICS PLATFORM*

- *CLINICAL METAPROTEOMICS WORKFLOW*
- *CLINICAL METAPROTEOMICS:COVID-19 PANDEMIC*
- *CLINICAL METAPROTEOMICS:CYSTIC FIBROSIS*
- ***CLINICAL METAPROTEOMICS: ORAL CANCER***

- *OCEAN METAPROTEOMICS*
- *METAPROTEOMICS EDUCATION*

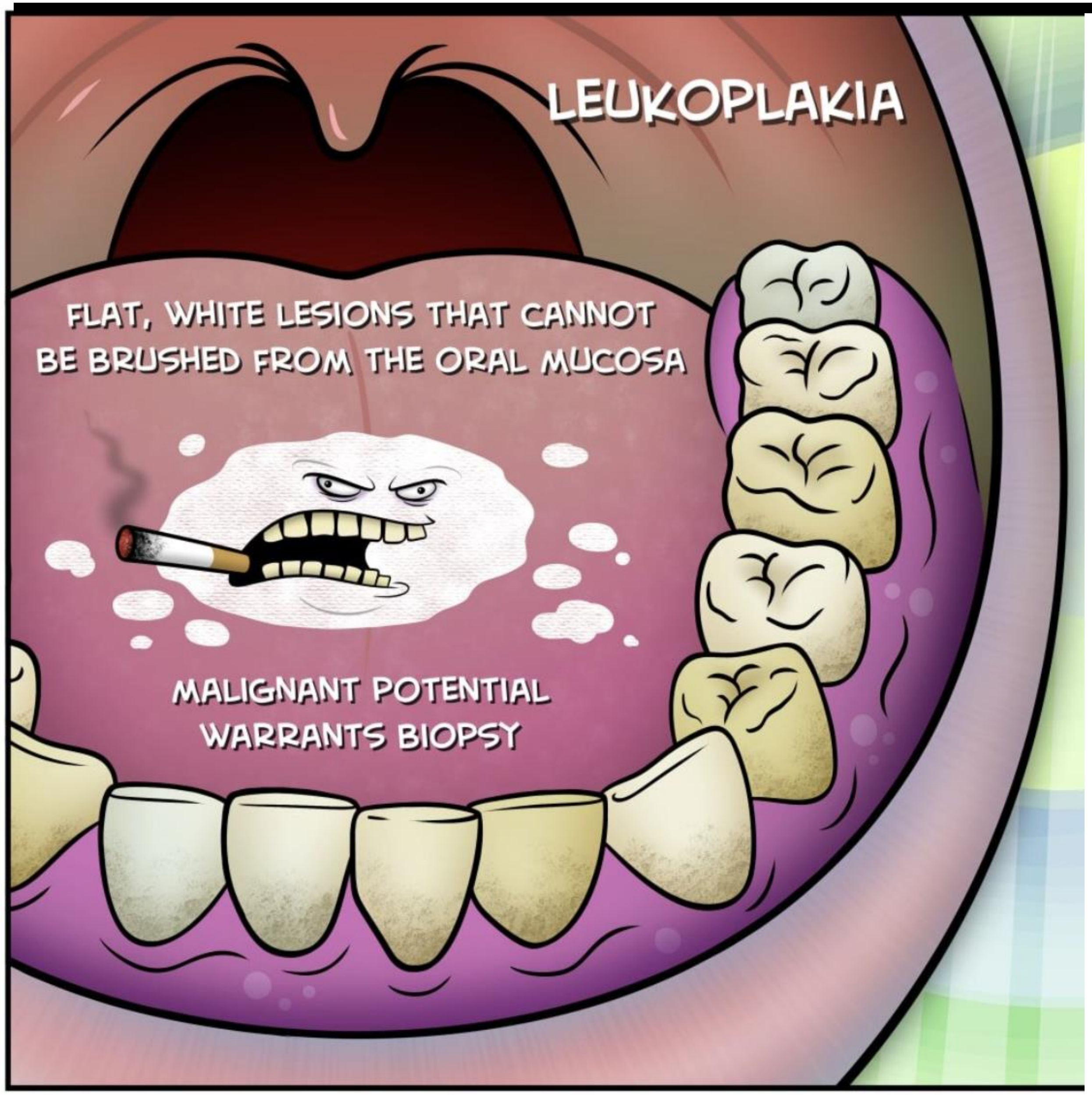
Investigating Key Host, Microbial and Variant Peptides for Detection of Oral Cancer using Advanced Multi-omics Methods.

Pratik Jagtap[1], *Ruben Shrestha*[2], *Beverly Wuertz*[3], *Monica Kruk*[4], *Subina Mehta*[1],
Alvaro Sebastian Vaca Jacome[2], *Matthew Willetts*[4], *Frank Ondrey*[3], *Timothy Griffin*[1]

[1]*Biochemistry, Molecular Biology and Biophysics, University of Minnesota, Minneapolis, USA*
[2]*Bruker Scientific LLC, San Jose, CA;*
[3]*Otolaryngology Department, University of Minnesota, Minneapolis, Minnesota;*
[4]*Bruker Scientific, LLC, Billerica, MA*

WORK NOT PUBLISHED YET

ORAL LEUKOPLAKIA: ORAL CANCER RISK



WWW.MEDCOMIC.COM

BACKGROUND

- ✱ PAINLESS, SLOW-GROWING LESION on MUCOUS MEMBRANES of ORAL CAVITY
- ✱ POTENTIAL PRECANCEROUS CONDITION

CAUSES

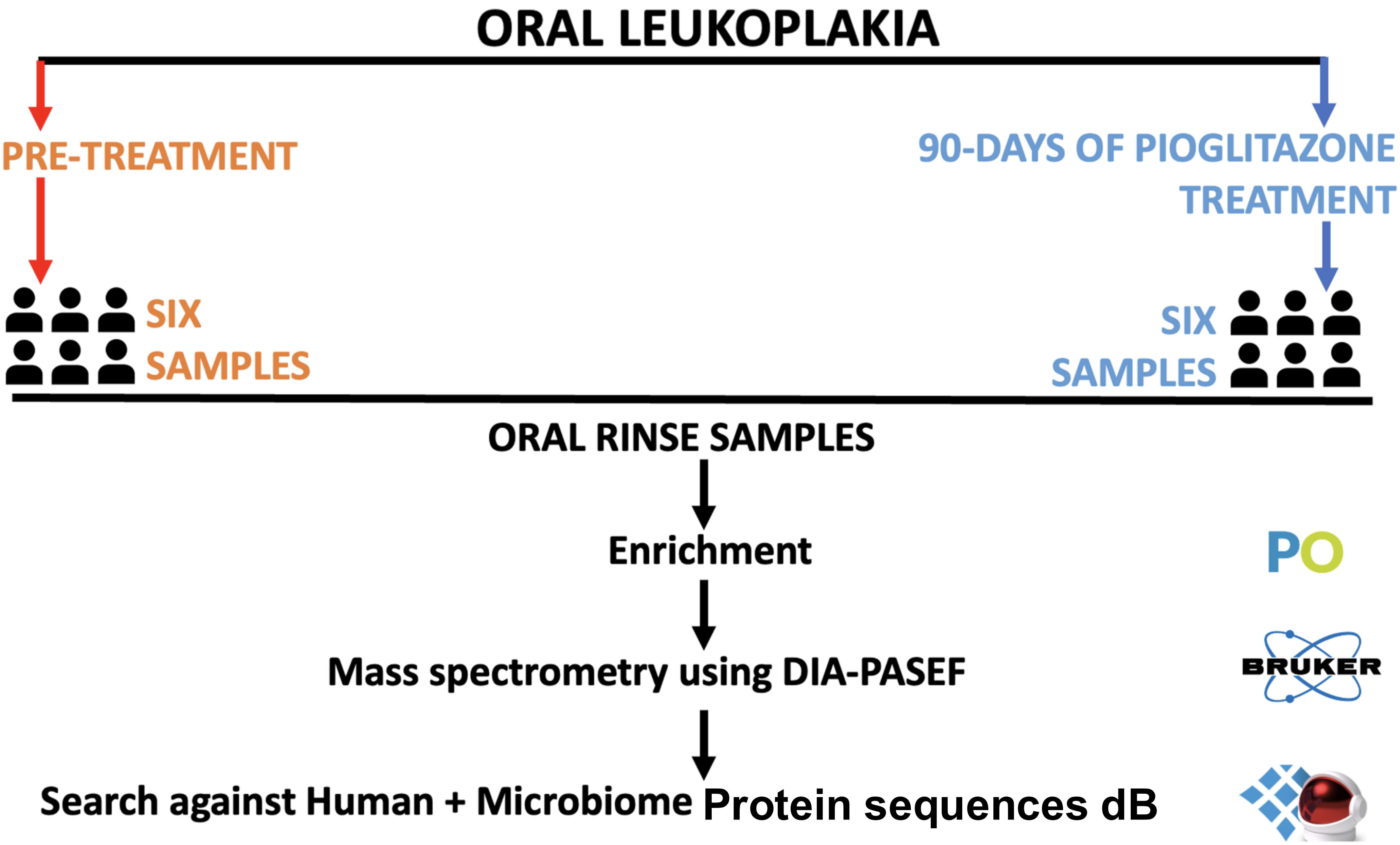
MOST COMMON

- ✱ HEAVY SMOKING
- ✱ CHEWING TOBACCO
- ✱ EXCESSIVE ALCOHOL USE

- ✱ POOR ORAL HEALTH
- ✱ LONG-TERM TRAUMA to ORAL CAVITY
- ✱ ADVANCED AGE
- ✱ HPV INFECTION

https://www.osmosis.org/answers/erythroplakia

EXPERIMENTAL WORKFLOW



ORAL LEUKOPLAKIA

PRE-TREATMENT

SIX SAMPLES

90-DAYS OF PIOGLITAZONE TREATMENT

SIX SAMPLES

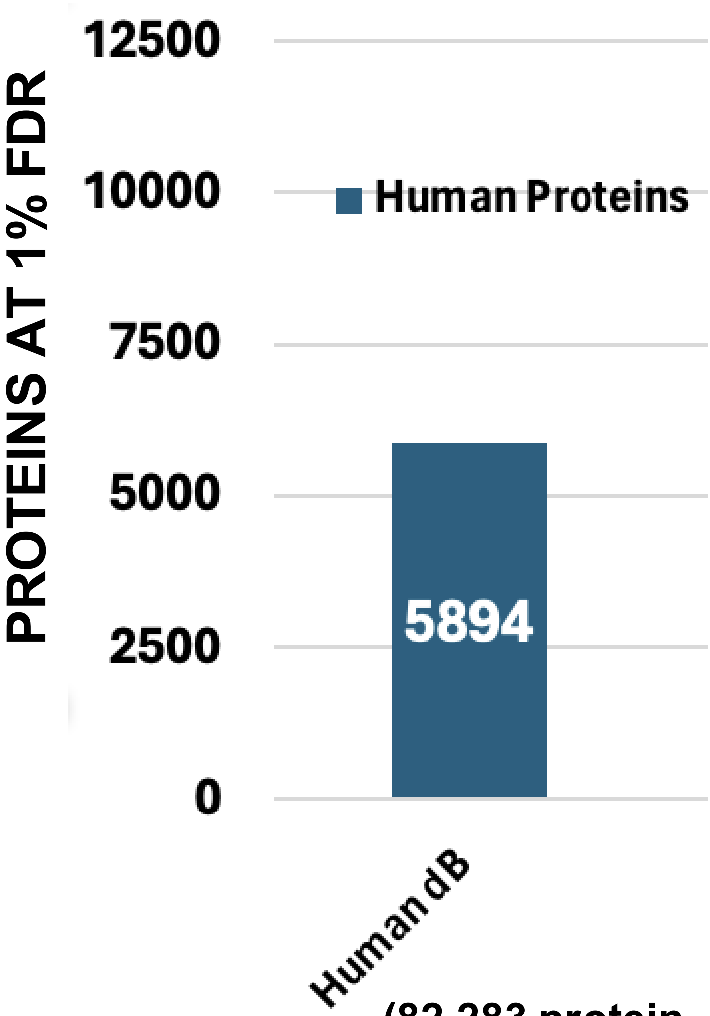
ORAL RINSE SAMPLES

Enrichment

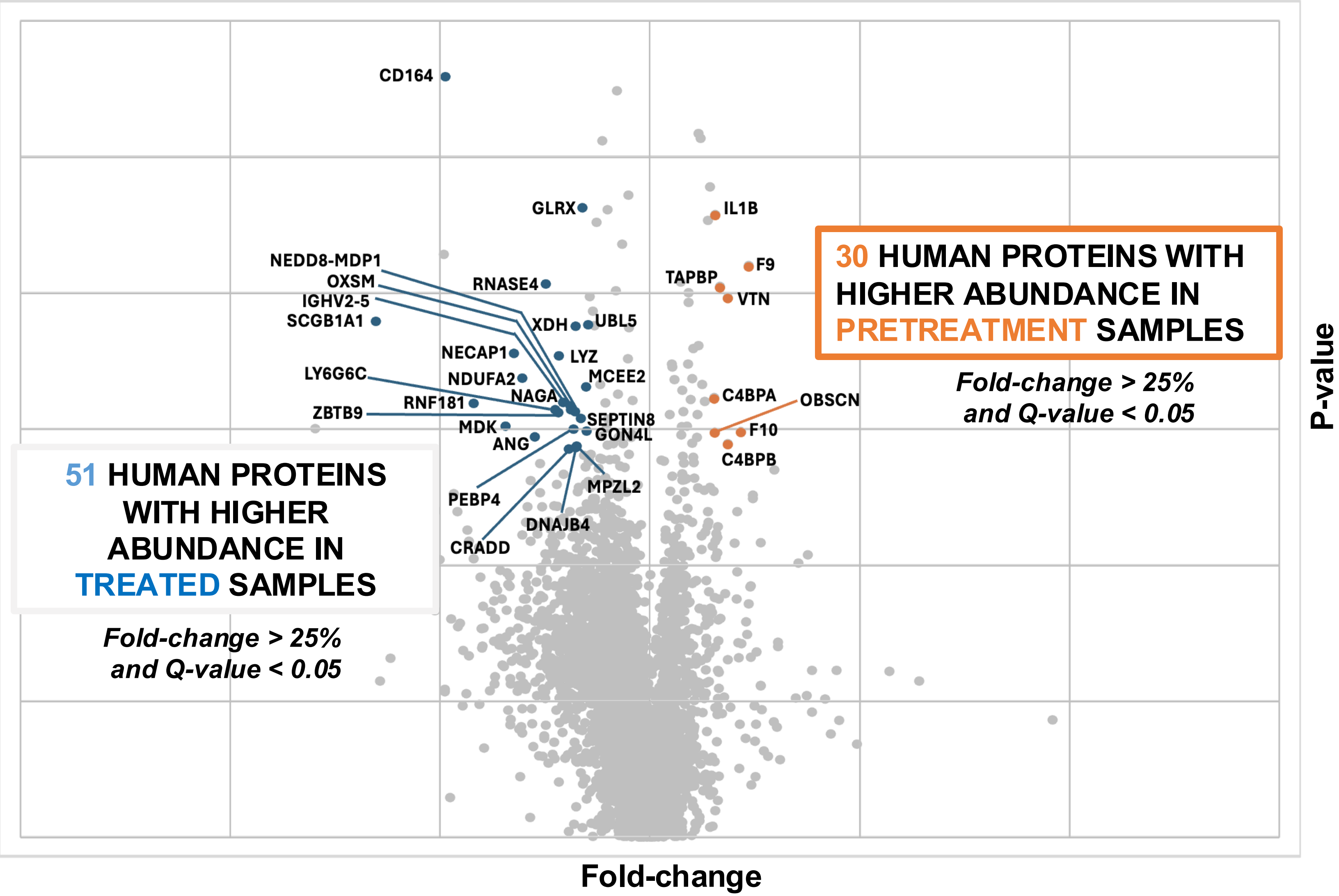
Mass spectrometry using DIA-PASEF

Search against Human + Microbiome Protein sequences dB

PROTEINS DETECTED AND DIFFERENTIALLY ABUNDANT PROTEINS



(82,283 protein Sequences)



51 HUMAN PROTEINS WITH HIGHER ABUNDANCE IN TREATED SAMPLES

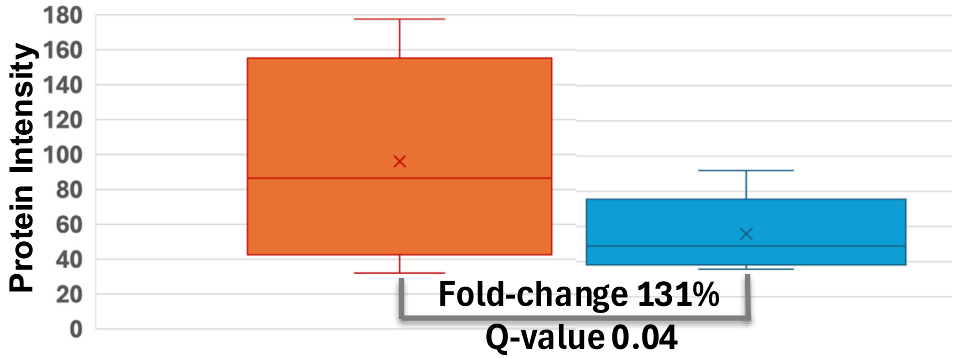
Fold-change > 25% and Q-value < 0.05

30 HUMAN PROTEINS WITH HIGHER ABUNDANCE IN PRETREATMENT SAMPLES

Fold-change > 25% and Q-value < 0.05

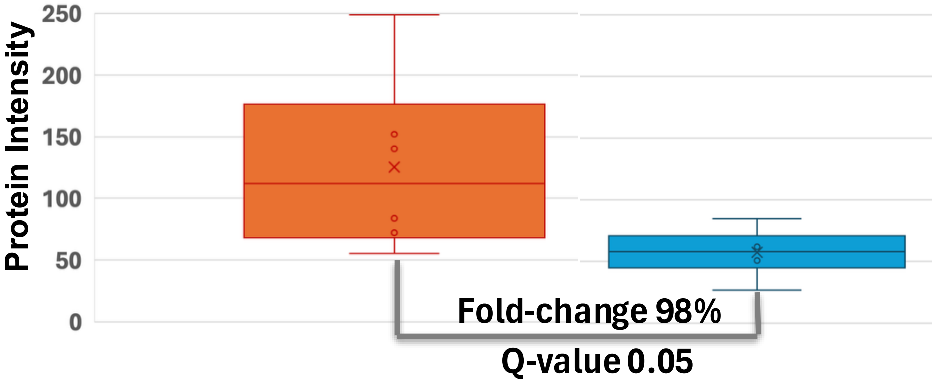
MMP1 & COAGULATION CASCADE: DOWNREGULATED AFTER TREATMENT

Interstitial collagenase MMP1 (17 peptides)



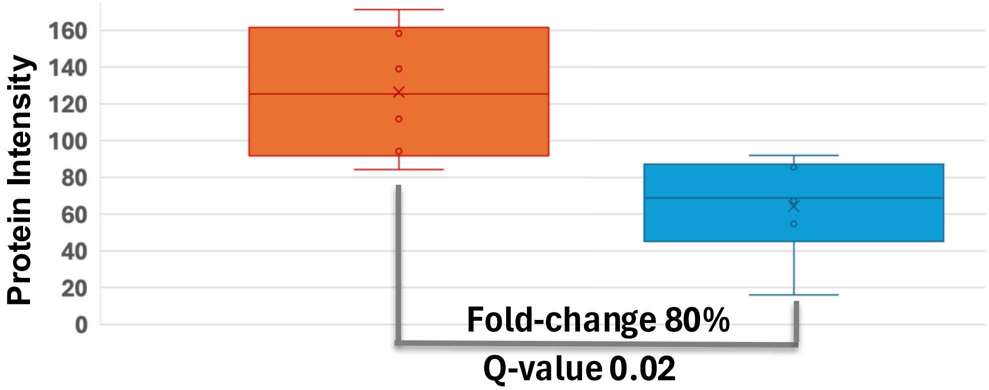
Fold-change 131%
Q-value 0.04

Vitamin K-dependent protein Z (3 peptides)



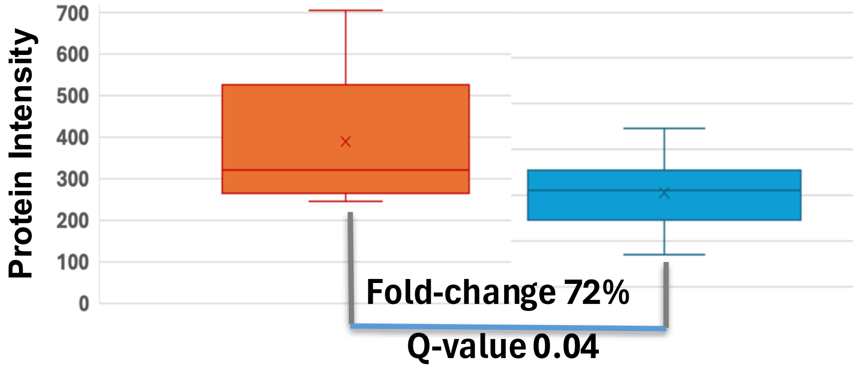
Fold-change 98%
Q-value 0.05

Coagulation factor IX (7 peptides)



Fold-change 80%
Q-value 0.02

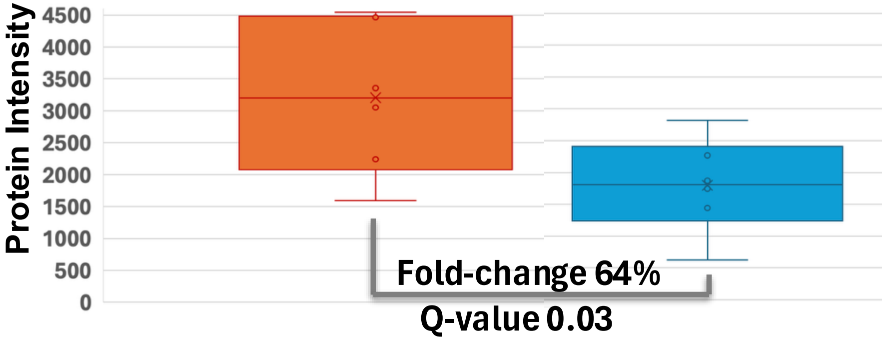
Coagulation factor X (6 peptides)



Fold-change 72%
Q-value 0.04

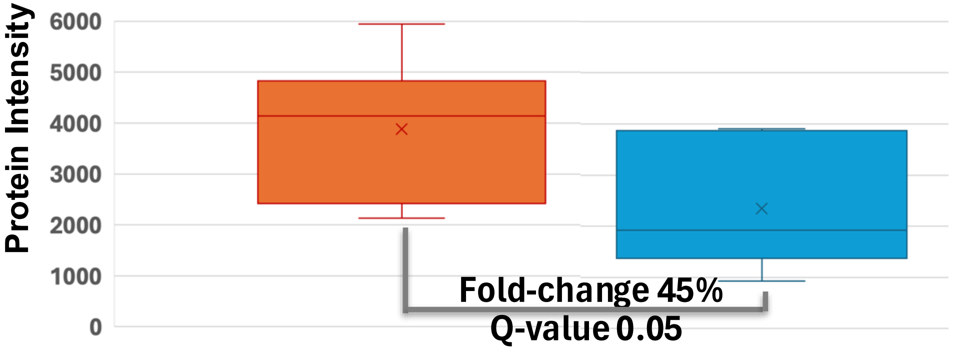
Coagulation Cascade

COMPLEMENT CASCADE: DOWNREGULATED AFTER TREATMENT



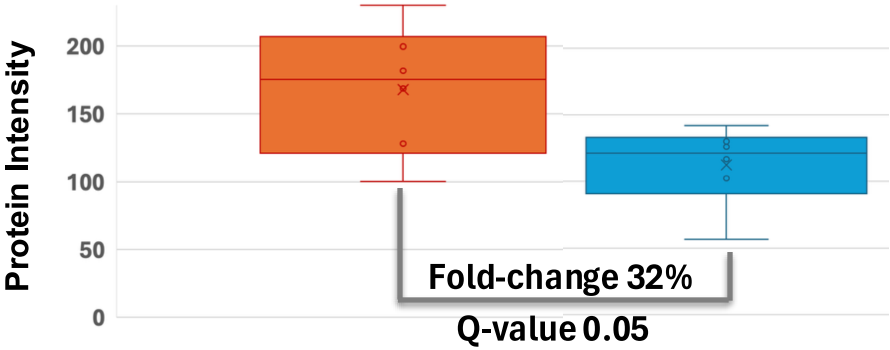
VITRONECTIN (12 peptides)

Fold-change 64%
Q-value 0.03



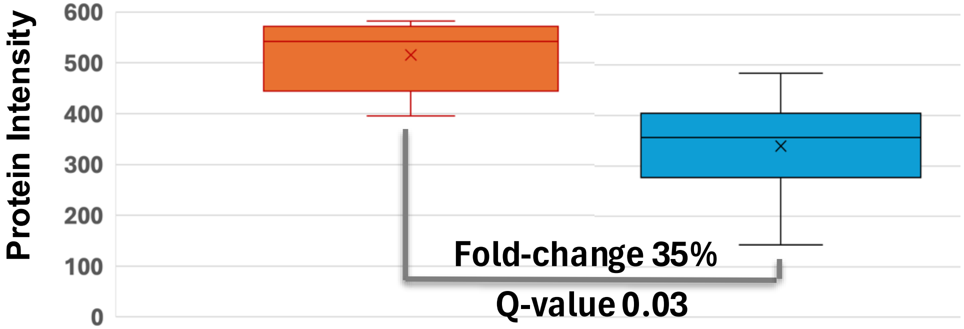
C4b-binding protein alpha chain (18 peptides)

Fold-change 45%
Q-value 0.05



Carboxypeptidase B2 (9 peptides)

Fold-change 32%
Q-value 0.05



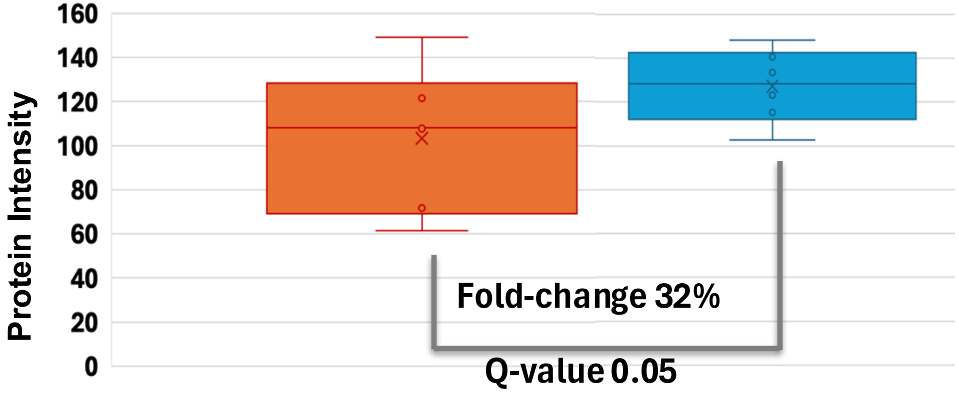
Complement component C8 beta chain (18 peptides)

Fold-change 35%
Q-value 0.03

Regulation of Complement cascade

APOPTOSIS: UPREGULATED AFTER TREATMENT

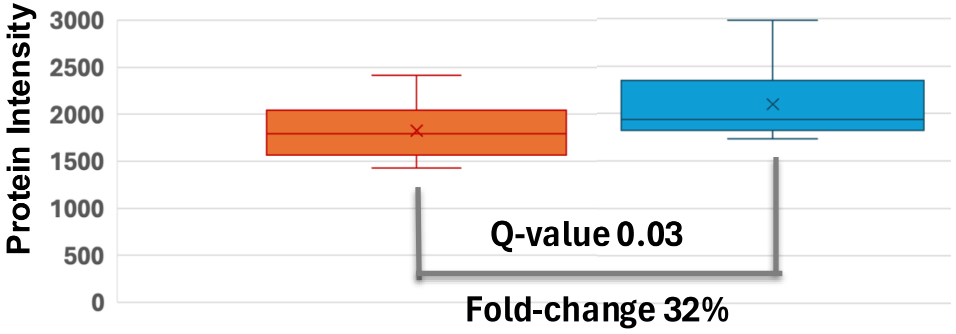
DESMOGLEIN-2 (16 peptides)



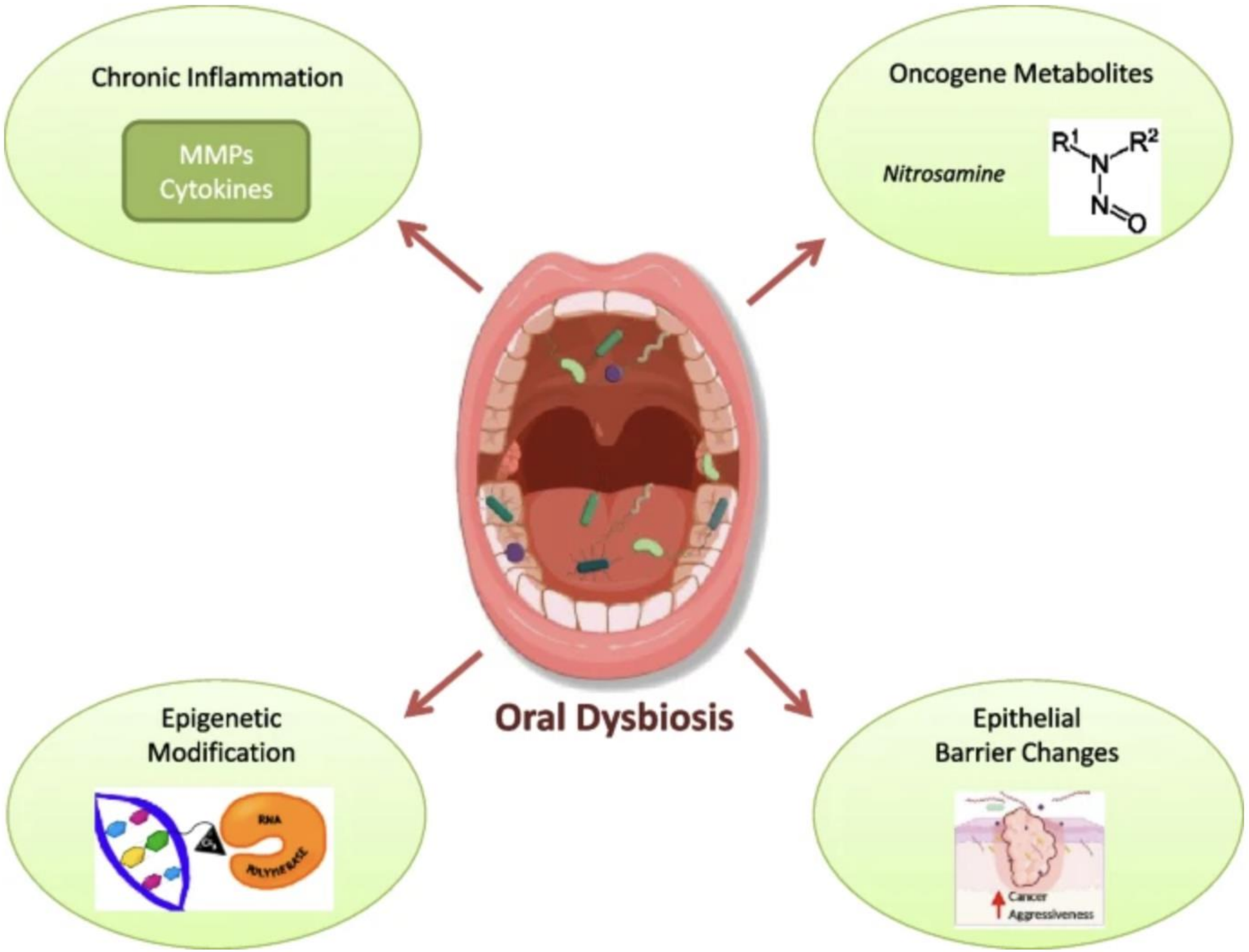
- Component of intercellular desmosome junctions mediating cell-cell adhesion.
- Involved in apoptotic pathway.
- Prognostic marker in renal cancer, pancreatic cancer, lung cancer, head and neck cancer, colorectal cancer and cervical cancer.

- An adaptor protein that is composed of two protein-protein interaction domains
- Functions as key mediator in apoptosis and inflammation via the activation of caspases.
- Prognostic marker in renal cancer

Apoptosis-associated speck-like protein containing a CARD (13 peptides)

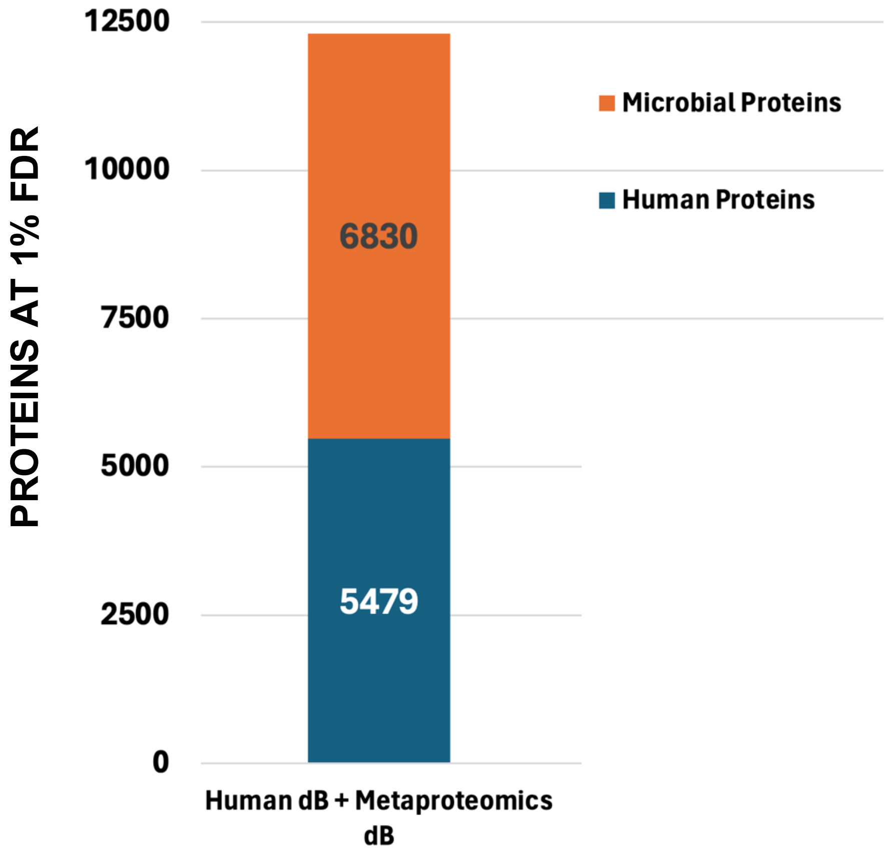


ROLE OF BACTERIA IN ORAL CANCER DEVELOPMENT

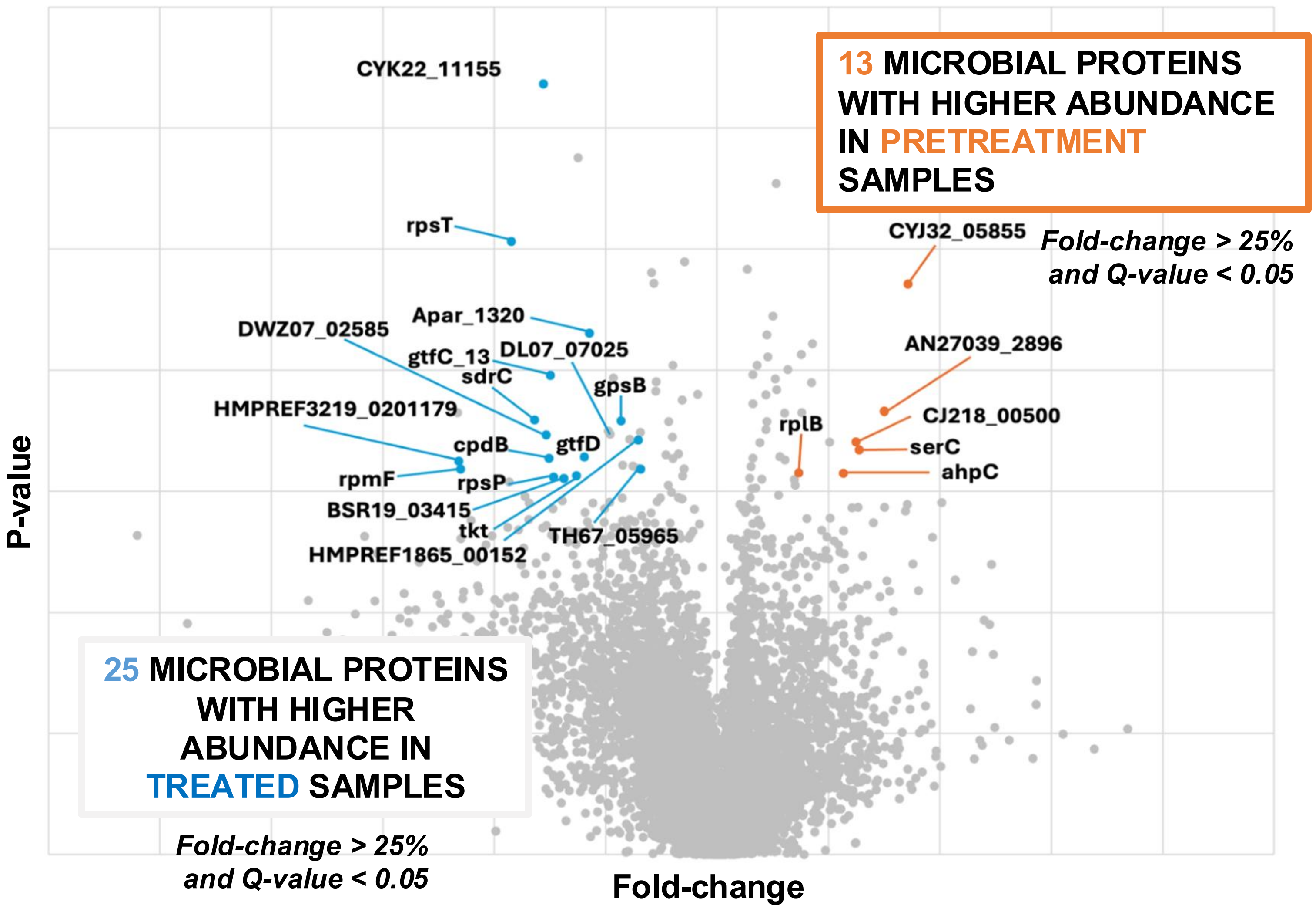


Asili, P., et al. J Gastrointest Canc (2023). https://doi.org/10.1007/s12029-022-00901-4

MICROBIAL DATABASE SEARCH RESULTS



(198,609 protein sequences)



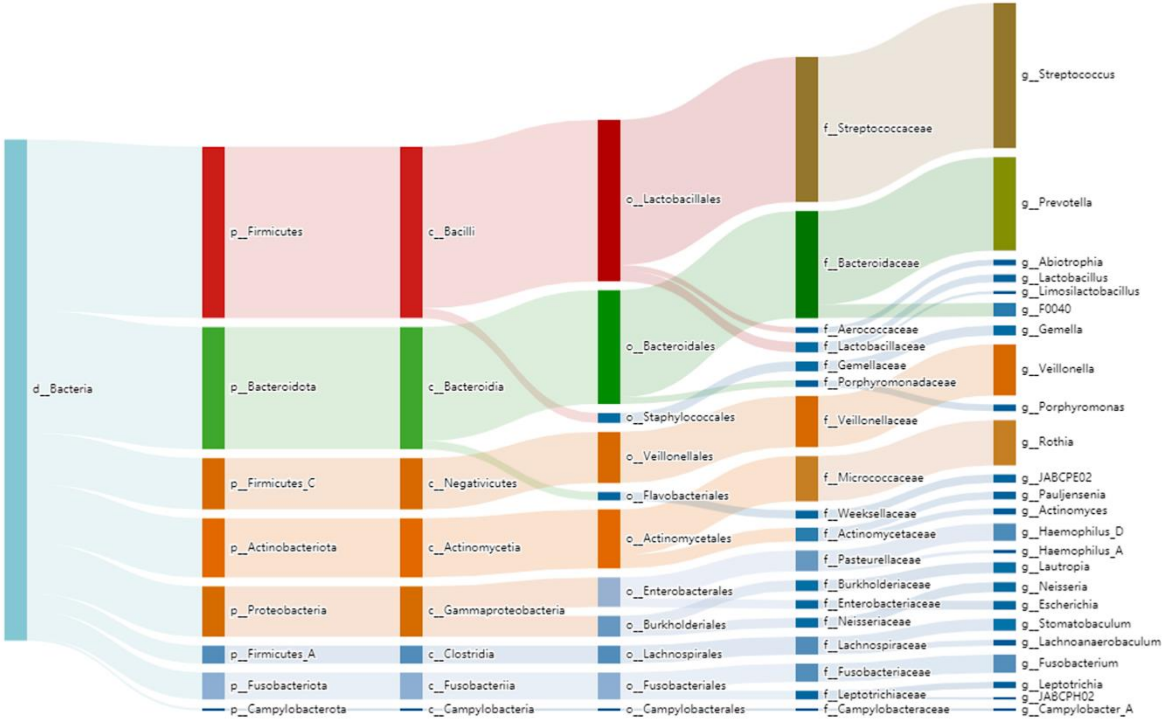
13 MICROBIAL PROTEINS WITH HIGHER ABUNDANCE IN PRETREATMENT SAMPLES

Fold-change > 25% and Q-value < 0.05

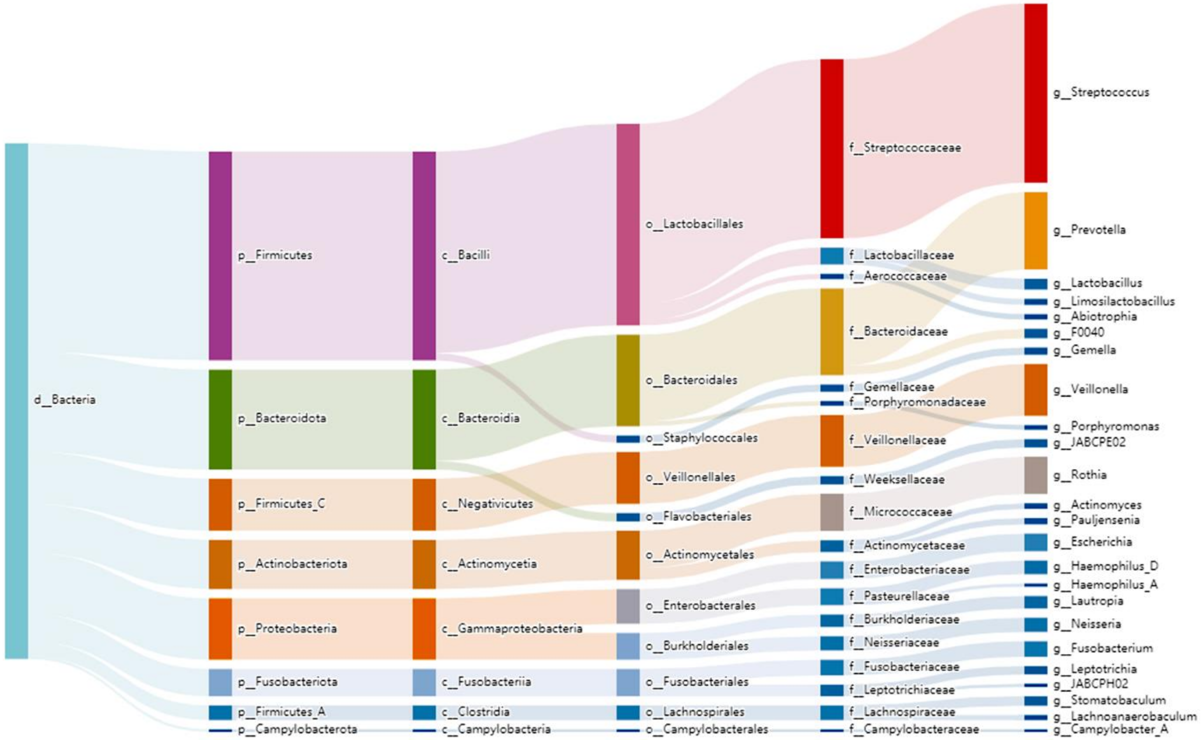
25 MICROBIAL PROTEINS WITH HIGHER ABUNDANCE IN TREATED SAMPLES

Fold-change > 25% and Q-value < 0.05

MICROBIAL TAXONOMY OUTPUTS



Genera detected in pretreated samples

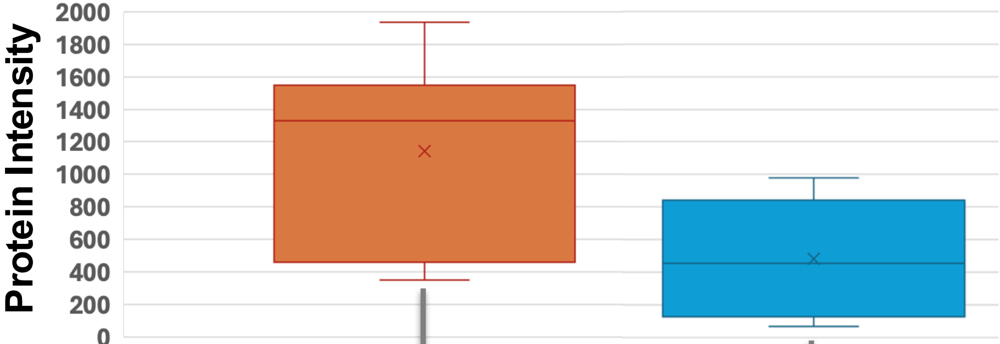


Genera detected in treatment samples

MetaLab ***and*** MetaX ***analysis by Kai Cheng, Qing Wu (Daniel Figeys Lab, University of Ottawa)***

MICROBIAL PROTEINS DOWNREGULATED AFTER TREATMENT

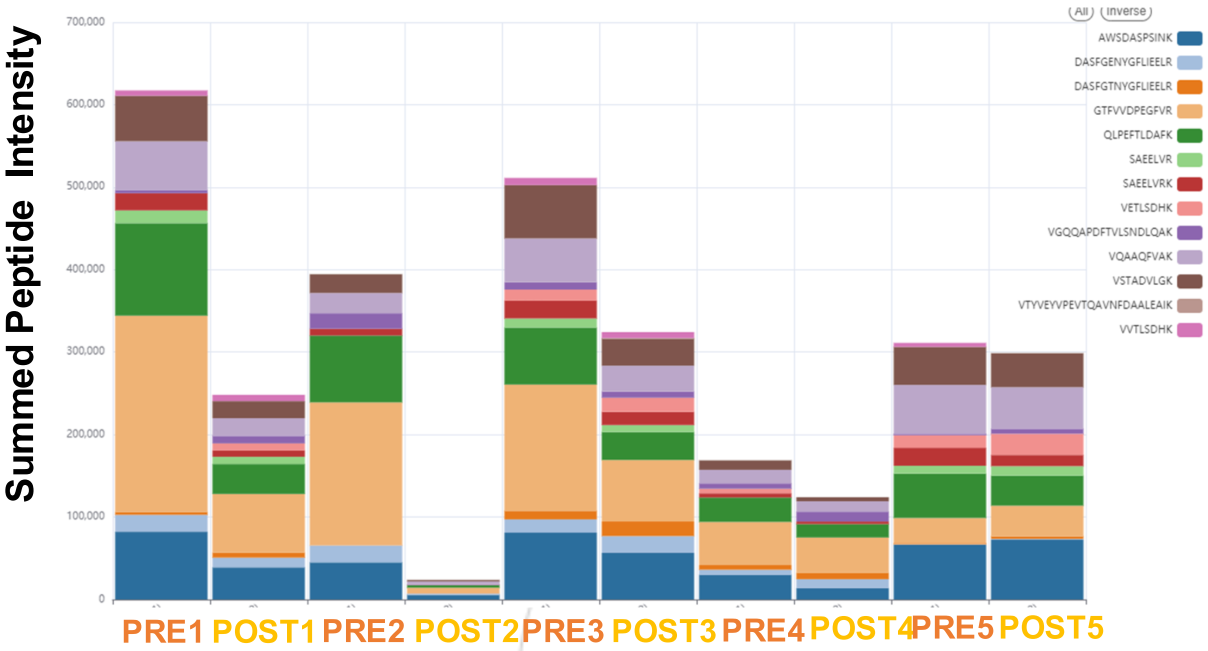
Alkyl hydroperoxide reductase C (11 peptides)



Fold-change 133%

Q-value 0.04

- **Responsible for the detoxification of reactive oxygen species.**
- **Survival under environmental stresses or during infection.**



In this study, the protein was expressed by *Veillonella* genus.

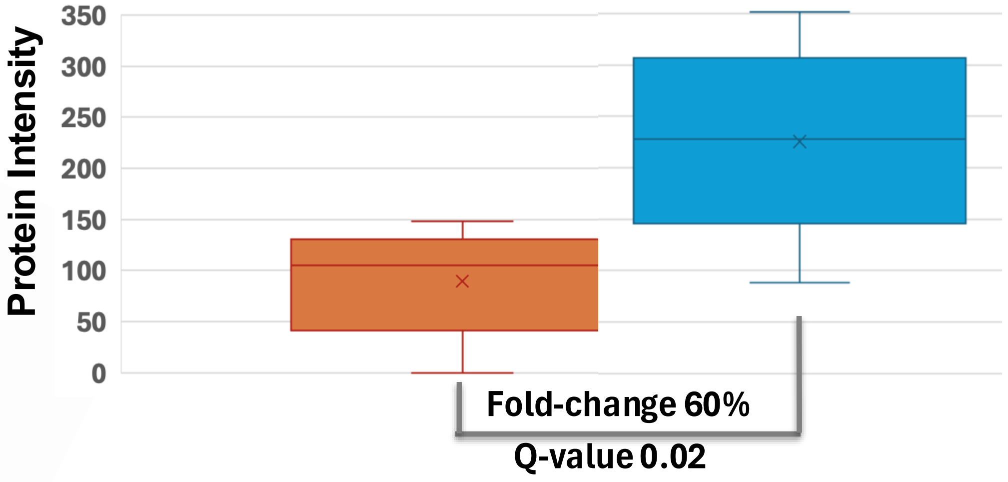
Veillonella

MetaLab and MetaX analysis by Kai Cheng, Qing Wu (Daniel Figeys Lab, University of Ottawa)

MICROBIAL PROTEINS UPREGULATED AFTER TREATMENT

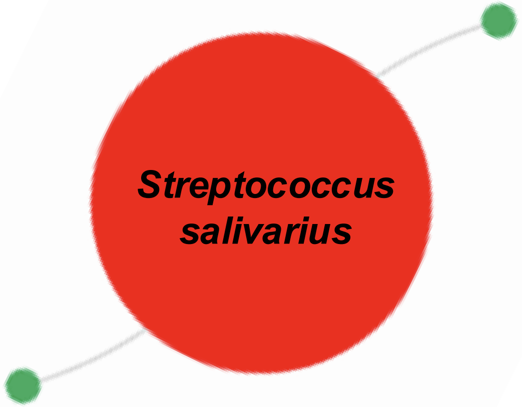
- **Glucosyltransferase that catalyzes the transfer of glucosyl residues to dextran polymer.**
- **Involved in biofilm formation.**

Dextransucrase (61 peptides)

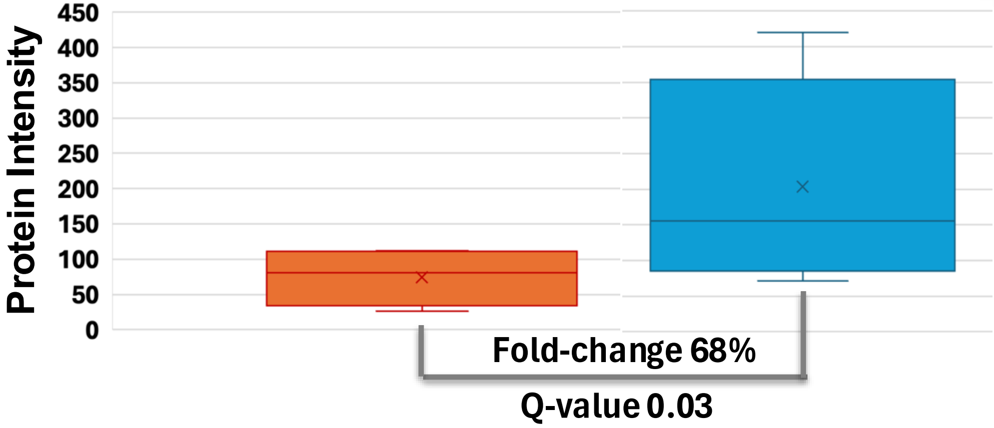


Fold-change 60%

Q-value 0.02



serine-type D-Ala-D-Ala carboxypeptidase (21 peptides)



Fold-change 68%

Q-value 0.03

- **Involved in bacterial cell wall synthesis by mediating peptidoglycan cross-linking.**

PEPTIDES FOR TARGETED ANALYSIS

	AFTER TREATMENT	
HUMAN PROTEINS	UP-REGULATED	DOWN-REGULATED
	Peptides (for targeted analysis)	Peptides (for targeted analysis)
Desmoglein-2	16 (3)	
Apoptosis-associated speck-like protein containing a CARD	13 (6)	
Chitinase-3-like protein 2	14 (5)	
Cathepsin D	18 (10)	
Lymphocyte antigen 6 complex locus protein G6c	2 (2)	
Lysozyme C	8 (7)	
Alpha-N-acetylgalactosaminidase	5 (3)	
Receptor-type tyrosine-protein phosphatase S	21 (6)	
Interstitial collagenase MMP1		17 (1)
Coagulation factor IX		7 (2)
Coagulation factor X		6 (2)
Vitronectin		12 (4)
C4b-binding protein alpha chain		18 (4)
Carboxypeptidase B2		9 (3)
Complement component C8 beta chain		6 (4)
MICROBIAL PROTEINS		
Dextransucrase	61 (3)	
Serine-type D-Ala-D-Ala carboxypeptidase	21 (2)	
Glutamate--ammonia ligase	7 (2)	
Alkyl hydroperoxide reductase C		11 (5)

ORAL CANCER DATASET: CONCLUSIONS AND FUTURE WORK

- **Several human, microbial proteins were detected to be differentially abundant in pretreatment and treated samples.**
- **Pathways such as coagulation and complement cascade were downregulated and apoptotic pathways were upregulated after treatment.**
- **Microbial functions associated with glucosyltransferase activity were upregulated and oxidative stress functions were downregulated after treatment.**
- **Peptides associated with differentially abundant human and microbial proteins will be used for targeted analysis.**

CLINICAL METAPROTEOMICS WORKFLOW TO STUDY HOST-MICROBIOME DYNAMICS

- *MICROBIOME RESEARCH*
- *MASS SPECTROMETRY DATA ANAYSIS*
- *METAPROTEOMICS RESEARCH*

- *GALAXY BIOINFORMATICS PLATFORM*

- *CLINICAL METAPROTEOMICS WORKFLOW*
- *CLINICAL METAPROTEOMICS:COVID-19 PANDEMIC*
- *CLINICAL METAPROTEOMICS:CYSTIC FIBROSIS*
- *CLINICAL METAPROTEOMICS: ORAL CANCER*

- *METAPROTEOMICS EDUCATION*

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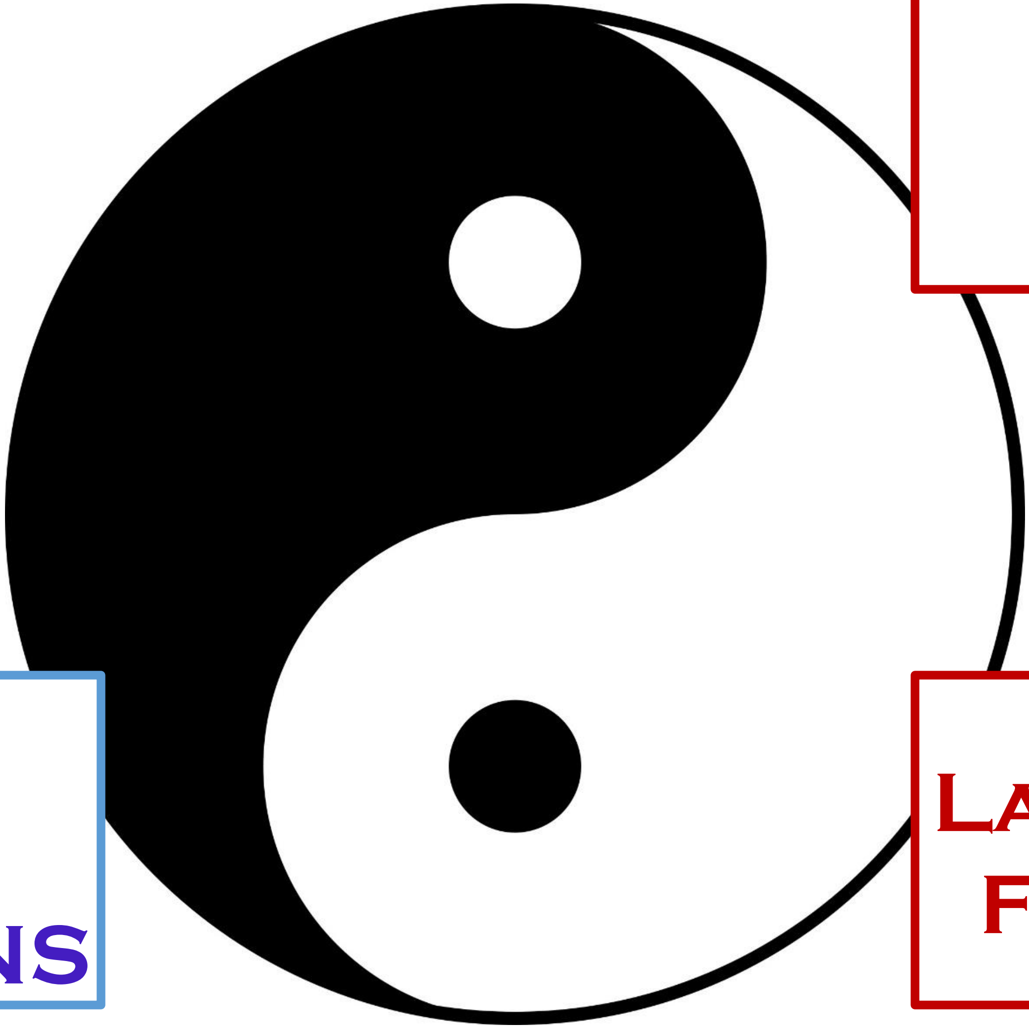
- *CLINICAL METAPROTEOMICS: ORAL CANCER*

- ***METAPROTEOMICS EDUCATION***

METAPROTEOMICS: STRENGTHS & CHALLENGES



FUNCTIONAL COMPOSITION

HOST-MICROBIOME INTERACTION

QUANTIFYING BIOMASS CONTRIBUTIONS

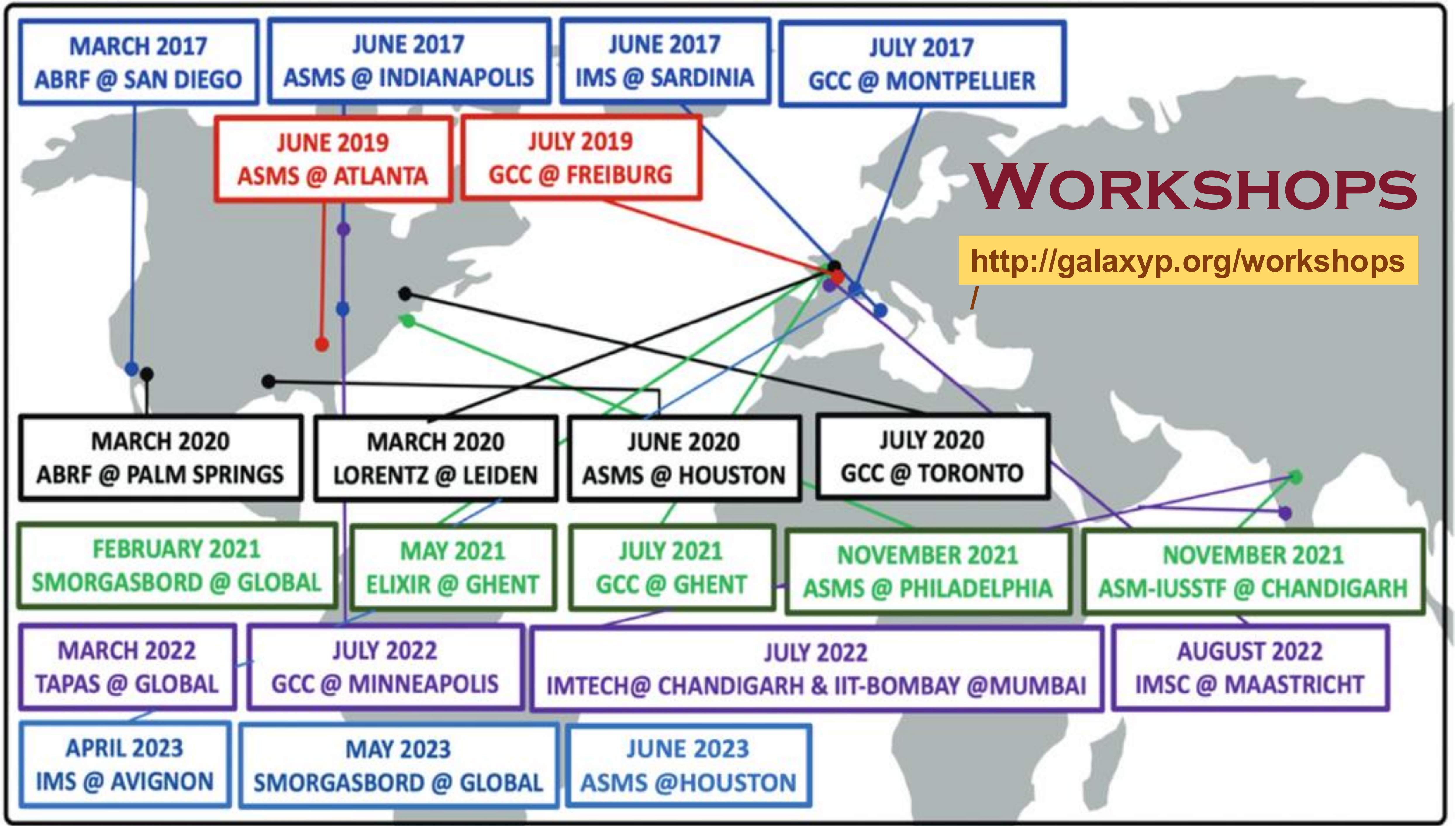
PROTEIN EXTRACTION

VARIABILITY & ABUNDANCE

Large Databases False Positives

WORKSHOPS

http://galaxyp.org/workshops/



MARCH 2017
ABRF @ SAN DIEGO

JUNE 2017
ASMS @ INDIANAPOLIS

JUNE 2017
IMS @ SARDINIA

JULY 2017
GCC @ MONTPELLIER

JUNE 2019
ASMS @ ATLANTA

JULY 2019
GCC @ FREIBURG

MARCH 2020
ABRF @ PALM SPRINGS

MARCH 2020
LORENTZ @ LEIDEN

JUNE 2020
ASMS @ HOUSTON

JULY 2020
GCC @ TORONTO

FEBRUARY 2021
SMORGASBORD @ GLOBAL

MAY 2021
ELIXIR @ GHENT

JULY 2021
GCC @ GHENT

NOVEMBER 2021
ASMS @ PHILADELPHIA

NOVEMBER 2021
ASM-IUSSTF @ CHANDIGARH

MARCH 2022
TAPAS @ GLOBAL

JULY 2022
GCC @ MINNEAPOLIS

JULY 2022
IMTECH@ CHANDIGARH & IIT-BOMBAY @MUMBAI

AUGUST 2022
IMSC @ MAASTRICHT

APRIL 2023
IMS @ AVIGNON

MAY 2023
SMORGASBORD @ GLOBAL

JUNE 2023
ASMS @HOUSTON

Galaxy Training Network

https://galaxyproject.org/events/gcc2021/training/

https://training.galaxyproject.org/training-material/topics/proteomics/

The Galaxy-P team seeks to continue integrating promising new software tools and workflows from leading laboratories into the Galaxy platform and encourages researchers to share their interests so that newer bioinformatics workflows can be made accessible via this resource.

EDUCATION PORTAL @ METAPROTEOMICS INITIATIVE

https://metaproteomics.org/education/

Want to stay up to date about the metaproteomics field and the Initiative?
Become a member via www.metaproteomics.org!

@MetaP_Init
info@metaproteomics.org

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Nashville, TN

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MOCA MINNESOTA OVARIAN CANCER ALLIANCE

MASONIC CANCER CENTER UNIVERSITY OF MINNESOTA

http://galaxyp.org/contact/

galaxyp.org

QUESTIONS?