Tyson™

Genome Sequencing (GS)

Industry Perspective

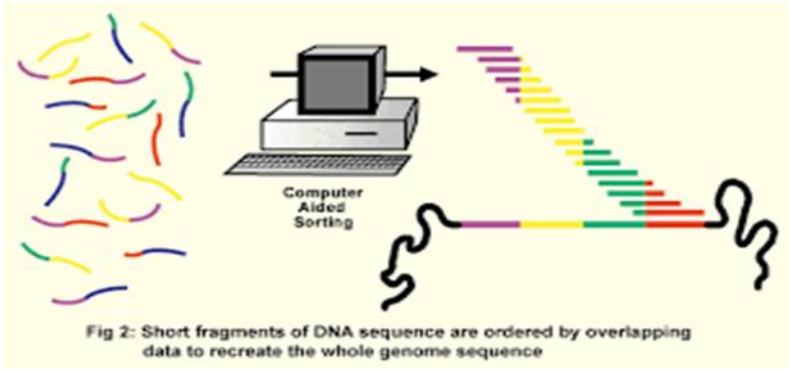


Fig 2: Short fragments of DNA sequence are ordered by overlapping data to recreate the whole genome sequence

So we are all on the same page….

Seems there is a better understanding – but we do not all have the same knowledge level.

Genome Sequencing

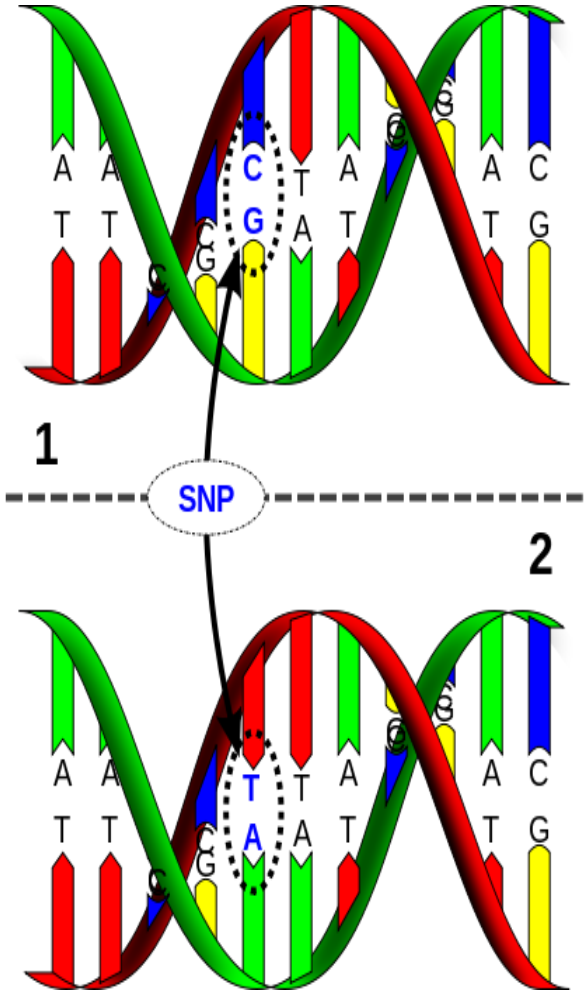
- Genome is the genetic material of the organism, the complete package:
  - Gene and Chromosome
  - By analysis, it is possible to plot out the DNA sequence of an organism

Genome

- To put in perspective, imagine the human genome is a book
  - The book (genome) would contain 23 chapters (chromosomes) and
  - Each chapter would contain 48 to 250 million letters (A,C,G,T) without spaces
- The human genome book contains over 3.2 billion letters total
- *Salmonella* is a short story in comparison, around 4.5 million letters depending on serotype

Genome Sequencing

- GS analysis is looking for differences at a single nucleotide — A, T, C or G – in the genome that is different between members of the same species.
- The differences are referred to as a single nucleotide polymorphism (SNP); a change of a nucleotide at a single base-pair location on DNA.



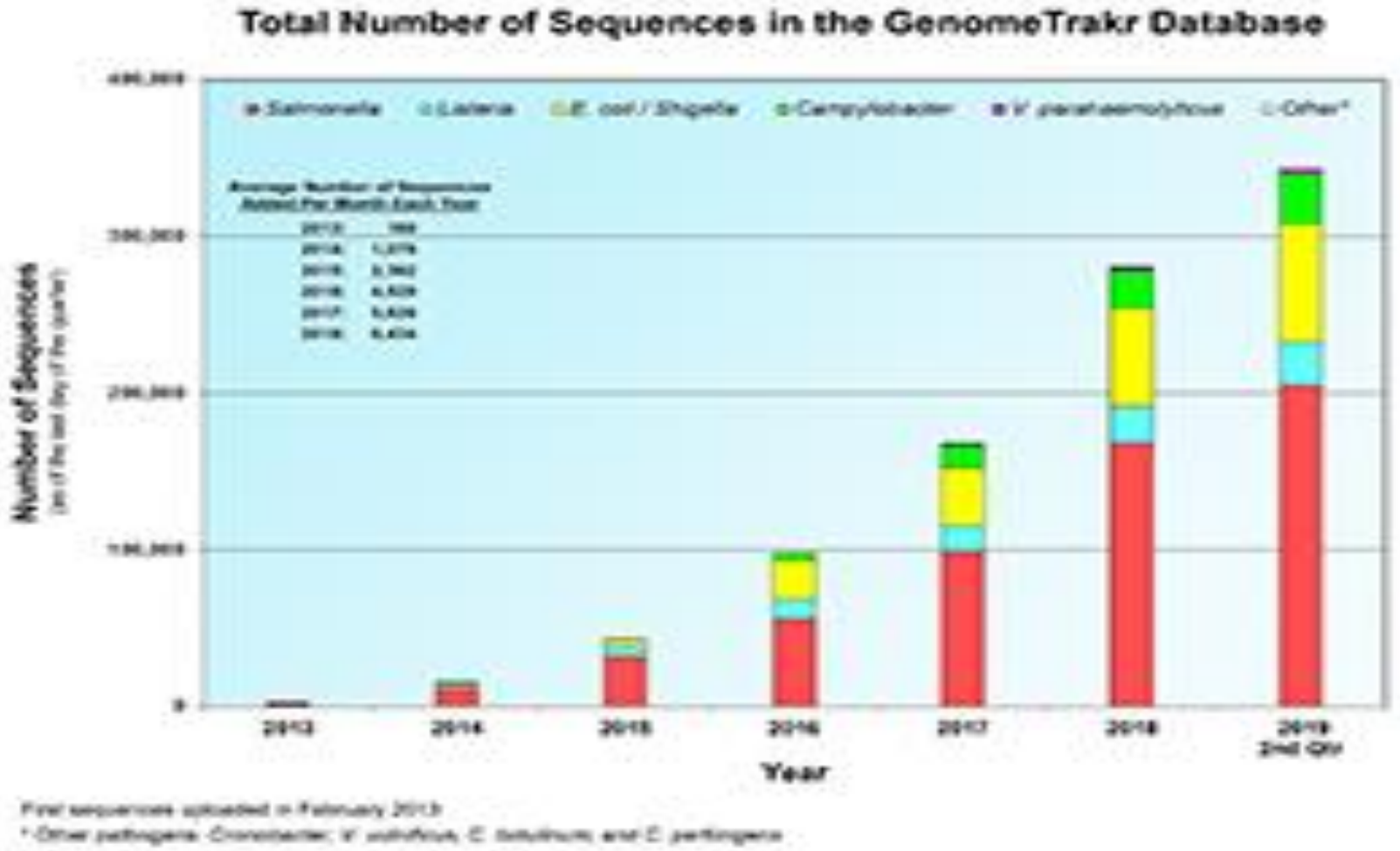
How It Works

- The process involves looking for a relationship between samples
  - Start with identifying genes
  - Go to identifying sequences within genes
  - Then determine whether differences (SNP) in sequences are truly different or random changes from a common sequence (ancestor)
- If derived from common sequence, samples are considered related (think “cousins”)
- The degree of the relationship is plotted on a “phylogenetic tree”

Growing the Data Base

- Larger the data base, better able to compare
  - Enter the Genome Trakr
  - "Consists of 15 federal labs, 25 state health and university labs, 1 U.S. hospital lab, 2 other labs located in the U.S., 21 labs located outside of the U.S."
- The data base is public and can be accessed by researchers, public health officials, and industry for real time comparison and analysis.

Genome Trakr



First sequences uploaded in February 2013

* Other pathogens: Cronobacter, V. vulnificus, C. botulinum, and C. perfringens

Geography

When isolates are entered into the database, the geographic location of where the sample was taken is also entered.

Geographic information enables the tracing of movement of the organism and can assist in identifying the likely geographic source of an outbreak.

Regulatory Uses

- Both Agencies routinely conducting sequencing on all positive pathogen samples
- FSIS and FDA can compare results to previous regulatory results to determine the persistence of specific pathogens in the environment

Regulatory/Public Health Uses

- Neither FDA or FSIS automatically proceed with any type of regulatory action based simply on WGS findings
  - FDA and FSIS utilize all investigative information and inspectional findings as part of their decision-making process.
    - Note: the presence of adulterant pathogens in foods or in those parts of a facility that come into contact with finished products will be considered a public health concern.
    - Corrective actions will be expected by the establishment

Regulatory/Public Health Uses

- Identify sources of foodborne outbreaks
  - Public health agencies are already using GS to determine whether samples from ill consumers and a food product are closely related genetically
  - Both FDA and FSIS have indicated they will continue to combine the data with epidemiological information
    - Outbreaks identified through WGS in recent years include *Listeria* associated with ice cream, caramel apples, ground beef
    - Outbreaks in deli meats have been identified that the CDC and FSIS have indicated the deli meat and patients were associated but no common product could be identified

Industry Use of GS

- This work has already begun
- Issues to work through:
  - Metagenomics and use of data
  - Which equipment and method to use
    - Short read vs. long read
  - Training for laboratories – complexity of technique
  - Common understanding of results

Industry Use of GS

In spite of the challenges -

- Industry should be open to using new tools for improving public health
  - May be in the form of research initially
  - *Remember you should be prepared to address potential public health findings at any point!*

Industry Use of GS

So how is or can Genome Sequencing be used by industry?

- The list is likely endless…
- GS could show a link among positives within an establishment demonstrating an on-going problem that needs addressing
  - High Event Periods for *E. coli* O157:H7 (the product is already condemned)
- GS has been particularly helpful in looking at the environment to determine whether *Listeria is transient or has formed a harborage*
  - Root cause analysis and corrective actions must be taken in either case….

Industry Use of GS

- GS could uncover a relationship between establishments or with a vendor showing issues arising from common source
  - For example an issue with a common ingredient
    - Need to be prepared to address the finding
    - Need to be certain the supplier knows you are sampling so the entire lot is being held

Industry Use of GS

- GS could assist in understanding how organisms (e.g., Salmonella) flow through the process
- GS could assist in understanding of vectors on the live side for Salmonella

Industry Use of GS

- GS may be used to maintain or enhance food quality of fermented products
  - The tool could be used to verifying the genetic stability of starter cultures prone to mutation over time (e.g. yeasts, molds, lactic acid bacteria, etc.) that are added to fermented products
- GS can be used for shelf-life studies
  - Many feel this is a good place to begin using the technology

Industry Use of GS

- Industry can use GS to further evaluate samples that are from their current sanitation monitoring program
- A map can be built of frequently occurring genes in a facility and changes can be looked for over time….
    - Can evaluate changes in cleaning procedures, new sanitation chemicals, new raw material sources by looking at the effect that these may have on the environment’s genetic background.

Why the Hesitation?

- If the data renders the need to make a food safety decision that data is available to the regulatory Agency
  - How will it be used?
  - Do we all interpret it the same?
  - 5 SNPs vs 10 SNPs vs X SNPs = what is related? Do we all agree? Do we all interpret it the same?
  - The Agency could compare the GS to patient data and look for matches
  - Who will be trained to review the data in FSIS? Who do we interact with?
- The establishment should use the results of data as appropriate…

Use of GS by Industry

Not if – but when

Not if – but how

Need to understand the technology so we can be prepared to use the methods to enhance our systems and improve food safety and public health

Questions?