The role of metagenomics in the identification of new pathogens
STaDG-ER 17.05.2022 – *Meredith Lloyd-Evans VetMB MAVC*

AVC – role and activities

- Qualified veterinarians, international in geography and scope – Europe, Asia-Pacific, Africa, the Americas
- All working in small independent consultancies or SMEs
- Providing advice, practical assistance and support to enterprises such as feed additive, pharmaceutical, vaccines, food production companies & governments
- Organising laboratory, pre-clinical and clinical studies for new animal health and nutrition products
- Experienced with all types of animals including pets, farm, aquaculture and bees, epidemiology, disease management
- Some also involved in other aspects of applied biosciences eg human biotechnology, biomaterials, investment, market strategy, communication and education
- AVC is an Interested Party at EFSA, EMA and HMA and provides responses to consultations

AVC and Emerging Risks - Topics

Metagenomics

⮑ **Definition & History**

⮑ **Fields of use**

⮑ **Application to detection of emerging pathogens**

Metagenomics: Definition & History 1

- **The analysis of a collection of genetic material (genomes) from a mixed community of organisms (microbiome)**
- **"Metagenomics" first used in 1998 (Handelsman *et al*.) - soil microbiome analysis for Natural Product discovery**
- **Global Ocean Sampling 2003-2007**
- **Cultivation-independent**
- **Dependent on Polymerase Chain Reaction and other snipping, amplification, matching techniques**
- **Very much dependent on quality of existing sequence libraries**

Metagenomics: Definition & History 2

- **Sequences can be cloned into industrial organisms and products of gene expression screened, even if organisms are unknown**
- **Sequences can be scanned against libraries to determine similarities or if are completely unknown**
- **Development of High-Throughput next-generation Sequencing technologies have accelerated use**
- **Development of Big Data management methods has significantly enhanced accuracy and impacts**
- **Shift from metagenome mining for new molecules to microbiome analysis for environmental, biodiversity, disease, physiology understanding**

Metagenomics – Fields of Use 1

Understanding and making use of metagenomics has applications in all "colours" of biotechnology

- **red** – health-related, for humans and animals
- **green** – agriculture and crops
- **blue** – aquatic bioresources
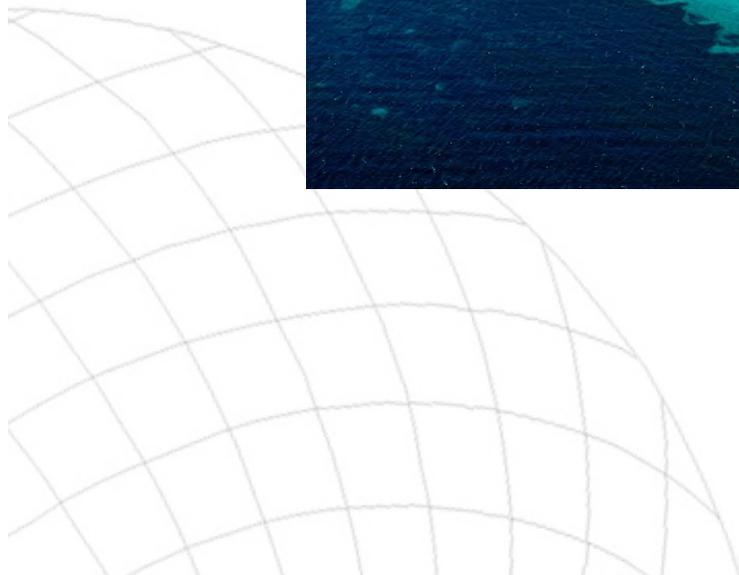 **white** – industrial
- **grey** – environmental
- **yellow** – food

Recent application – Lake Hillier Australia

Assumed to be Dunaliella – but primarily Purple Sulphur-Producing bacteria and Salinibacter

Metagenomics – Fields of Use 2

Metagenomic profiling maps the genes of known organisms and picks up the presence of unknown organisms

- Deep-sea microbiomes
- Gut, respiratory and skin microbiomes
- Microbial pathogens analysis
- Environmental remediator microbes
- Soil microbiome
- Rhizosphere organisms
- Viral metagenomics

Metagenomics & Pathogens 1

Profiling of emerging pathogens or complexes requires sequence-independent amplification – eg displacement polymerase – and HTPS systems eg Illumina

- Bocavirus, torque teno virus, circoviruses 2 & 3 in pigs
- Bee viruses
- Bat coronaviruses
- Bovine mixed pathogens
- Screening for arthropod vectors and pathogens

Use in diagnostics aided by Functional Metagenomics in addition to structural metagenomics

Metagenomics & Pathogens 2

Sampling, sample preparation, nucleic acid release, removal of debris & interference etc., capture of sequence information, matching against libraries, assessment of degrees of similarity/homology, alignment with known pathogens, assignment to new/previously-unknown pathogens.

- Bovine respiratory viruses – adeno, influenza D, rhinitis A, plus new astrovirus, picobirnaviruses
- Bovine mastitis - deep Whole Metagenome Sequencing - specific bacterial genera, viruses and, surprisingly, Archaea
- Bovine reproductive disorders – strongest association with Bacteroidetes, Fusobacteria

Metagenomics Refs

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