FOOD FOR HEALTH IRELAND

Decoding Functional Foods using Mass Spectrometry

Dr. Eugene Dillon

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UCD DUBLIN · UCC University College Cork, Ireland · University of Limerick · Teagasc · DCU · National University of Ireland Galway · NUI Maynooth · Carbery · glanbia · Kerry · Ornua The Home of Irish Dairy · Technology Centre Enterprise Ireland IDA Ireland Supported

Overview

Introduction to FHI & Bioactive peptides

Mass Spectrometric characterization

Application

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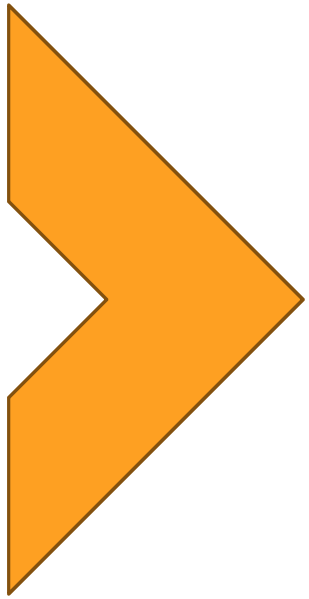
What is FHI?

- **Partnership between:**
  - Public Research Organizations
  - Irish food industry
- **Funded by**
  - Enterprise Ireland and Industry partners
  - Budget € 19,2 mio plus in-kind contributions
  - Second 5-year term, since September 2013
- **Industry-led research agenda:**
  - Research on functionality of milk components
  - Infant nutrition, glycemic management, appetite modulation, healthy ageing, healthy cheeses, technology
  - Strong market position of industry partners



FHI combines world-class science and industry expertise to improve health, wellness and quality of life through innovation in food

Five competitors working together in FHI

glanbia INGREDIENTS IRELAND LIMITED

CARBERY

KERRY

Dairygold Food INGREDIENTS

Ornua THE HOME OF IRISH DAIRY

- Competitors in the market, pre-competitive research together
  - World class research requires collaboration
  - Results of research brought to consumers in competitive way
- Direct Industry input makes program highly relevant to industry customers
- Access to FHI research and inventions through the industry partners

Model for "Open Innovation"

fhi FOOD FOR HEALTH IRELAND

All Irish food science capabilities working together for FHI

FHI target groups and health benefit areas

Target groups	**Infants, Mothers**	**Obese, Diabetics**	**Elderly, Athletes**
Target health benefits	Functionality/ composition of mother's milk	Appetite Modulation	Healthy ageing and muscle health
	Maternal nutrition	Glycemic Management	Performance nutrition
Nutritional food matrix	**Healthy Cheeses**	Health benefits of cheese	
Enabler	**Technology**	Generation, characterization, u p-scaling, delivery matrices	

Protein functional food

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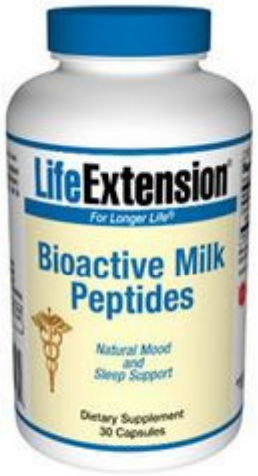
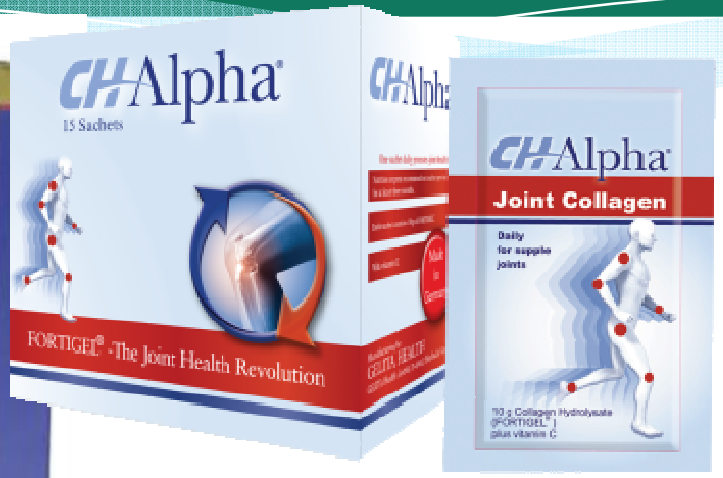
Bioactive peptide as functional food ingredient





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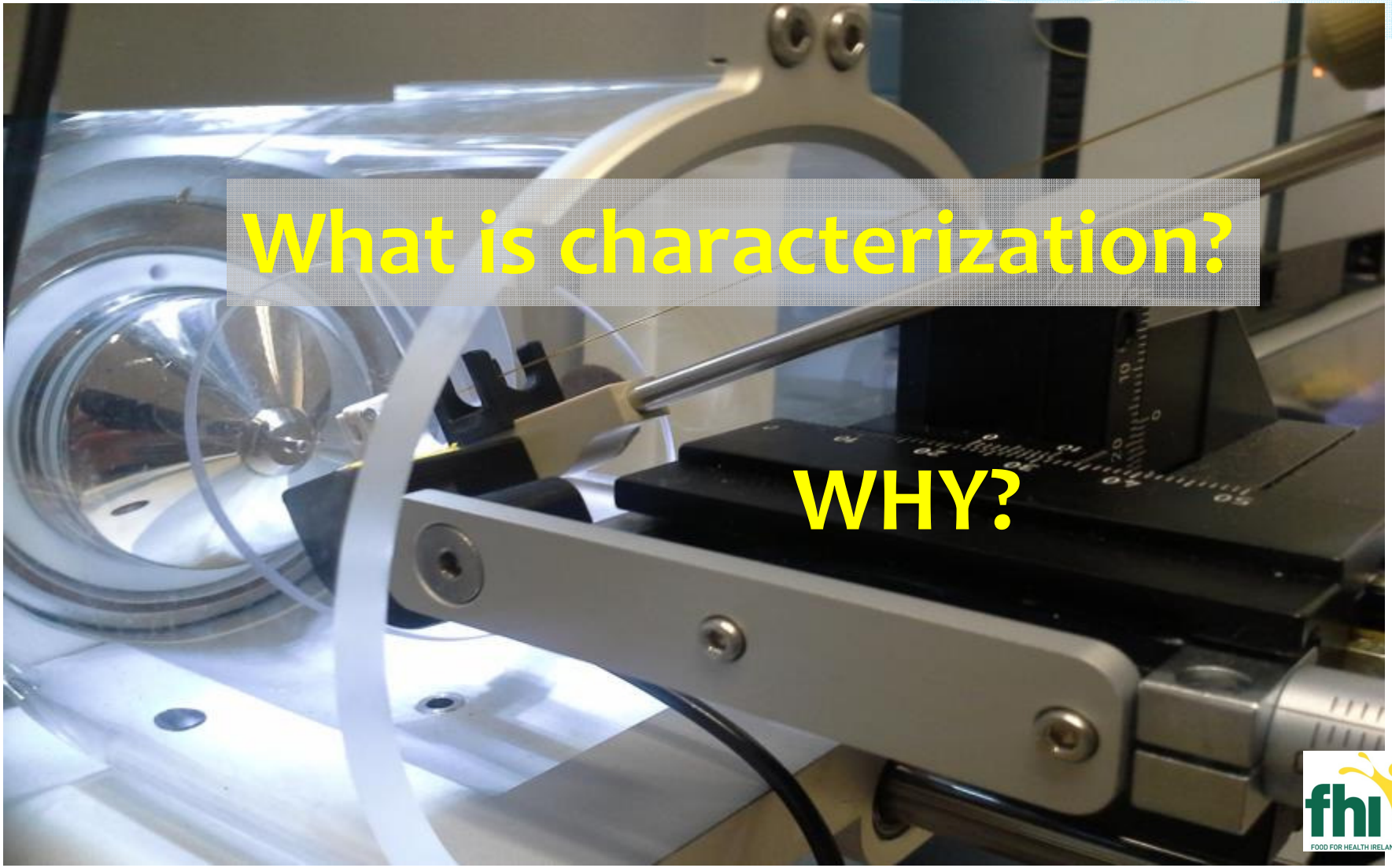
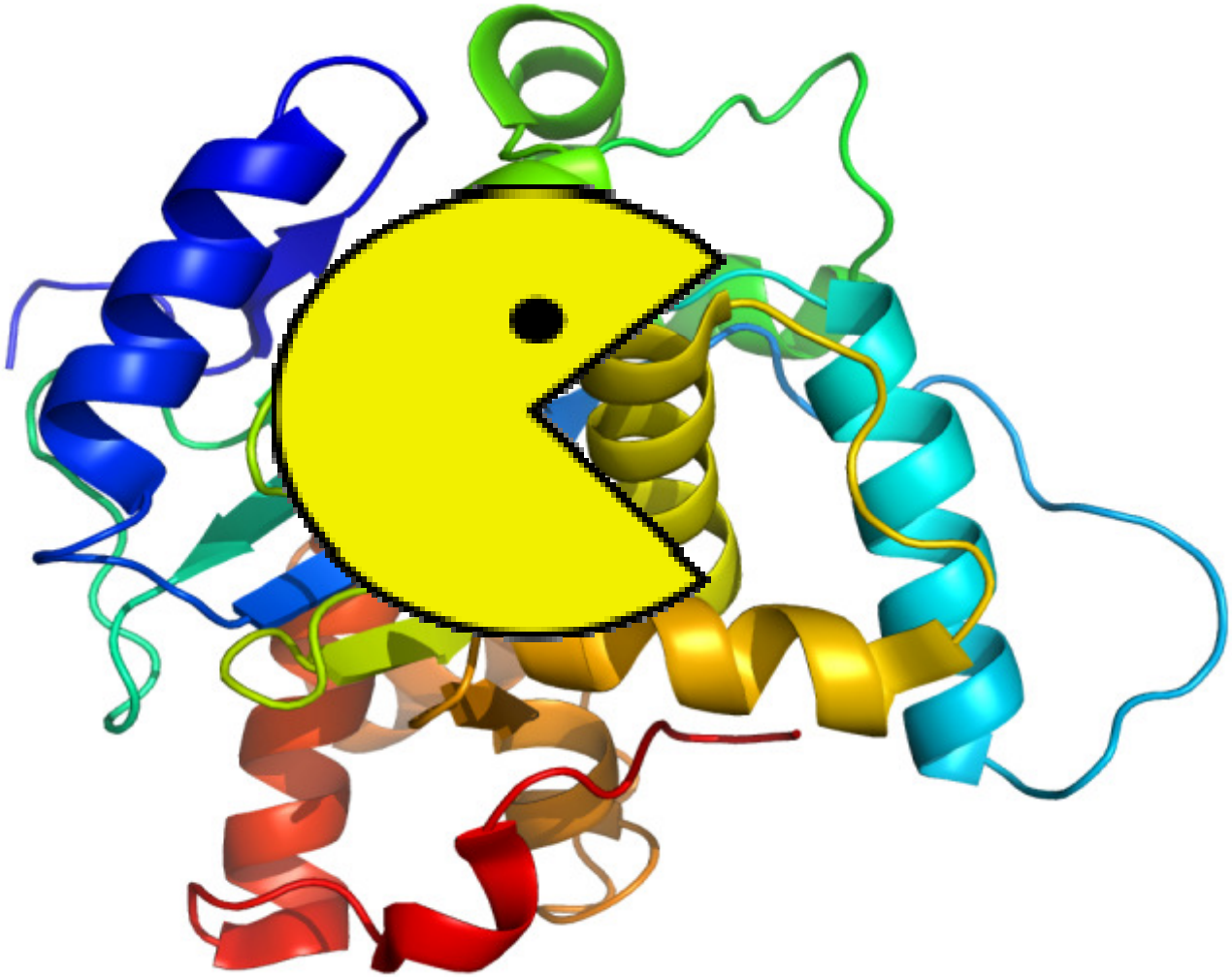
Characterization of bioactive peptides



Proteins to bioactive peptides



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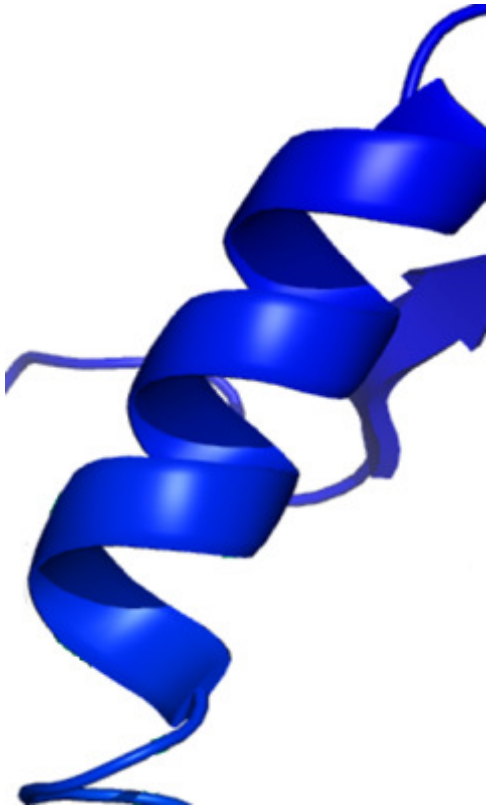
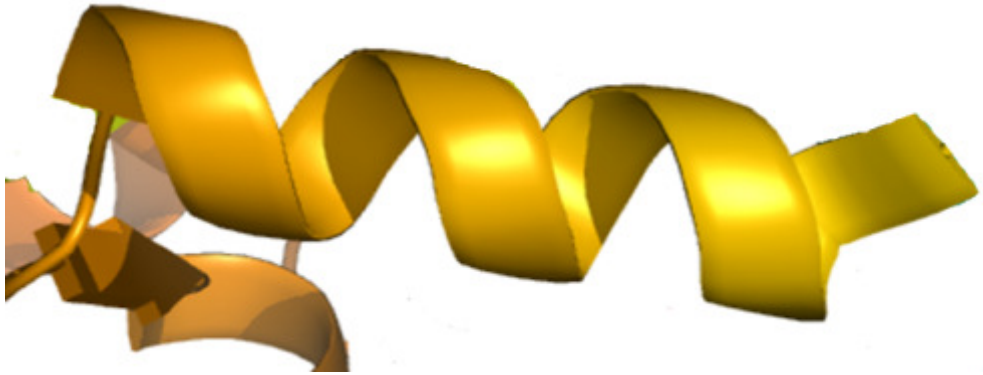
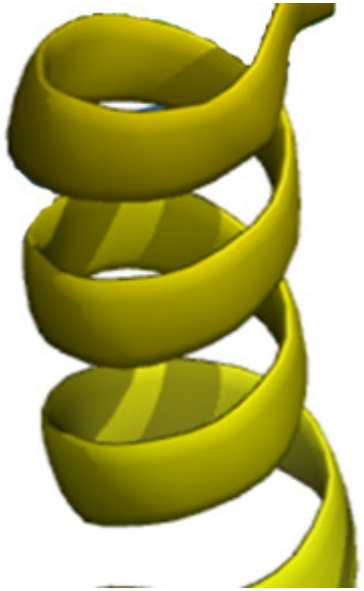
Proteins to bioactive peptides







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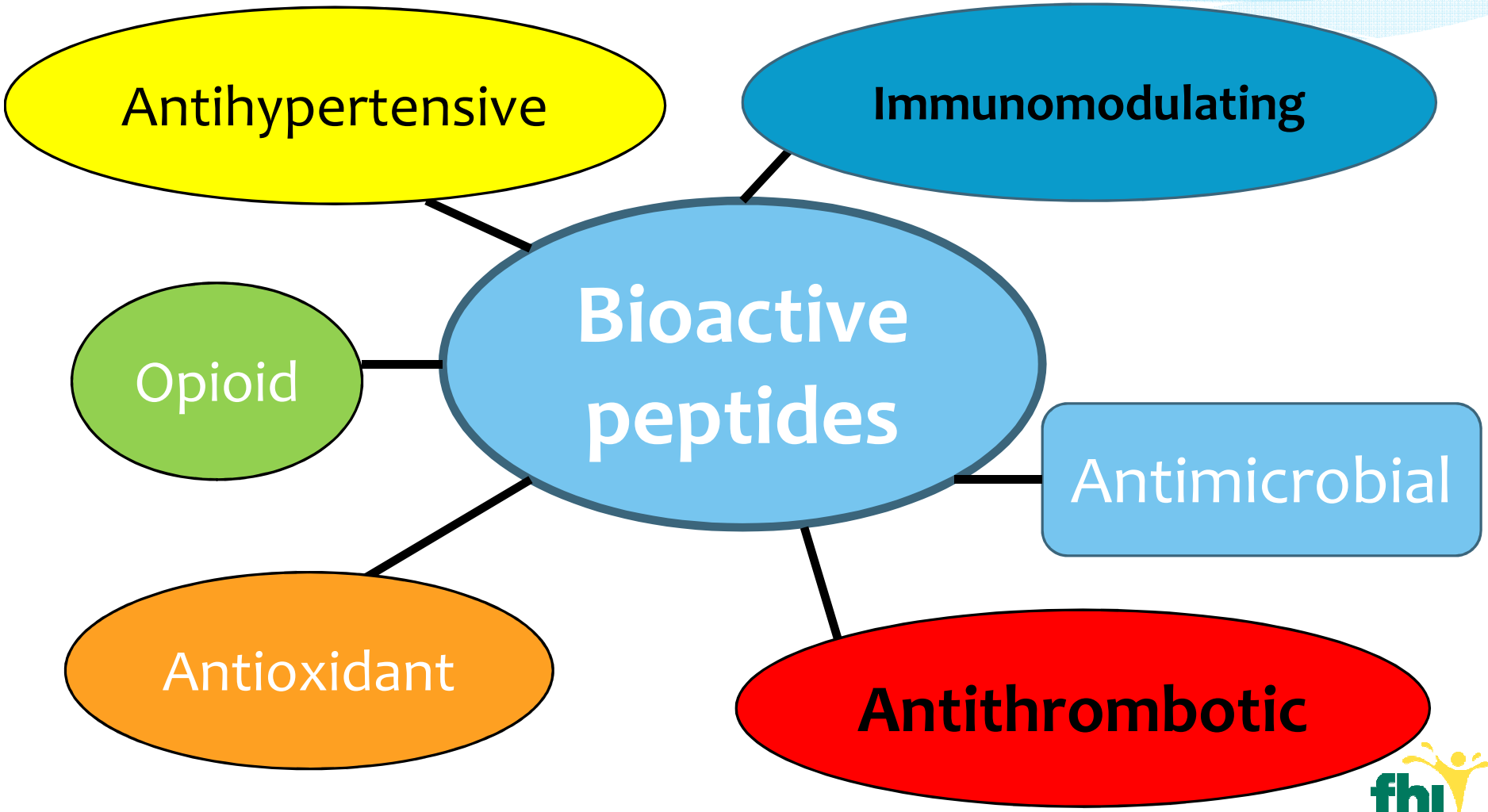
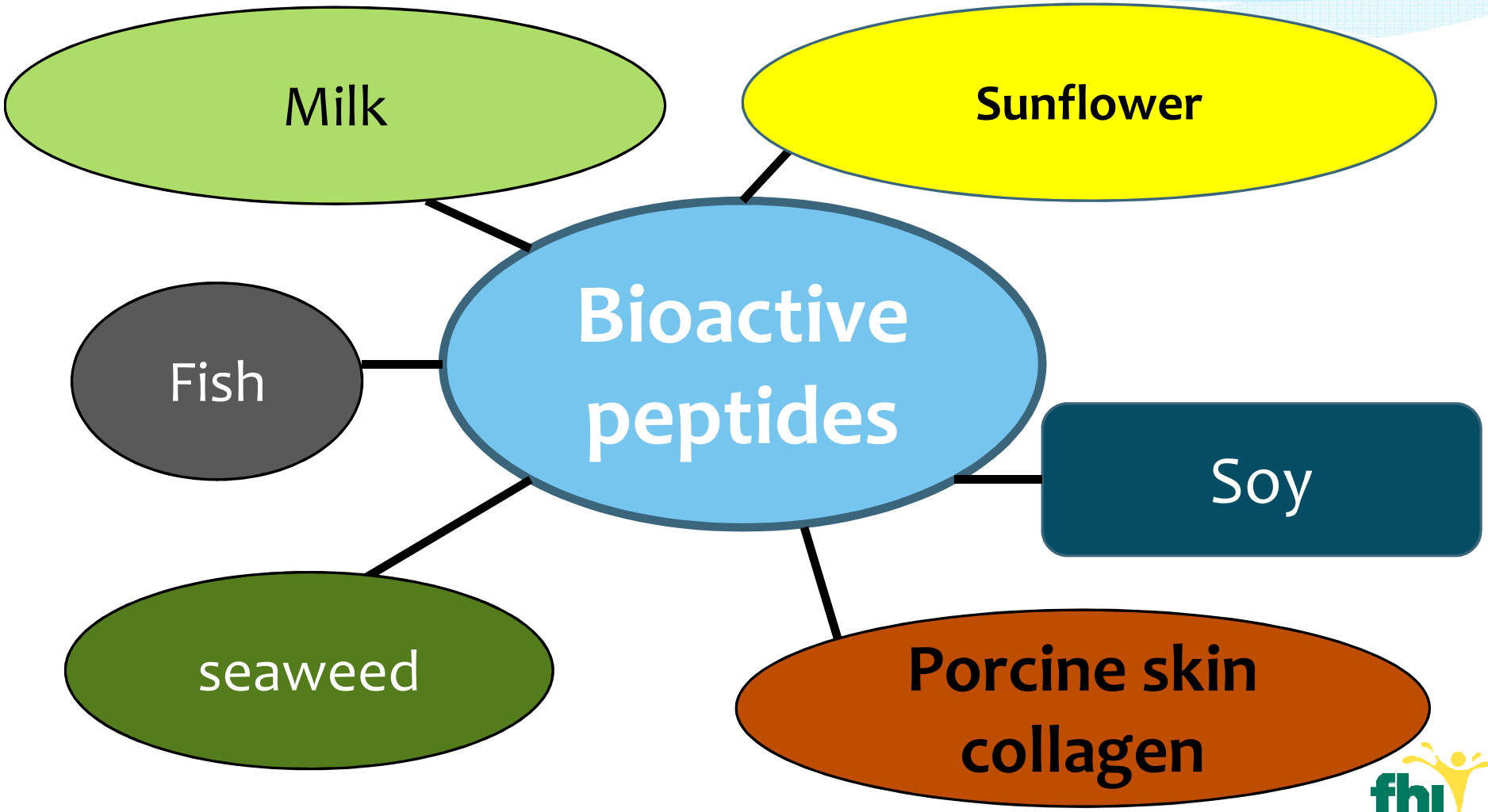
Biological effects in maintenance of health, disease and performance



Variety of food sources



Milk as rich source of bioactive peptides

Milk as rich source of bioactive peptides

Antihypertensive

Immunomodulating

Opioid

Antimicrobial

Antioxidant

Antithrombotic

Mass spectrometry & bioinformatics team

Dr. Gerard Cagney
Group Leader
Cagney Proteomics

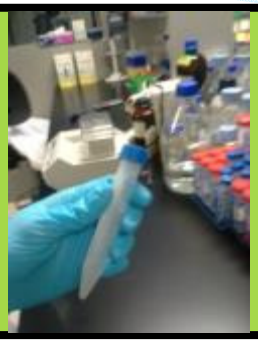
Dr. Eugene Dillon
Postdoctoral Scientist
Nutritional proteomics

Prof. Denis Shields
Group Leader
Shields Bioinformatics Group

Dr. Therese Holton
Postdoctoral Scientist
Food bioinformatics

Mass Spectrometry

Sample Preparation



Mass Spectrometry

Computational analysis

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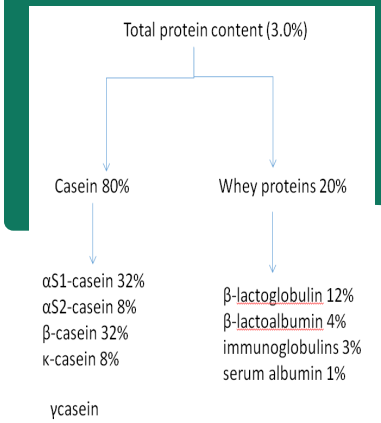
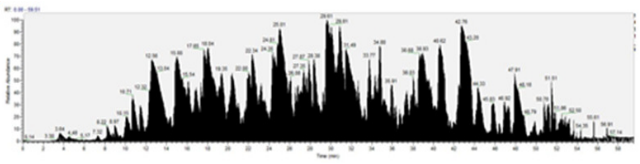
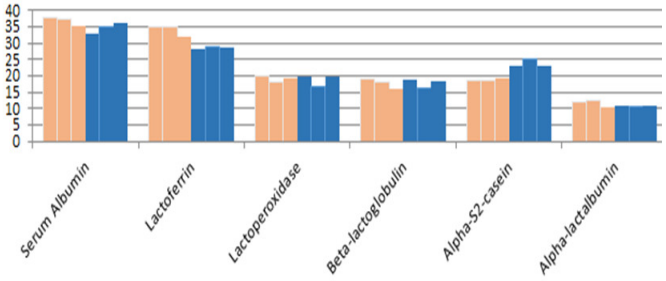
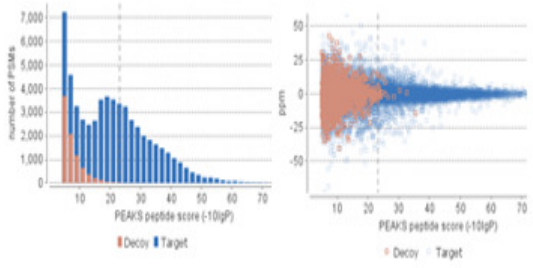
The 'dark matter' of milk

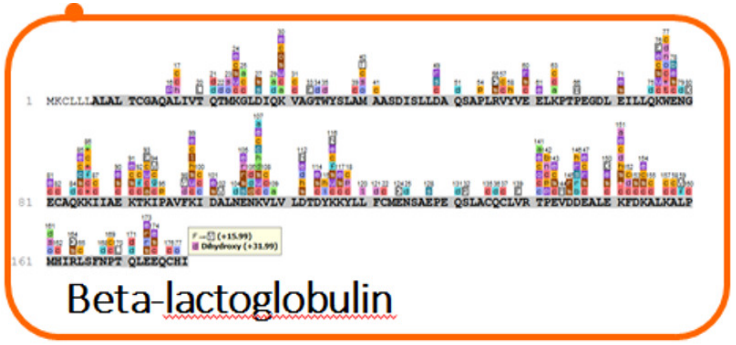








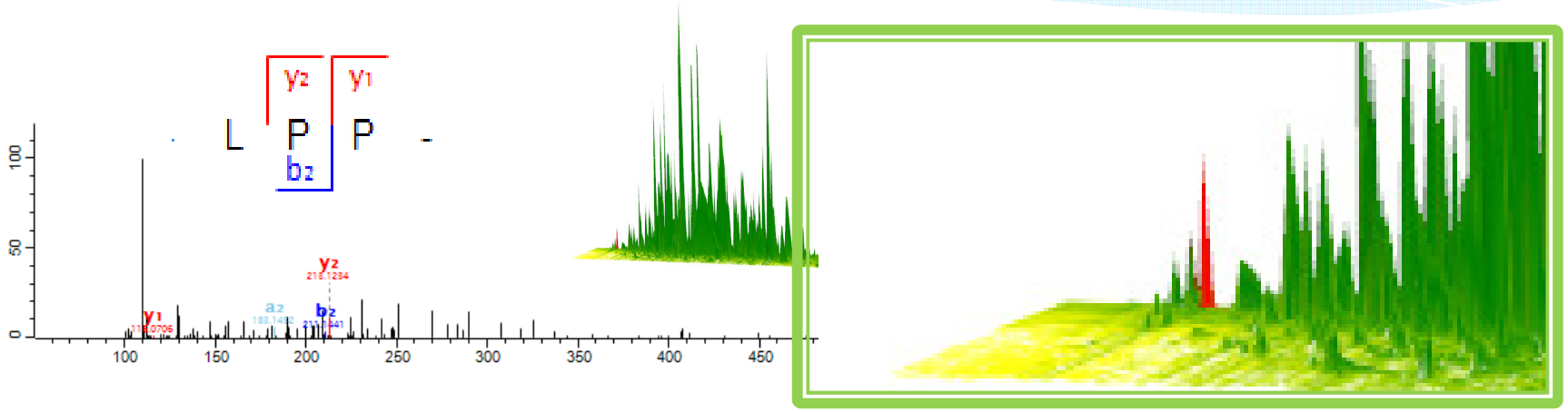
- *>10% of 'peptide-like' features are being identified*
- *Using* de novo *match algorithms, we have increased this to 25%*

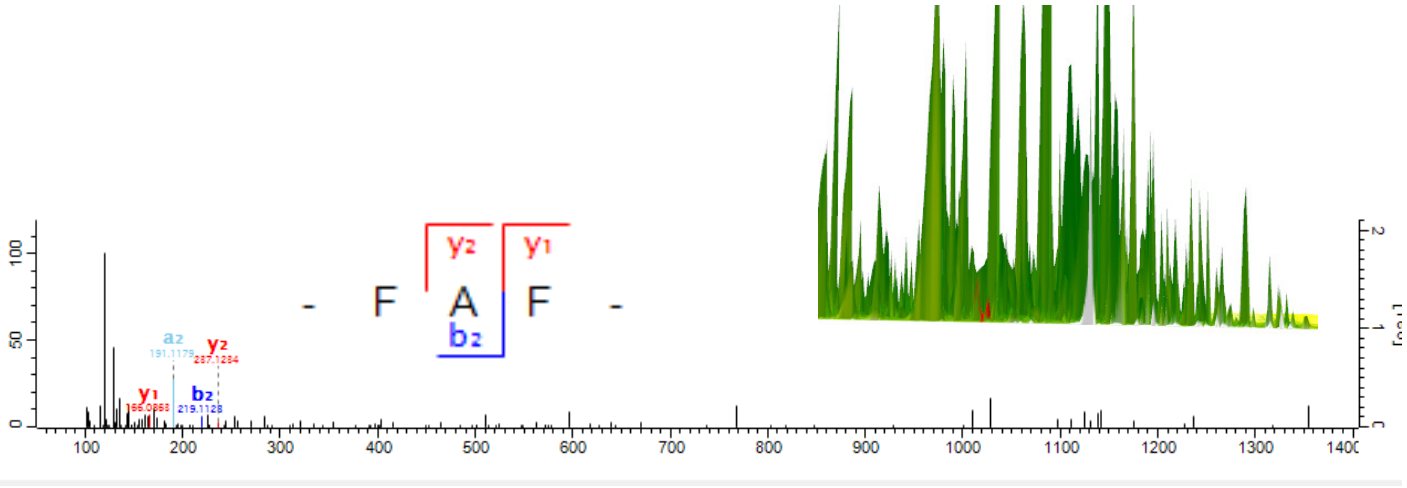


<u>*Outputs for FHI*</u>

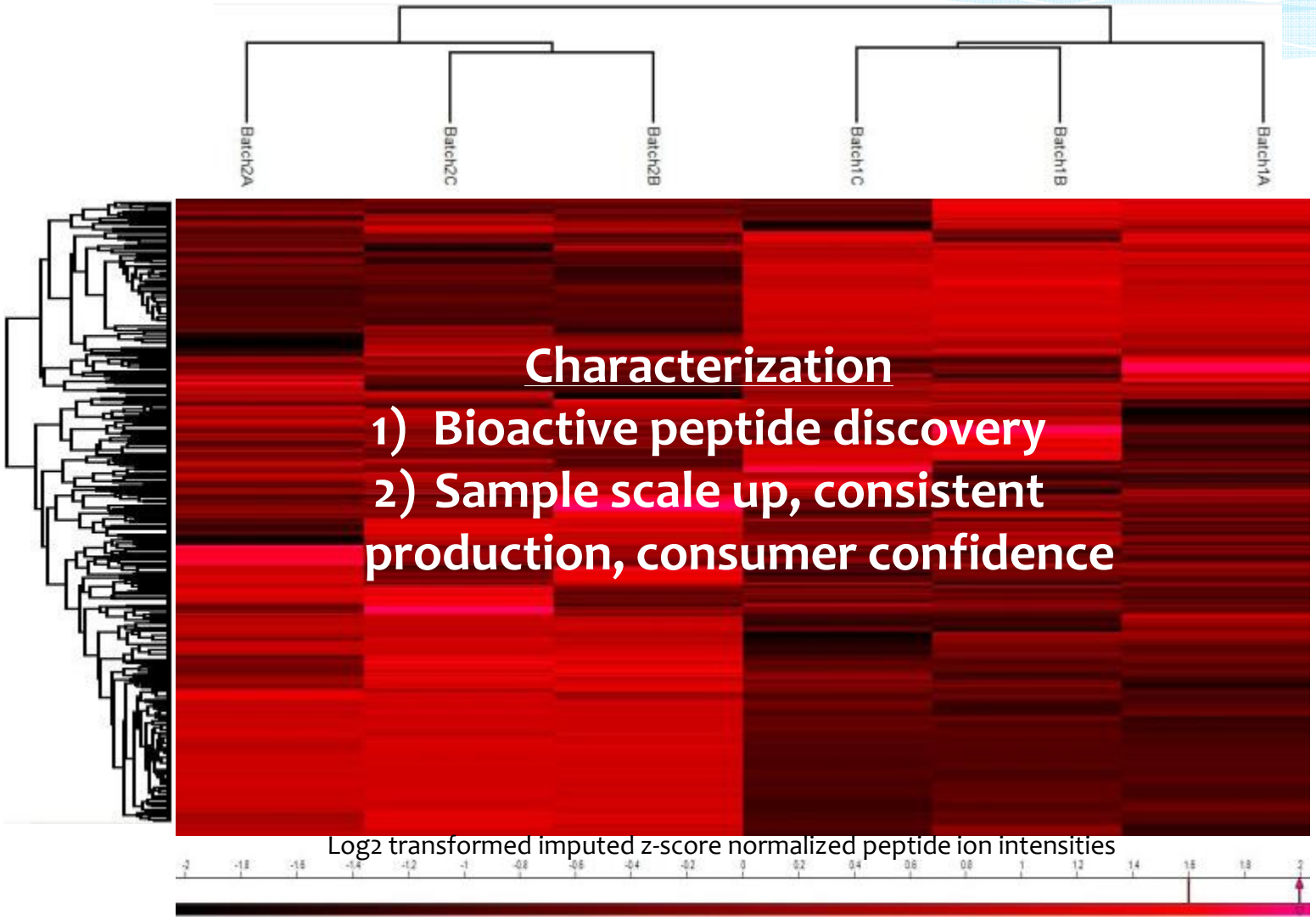
- *Dataset of milk protein isoforms (perhaps most complete globally)*
- *More powerful ability to match hydrolysate ingredients to function*

Identification & semi-quantification of di- and tri-peptides





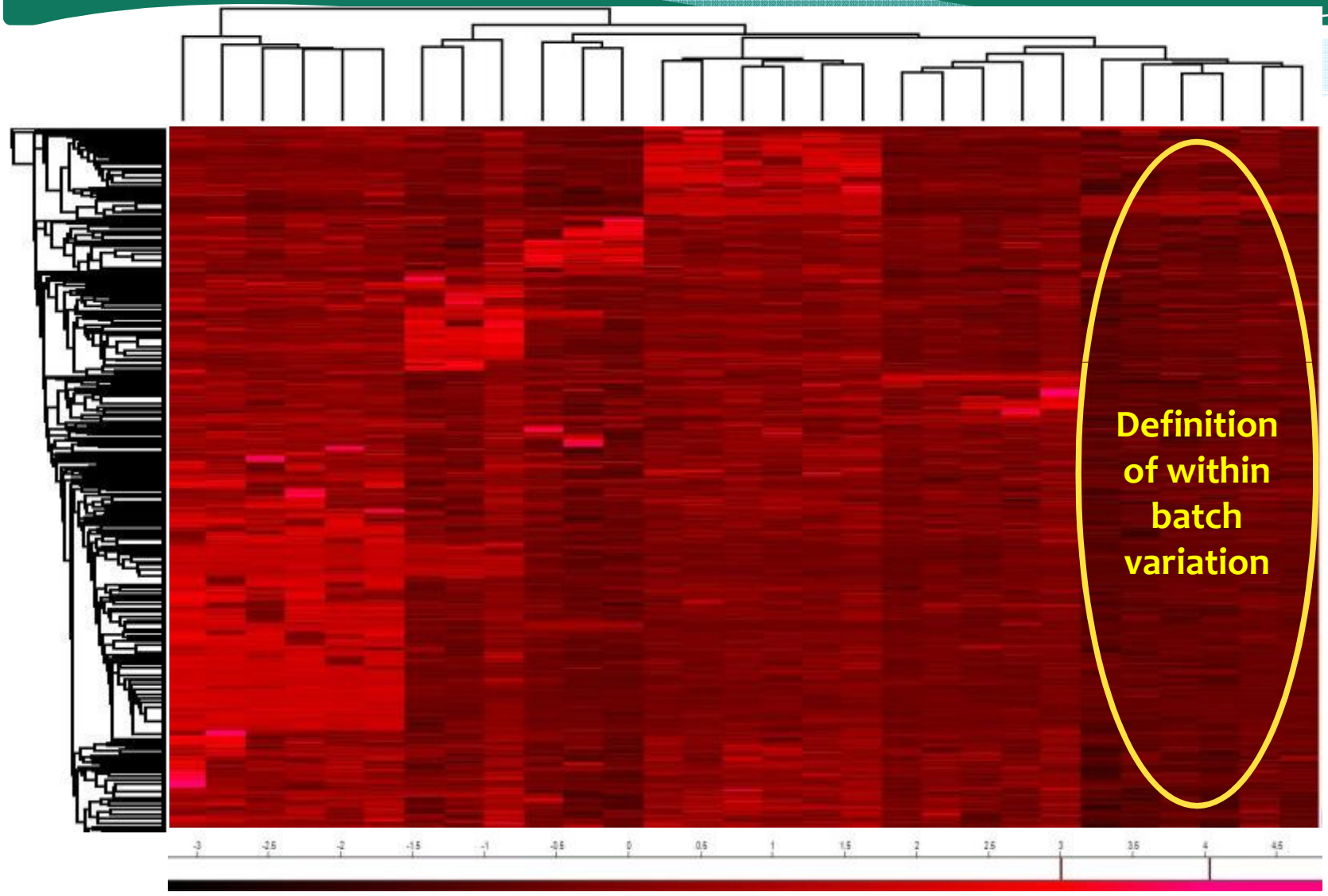
Mass spectrometric characterization



Characterization

1) Bioactive peptide discovery
2) Sample scale up, consistent production, consumer confidence

Batch to batch variations and related formulations tracked through global peptidome



APPLICATION:
Bioactivity demonstrated by peptide fraction

* Bioactivity demonstrated in *in vitro* assays for promotion of insulin secretion

* Bioactivity demonstrated in *in vivo* feeding studies for significant effect on glucose surge, fasting insulin levels, insulin signalling & proinflammatory cytokines

* Effect demonstrated in human feeding studies in blood glucose control

Bioactivity demonstrated by peptide fraction

MASS SPECTROMETRY:

- **What was the peptide?**
- **Can we consistently produce this peptide and guarantee bioactivity?**

Bioactive peptide fraction from FHI-1

In vitro

promotes insulin secretion in pancreatic beta cells and pancreatic islets

In vivo

Acute

Significant reduction in post prandial glucose surge

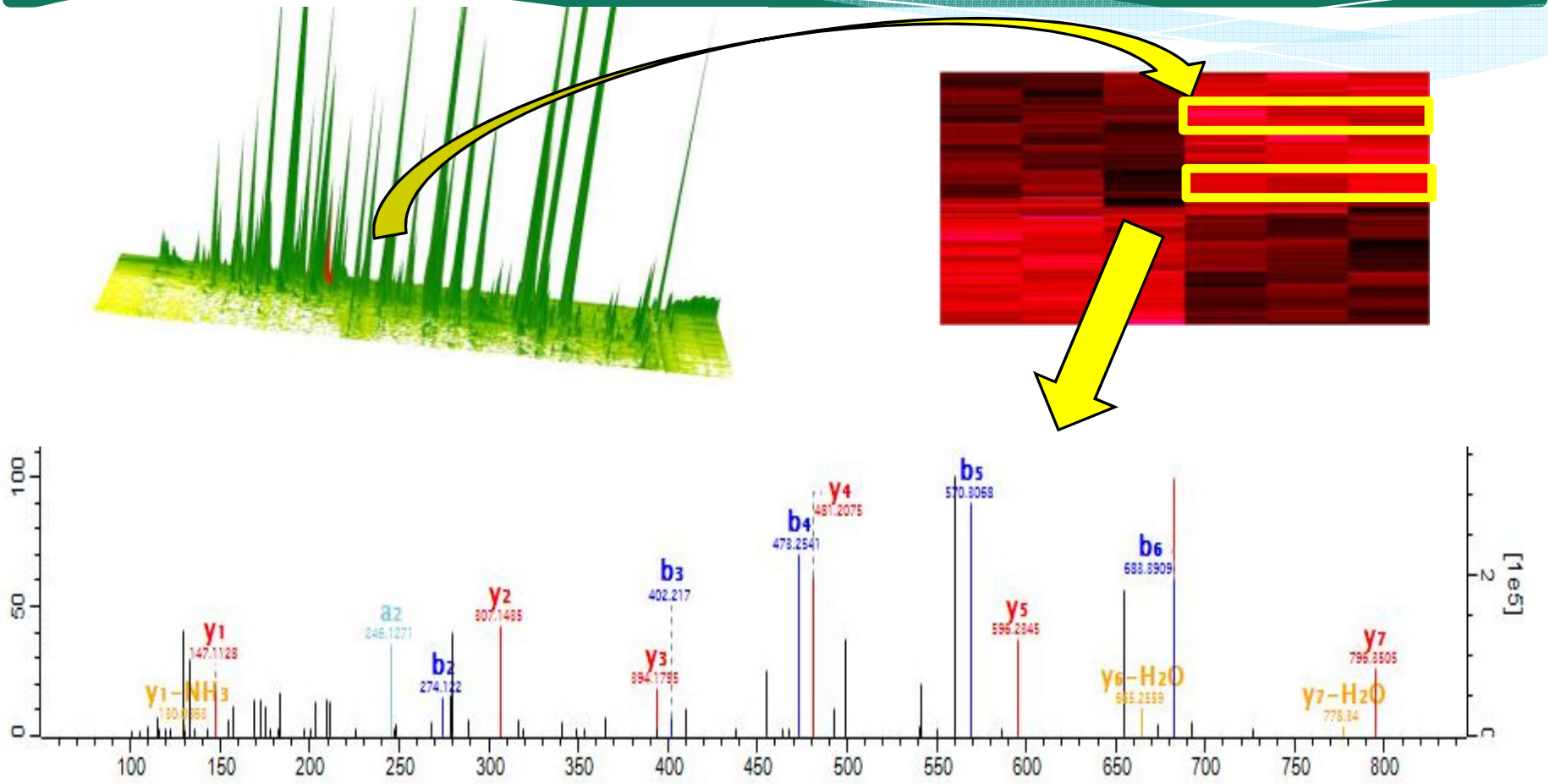
Chronic

Reduction of diet induced fasting insulin & insulin secretion

Human translational

Improves blood glucose control

Bioactive peptide discovery using mass spectrometry



[NH_2] P E P T I D E [COOH]

Conclusion

* Mass spectrometry is a very powerful technique
* Very useful for the identification of bioactive peptides
  * Guarantee bioactivity, functionality in our functional food products
* For characterization of batch to batch variation
  * Ensure consumer confidence in an emerging industry
* Broader implications – other protein sources

Acknowledgements

Cagney Proteomics Lab

- Dr. Gerard Cagney
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- Dr. Eugene Dillon

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- Kieran Wynne

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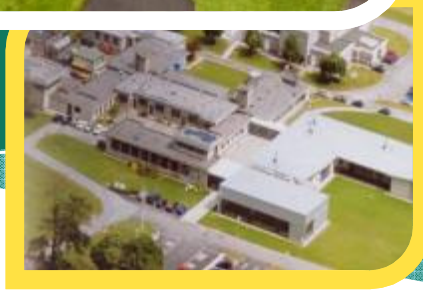
- Dr. Nessa Noronha
- Claire Mac Evilly
- Dr. Fiona Lalor
- Gillian Davis
- Sinead Proos

Shield Bioinformatics

- Prof. Denis Shields
- Dr. Therese Holton
- Dr. Ilias Stavropoulos

The whole FHI team



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Thank you

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