

New approach for AMR monitoring and surveillance using NGS

27 May 2024, Berlin

Hyochin Kim

National Institute of Food and Drug Safety Evaluation,

Ministry of Food and Drug Safety



Agenda

- 1. Antimicrobial resistance (AMR)**
- 2. Next Generation Sequencing (NGS)**

Antimicrobial resistance (AMR)



One Health AMR

AMR Info

R & D

Test Method

KOR ENG

"Healthy and Happy"
with the right antibiotics



Human Consumption



Human Resistance Rate



Livestock Sell

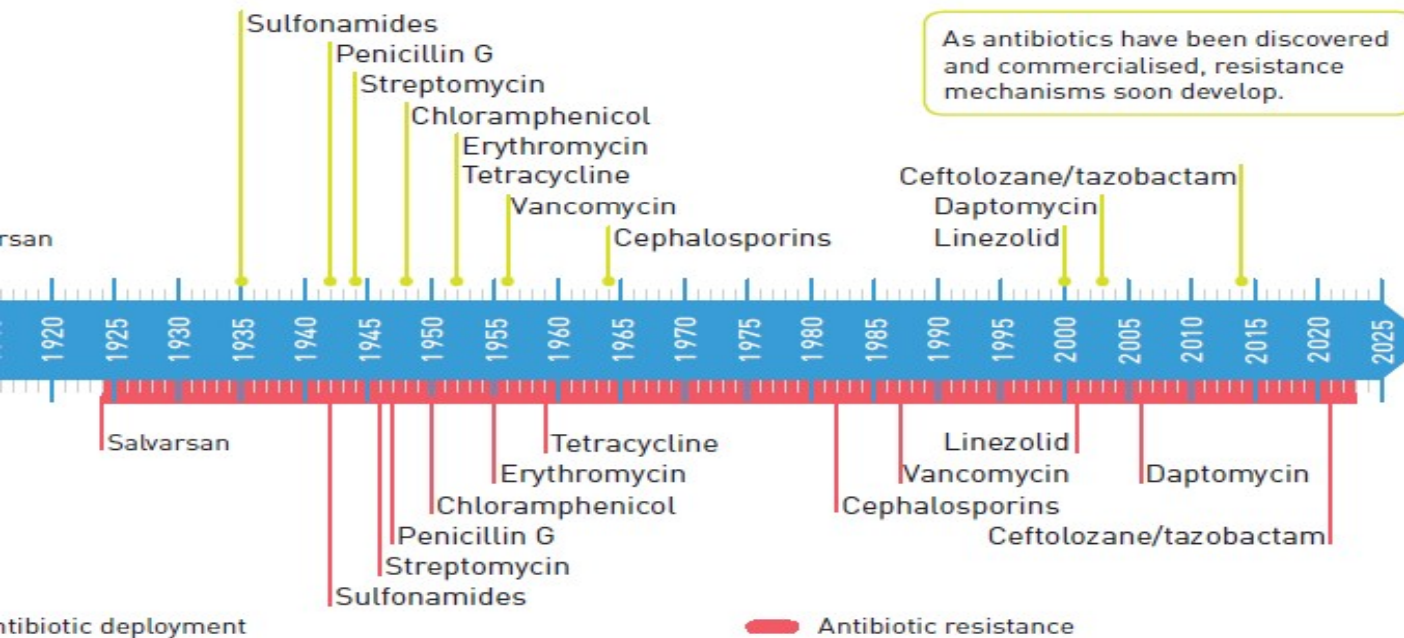


Livestock Resistance Rate

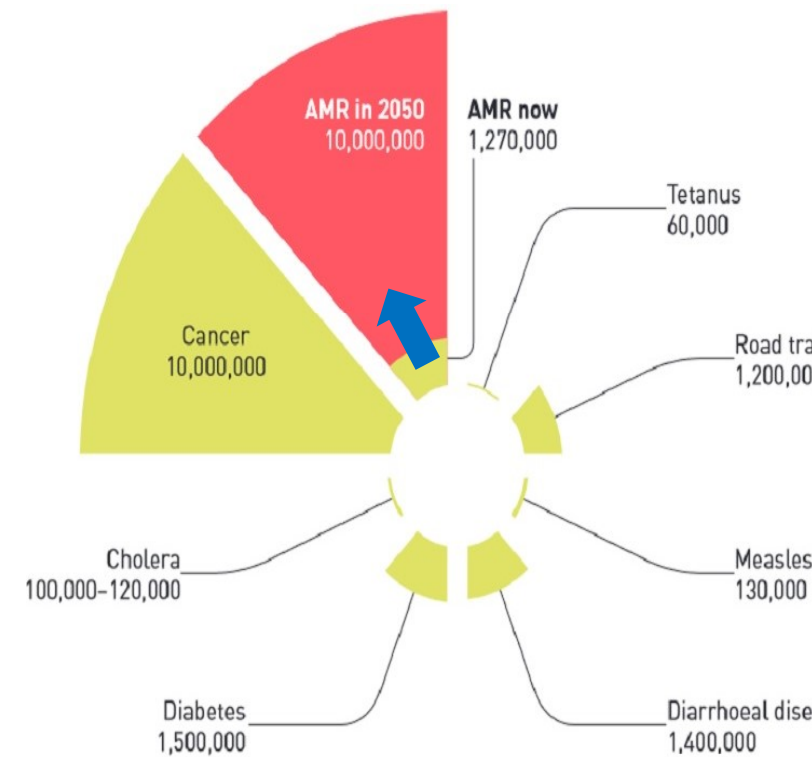


Resistance Rate
Comparisons Between
Countries

AMR is a global public health concern

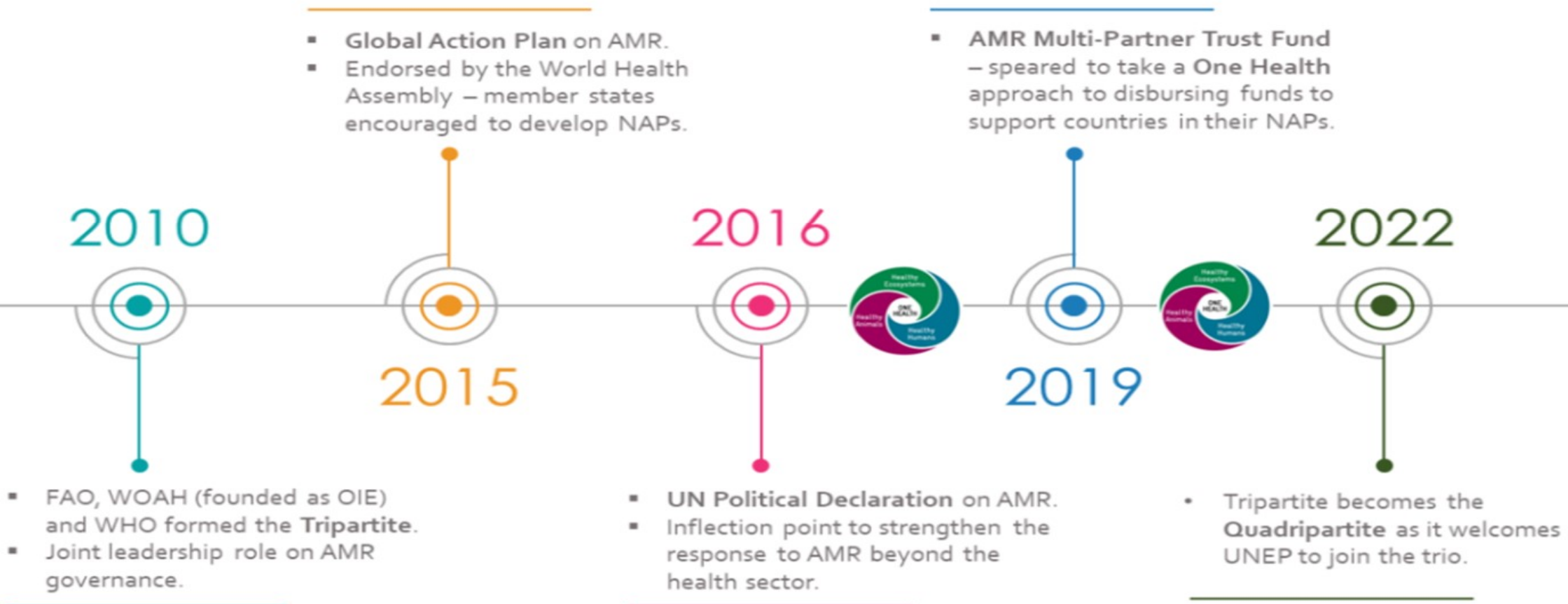


Antibiotics and their resistance

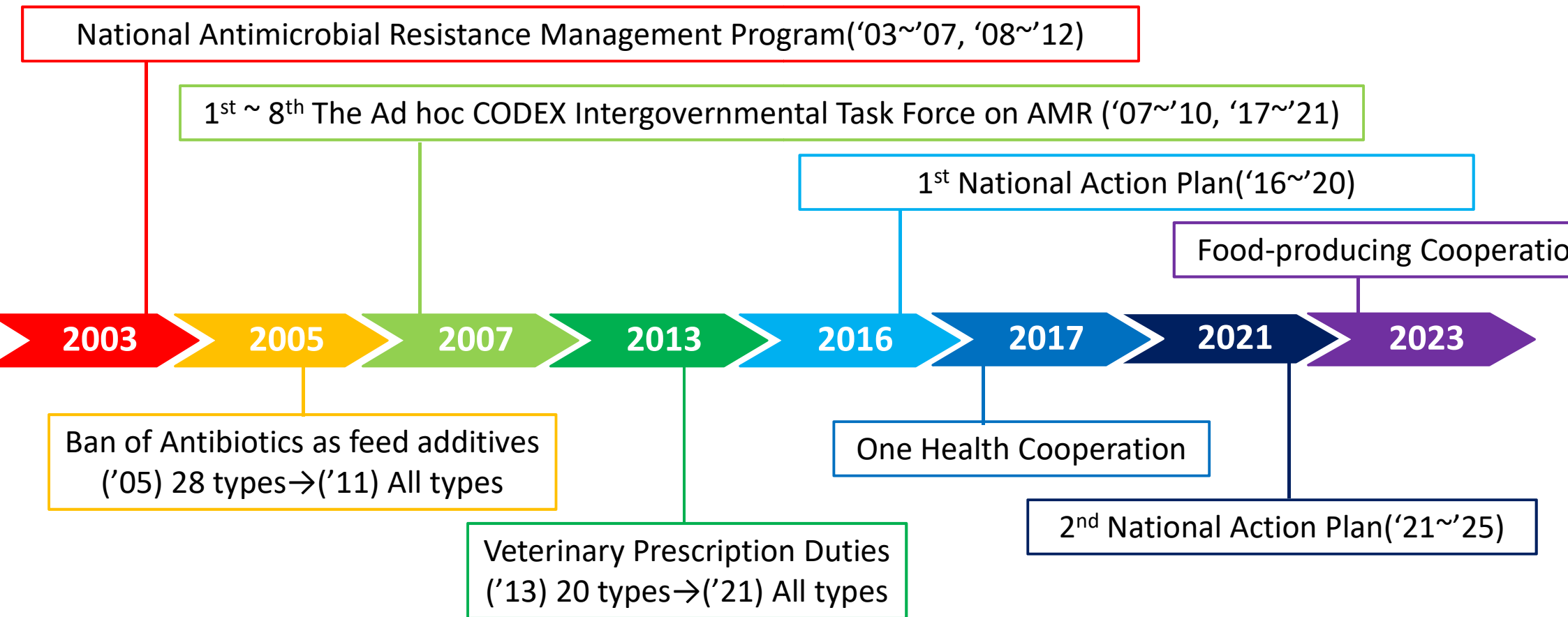


Predicted mortality

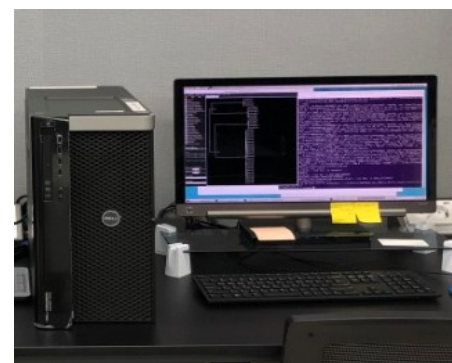
Global AMR response



Korea AMR response



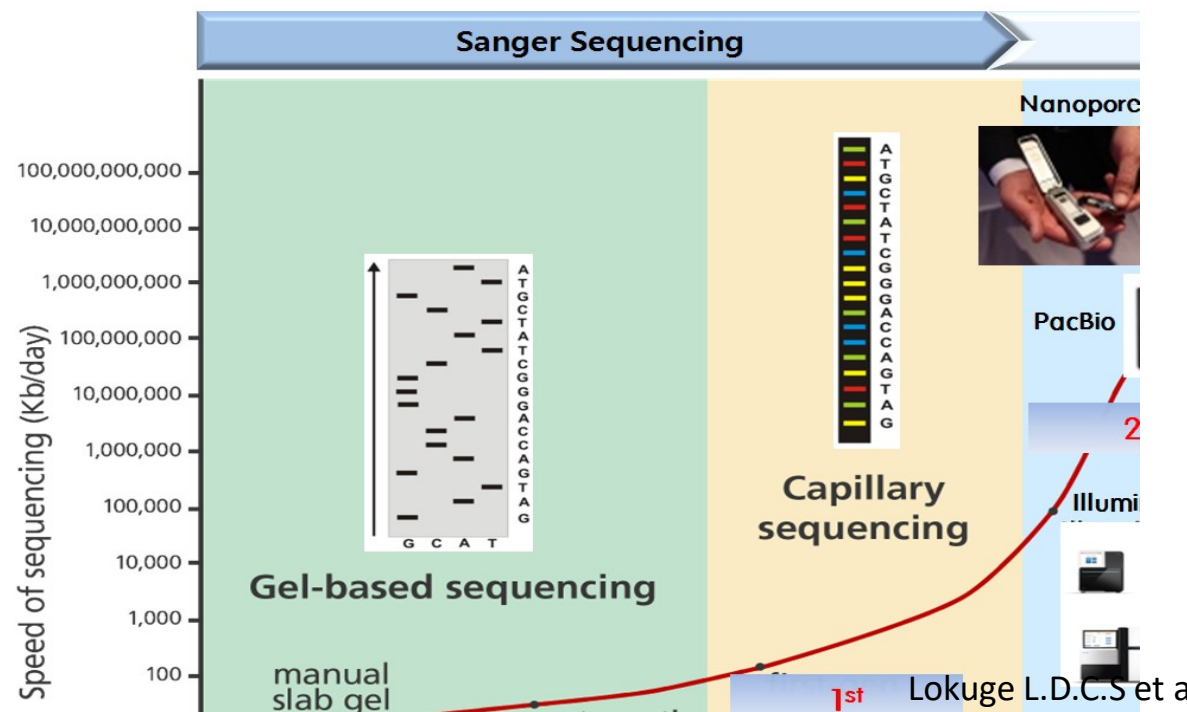
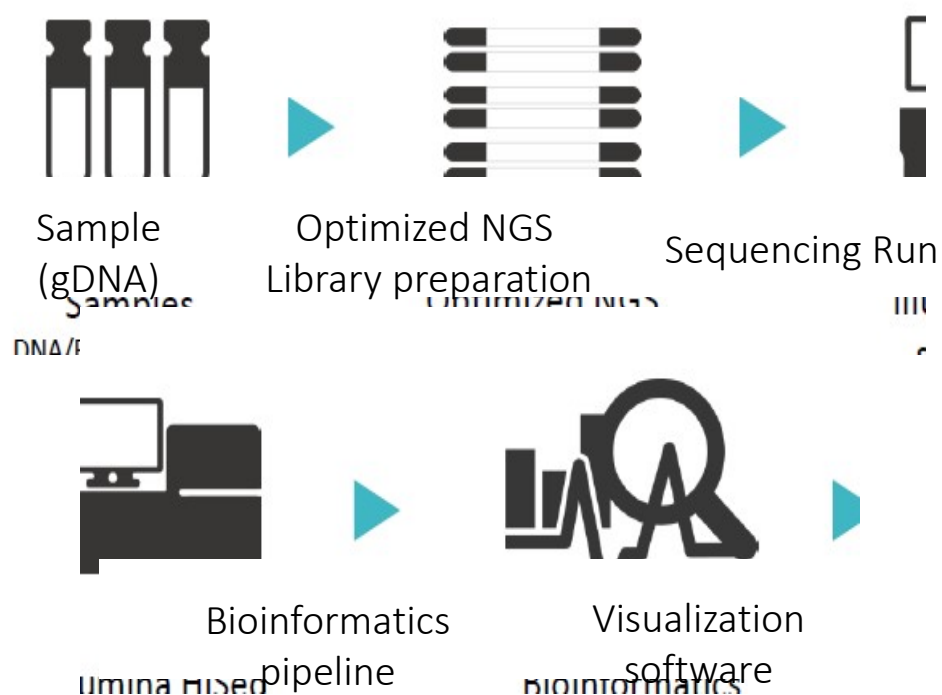
Next Generation Sequencing (NGS)



NGS is ...

Massively parallel sequencing

→ Able to provide a “complete” set of data on the genetic material in sample



As the M&S tool, NGS can

1. Predict AMR with mechanistic information

Not only phenotypically determination (R/S), reveal molecular mechanisms

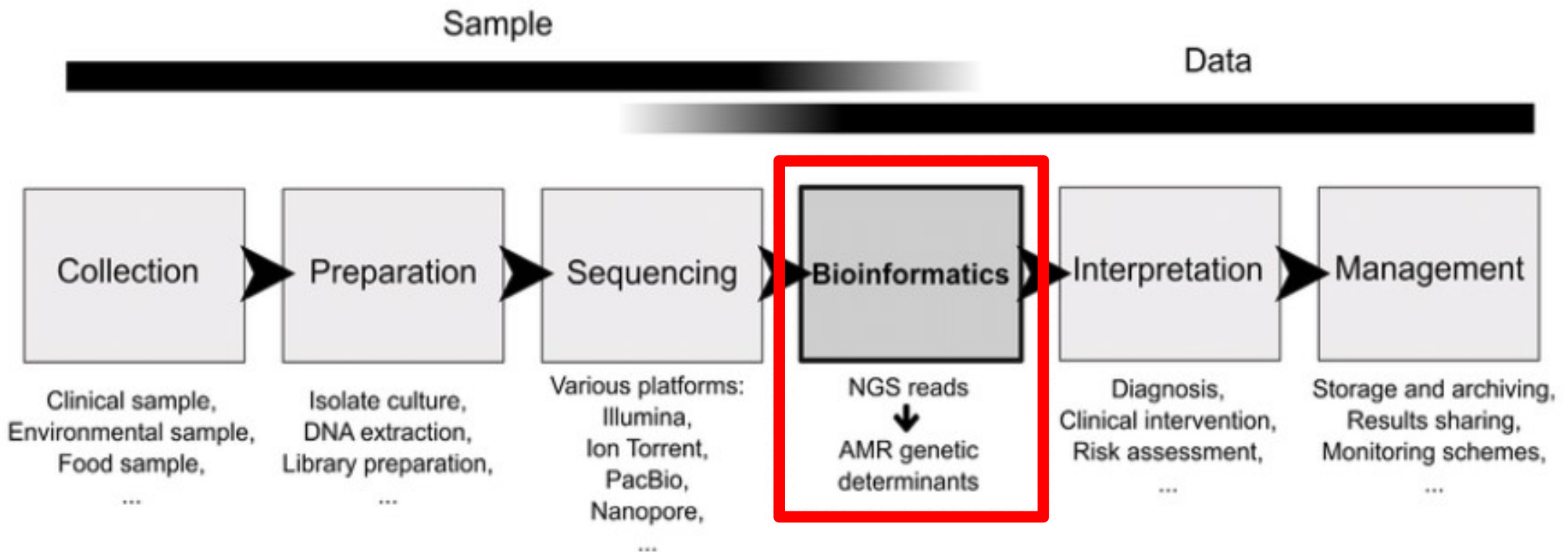
2. Link the different fields: environment, animals and foods

Not culture-dependent method

3. Allow data storage and accumulation

Possible to save for future analyses

Bioinformatics, a key of NGS



NGS application rules

RECOMMENDATION

Use simple rules for the sharing of bacterial
genotype—Phenotype data on antimicrobial
resistance

- Provide data in well-defined format
- Provide relevant contextual sample metadata
- Make all samples identifiable
- Provide raw quantitative data for phenotypic AST results
- Include phenotyping method
- Share tabular data files in machine-readable format
- Make raw genomic data available
- Make genotypic resistance calls in a reproducible manner
- Report novel resistance determinants in a systematic way
- Share the data to the fullest extent possible

Chindelevitch, L. et al., 2023

Box 1. Recommended format for reporting genotype and AMR phenotype data

Based on a review of the available formats, we recommend the use of a single file in a tabular format, with 1 row per isolate, and the following information made available for each one:

- Internal ID (this can be helpful as the key for merging genotype and phenotype tables)
- Accession number for the raw genotypic data in databases (NCBI, ENA, and DDBJ [12])
- Additional accession numbers specific to the isolate, such as the assembled contigs
- Collection date, in a “long format” (e.g., 12 October 2022) to avoid potential confusion
- Collection location, ideally in an unambiguous format such as longitude and latitude
- Source of isolation (animal, clinical, environmental, etc.)
- For clinical isolates, the fluid or tissue the isolate is from (blood, sputum, stool, urine, etc.)
- Isolate genus and species
- Experimental approach used to measure phenotypic susceptibility (agar dilution, Etest, Vitek2, etc. [13])
- For each drug or combination tested for susceptibility, ideally the 3 columns specified in Rule 4, otherwise 1 column with the resistance status (susceptible (S), intermediate susceptibility (I), resistant (R))

NIFDS NGS application



Outbreak Investigation

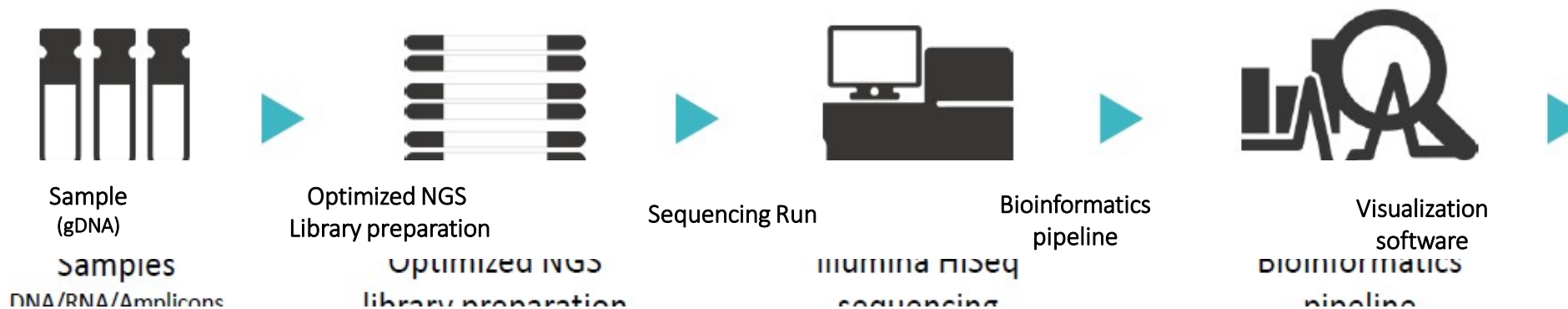


Characteristics Analysis



Identification of Probiotics

NIFDS NGS application



Outbreak Investigation



Characteristics Analysis



Identification of Probiotics

NGS targeted gene panel

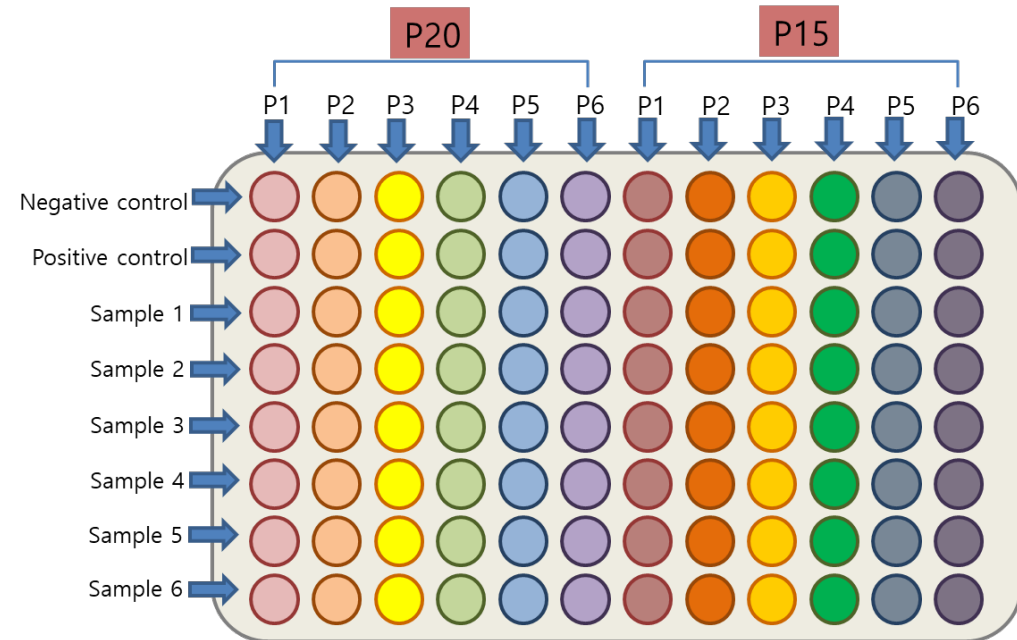
NGS based multigene panel for high throughput detection of food-borne pathogens

15 Target DNAs

- *Campylobacter jejuni* (**mapA**)
- *Campylobacter coli* (**ceuE**)
- *Clostridium perfringens* (**cpe**)
- *Vibrio cholerae* (**ctx**)
- *Vibrio vulnificus* (**glnA**)
- *Vibrio parahaemolyticus* (**tdh**)
- *Salmonella* spp. (**his**)
- *Listeria monocytogens* (**iap**)
- *Bacillus cereus* (**bceT**)
- *Yersinia enterocolitica* (**ail**)
- *Staphylococcus aureus* (**coa**)
- EHEC (**VT1, VT2**)
- ETEC (**STh, STp**)

20 Target DNAs

- *Campylobacter jejuni* (**hipO**)
- *Campylobacter coli* (**glyA**)
- *Clostridium perfringens* (**cpa, cpe**)
- *Vibrio cholera* (**hly**)
- *Vibrio vulnificus* (**vvh**)
- *Vibrio parahaemolyticus* (**toxR**)
- *Salmonella* spp. (**invA**)
- *Listeria monocytogens* (**prfA**)
- *Bacillus cereus* (**groEL**)
- *Yersinia enterocolitica* (**inv**)
- *Staphylococcus aureus* (**femA**)
- EHEC (**VT1, VT2**)
- ETEC (**STh, STp**)
- EAEC (**aggR**)
- EPEC (**eaeA, bfpA**)
- EIEC (**ipaH**)



NIFDS NGS application



-
-
-

Outbreak Investigation

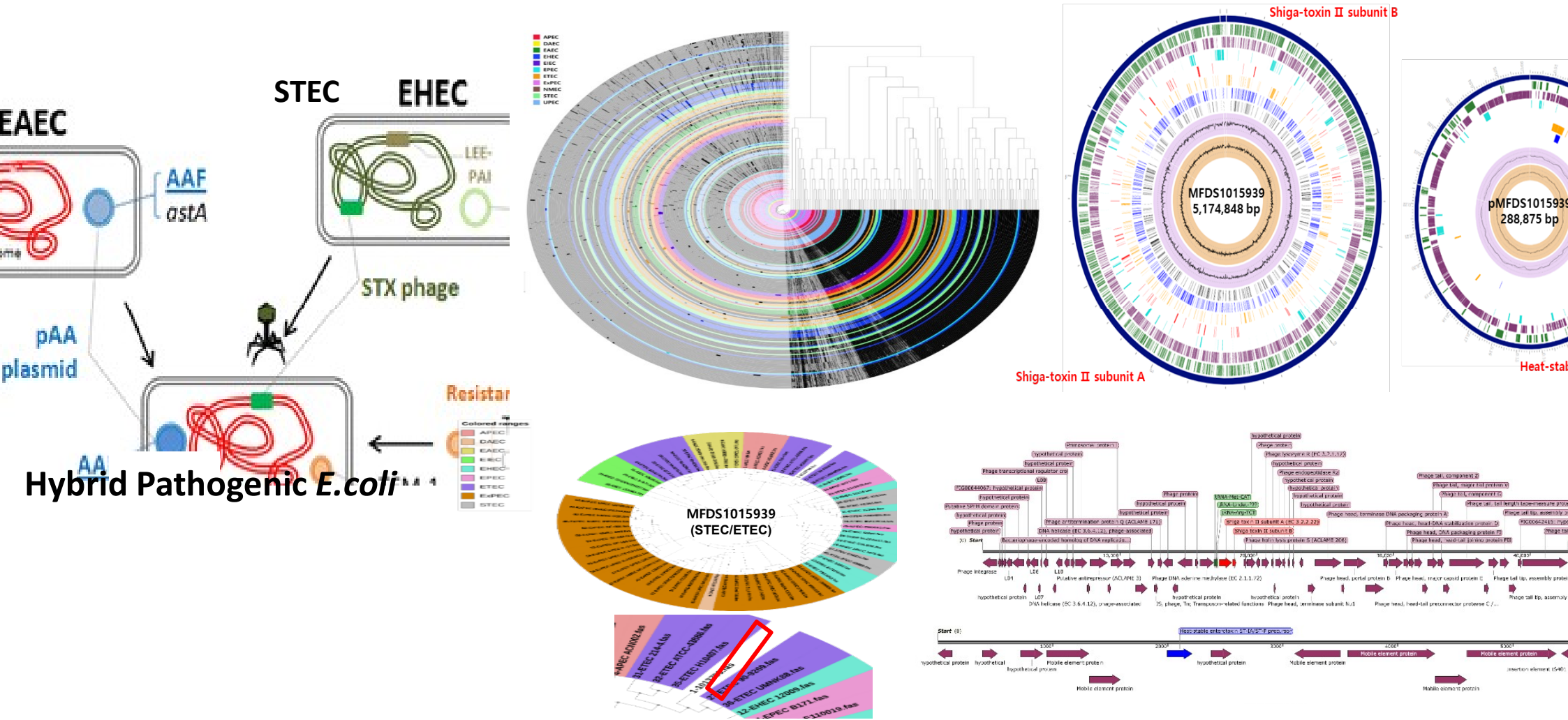
Characteristics Analysis

Identification of Probiotics

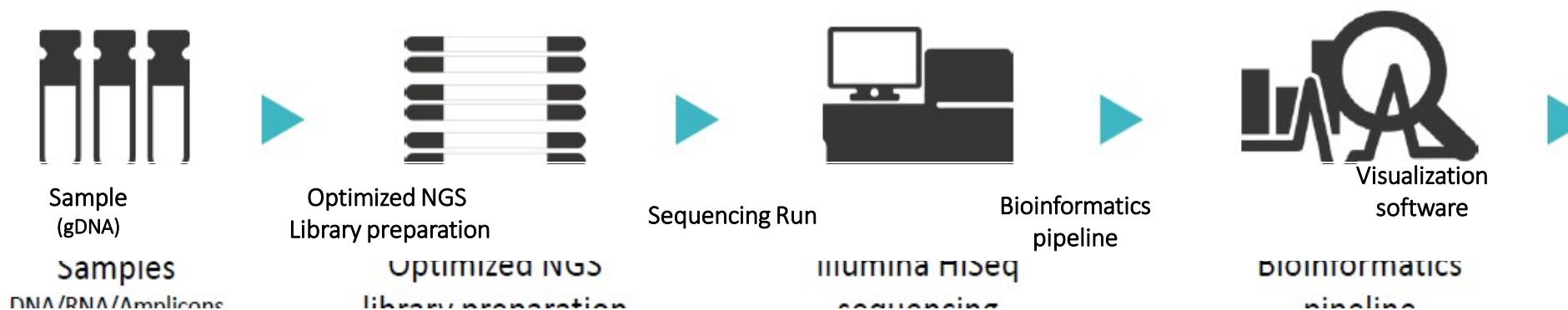
Comparative Genomics and Characterization of Hybrid pathogenic *E.coli*

Virulence and transcriptome profile of Hybrid pathogenic *E.coli*

Correlation analysis between virulence expression and regulatory factors in *E. coli*



NIFDS NGS application



Outbreak Investigation



Characteristics Analysis



Identification of Probiotics

Probiotics 10 Plus is a unique blend of probiotics. It supports normal bowel activity by restraining the growth of harmful bacteria.

Supplement Facts

Serving Size: 1 Packet (About 2.5 g)

Serving	% Daily Value
bacteria blend	92.5 mg **
Lactobacillus plantarum, Lactobacillus rhamnosus, Lactobacillus casei, Bifidobacterium longum, Lactobacillus acidophilus, Lactobacillus paracasei, Lactobacillus bulgaricus, Streptococcus thermophilus, Lactobacillus fermentum, Lactobacillus gasseri, Lactobacillus salivarius, Lactobacillus reuteri, Lactobacillus helveticus, Lactobacillus helveticus, Lactobacillus helveticus	**
Probiotic Fiber Blend	407 mg *
Organic Acacia Fiber Blend	**

Production No.: 16001
Expiration Date: 2017.04.11

100% ALL-NATURAL probiotic TECHNOLOGY

Lactobacillus plantarum,
Lactobacillus rhamnosus,
Lactobacillus casei,
Lactobacillus paracasei,
Lactobacillus fermentum,
Bifidobacterium longum,
Bifidobacterium breve
Bifidobacterium bifidum,
Bifidobacterium lactis,
Streptococcus thermophilus

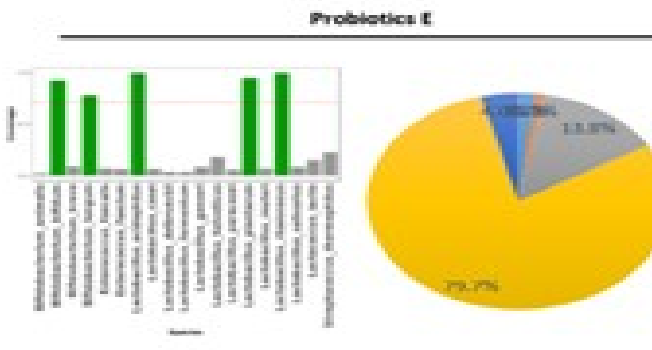
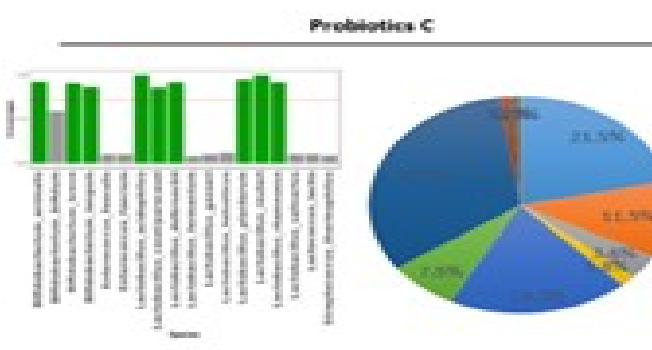
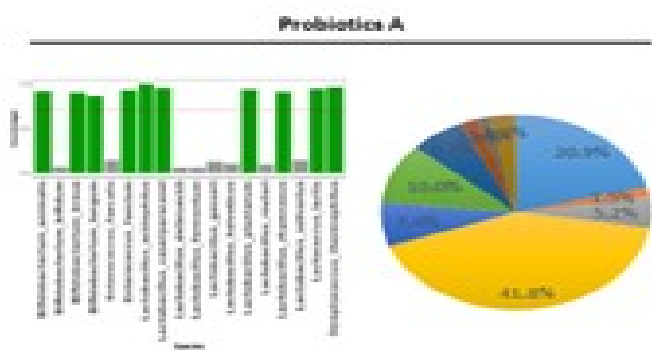
Supplement Facts

Serving Size: 1 Capsule
Per Container 30

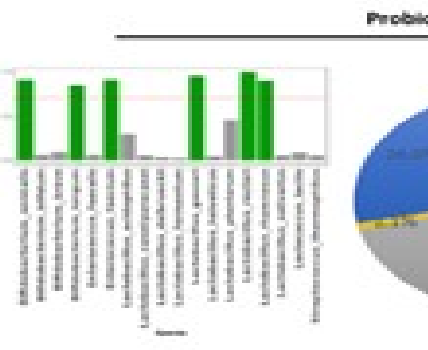
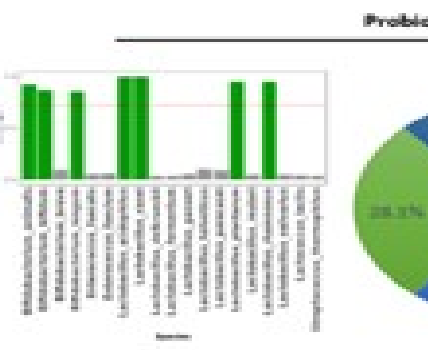
Probiotic Blend	218 mg	+
Lactobacillus acidophilus		
Lactobacillus casei		
Lactobacillus gasseri		
Lactobacillus plantarum		
Lactobacillus paracasei		
Lactobacillus brevis		
Lactobacillus bulgaricus		
Lactobacillus rhamnosus		
Lactobacillus salivarius		
Lactobacillus fermentum		
Probiotic Cultures (35 Billion CFU)		
Bifidobacterium lactis		
Bifidobacterium breve		
Bifidobacterium infantis		
Bifidobacterium longum		
Probiotic Cultures (15 Billion CFU)		
Probiotic Cultures	50 Billion CFU ¹	
Probiotic Fiber Blend	407 mg	-
Organic Acacia Fiber Blend	**	

Production No.: 16001
Expiration Date: 2017.04.11

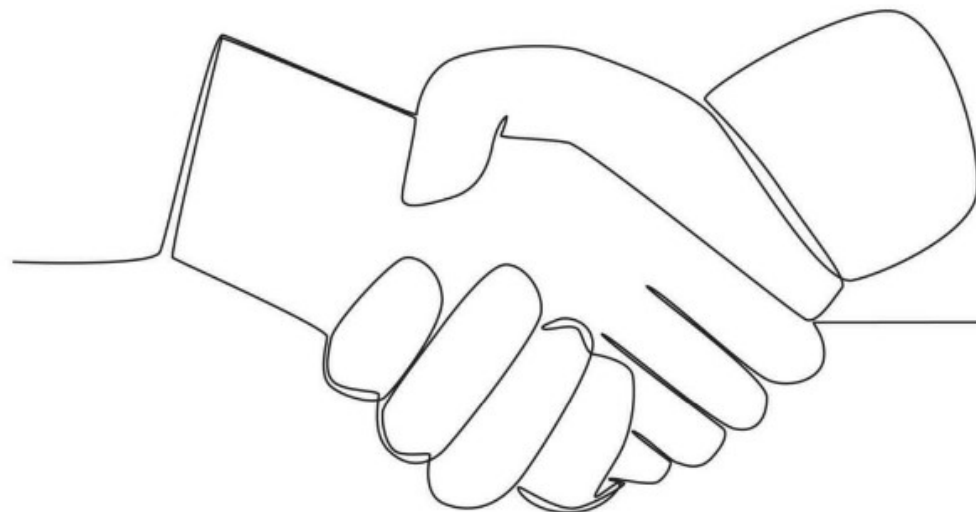
Lactobacillus acidophilus,
Lactobacillus casei,
Lactobacillus gasseri,
Lactobacillus plantarum,
Lactobacillus paracasei,
Lactobacillus rhamnosus,
Lactobacillus fermentum,
Lactobacillus bulgaricus,
Lactobacillus salivarius,
Bifidobacterium longum,
Bifidobacterium breve,
Bifidobacterium bifidum,
Bifidobacterium lactis,
Bifidobacterium infantis



Probiotics G



Probiotics H



THANK YOU!

A solid green horizontal bar at the bottom of the page, spanning the entire width.