WOAH AMR training 2026
Rakuno Gakuen University

Veterinary Epidemiology 1

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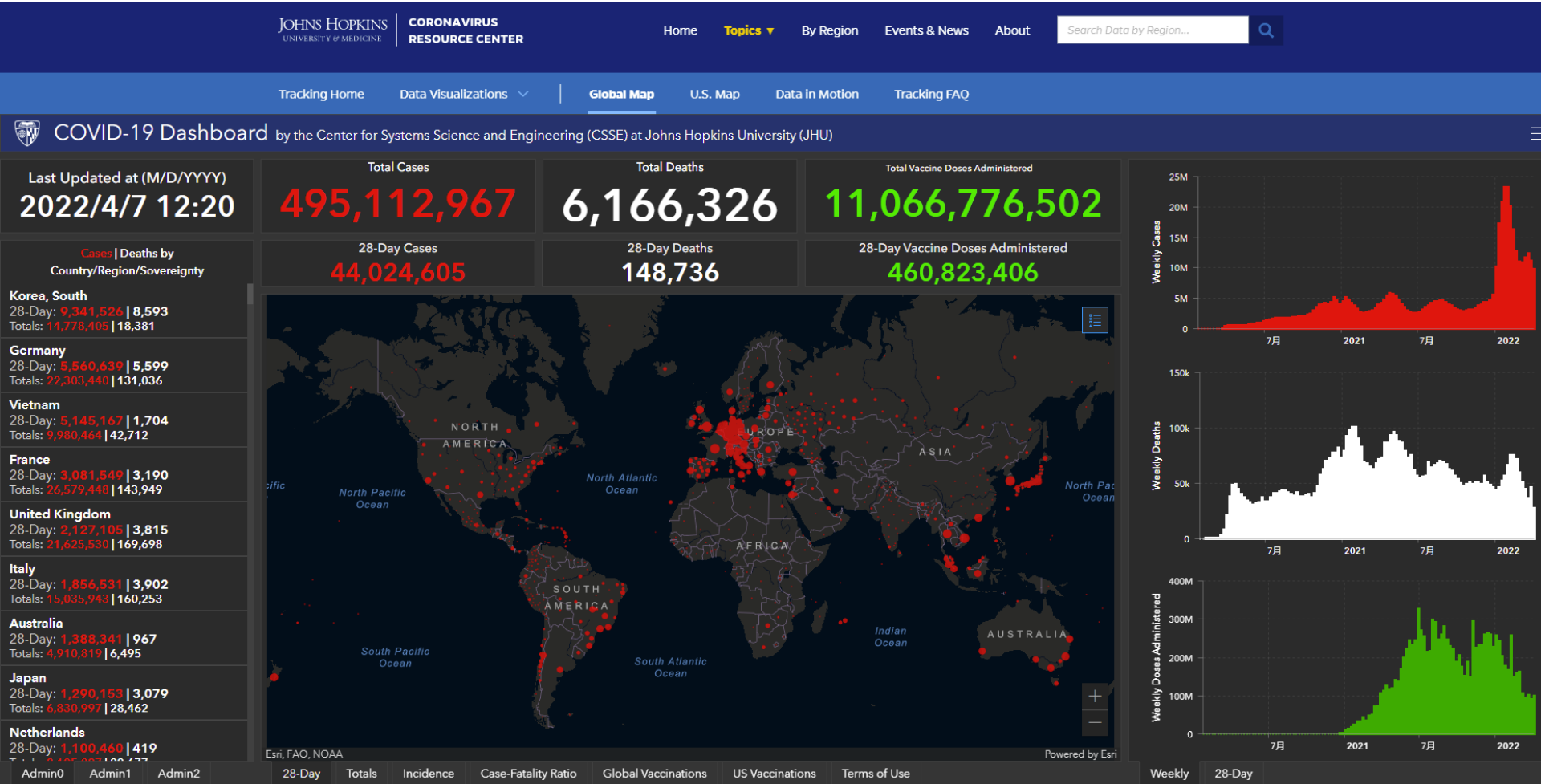
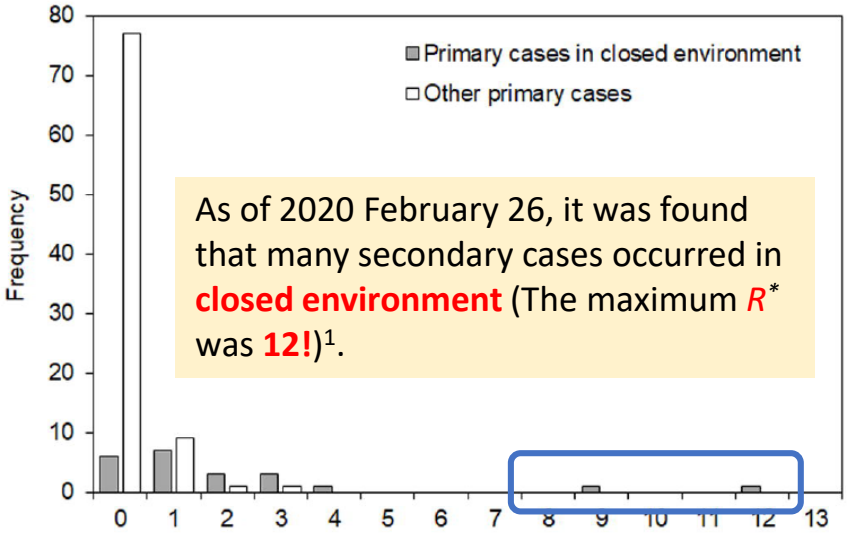
WOAH Collaborating Centre for Food Safety
World Organisation for Animal Health
Founded as OIE

Coronavirus disease 2019 (COVID-19)



"Three Cs" (closed spaces, crowded places, and close-contact settings) were developed based on epidemiology

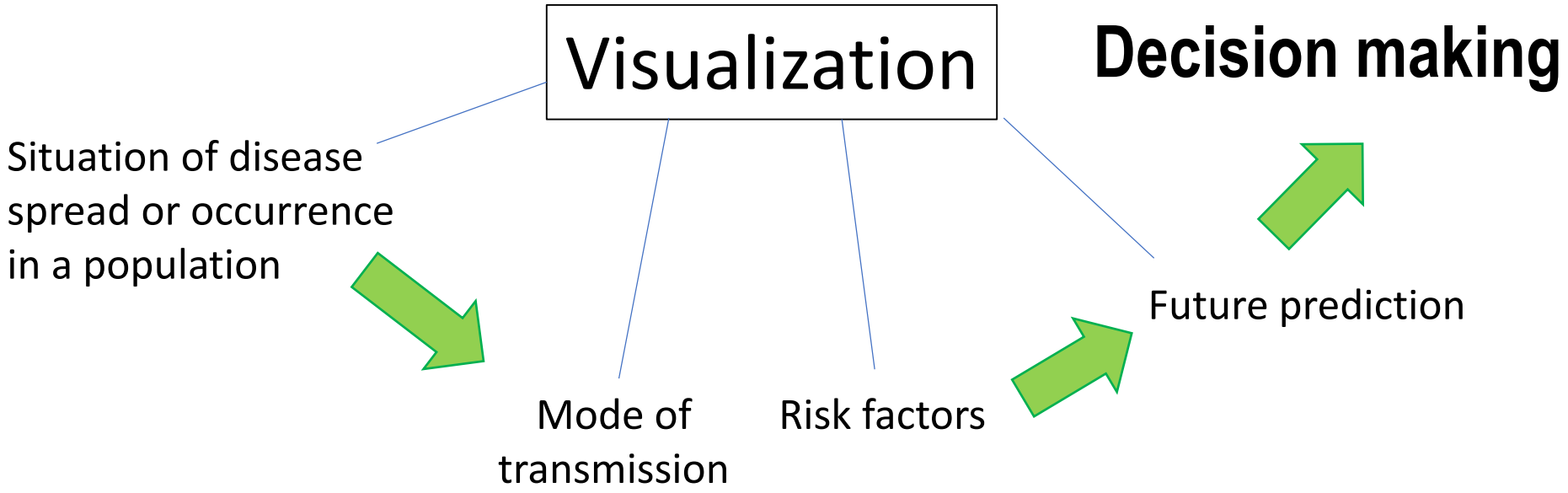


As of 2020 February 26, it was found that many secondary cases occurred in **closed environment** (The maximum R^* was **12!**)[1].

The number of secondary cases infected by an infected individual with SARS-Cov2

*R: the number of secondary cases in the situation when infections are going on.
(effective reproductive ratio)

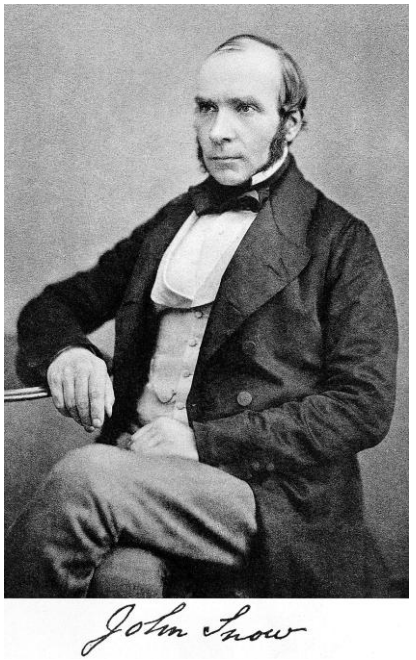
Epidemiology is:



Epidemiology

- Epidemiology is the study of disease in populations and of factors that determine its occurrence

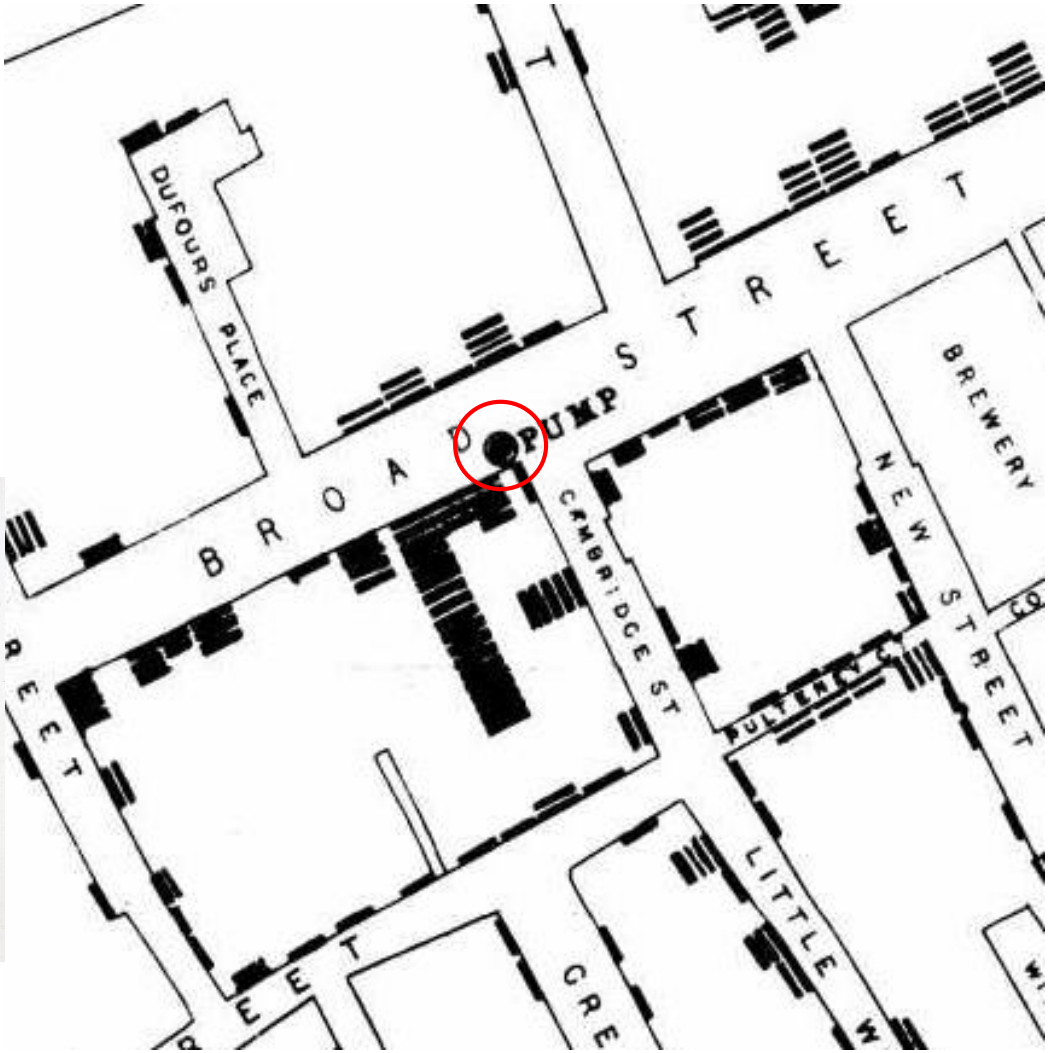
Cholera in 1854 in London killed 500 people in 10 days from August 31th.



OXFORD STREET
REGENT CIRCUS
MARGARET STREET
CASTLE ST EAST
GT CASTLE ST
JOHN STREET
OXFORD MARKET
MARKET ROW
WELLS STREET
BERNERS STREET
NEWMAN STREET
PERRYS PLACE
RATHBONE PLACE
CHARLES STR
FALCONBERG MEWS
PRINCES STREET
REGENT STREET
PHOENIX YARD
QUEEN STREET
BLENHEIM MEWS
BLENHEIM STREET
MARLBOROUGH MEWS
NOEL STREET
BERWICK STREET
WARDOUR STREET
DEAN STREET
SOHO SQUARE
SUTTON STR
MOLLEN STREET
TITCHFIELD ST
CROWN COURT
LITTLE CHAPEL STREET
CARLISLE STREET
GREAT CHAPEL STREET
POLAND STREET
GREAT MARLBOROUGH STREET
LITTLE ARGYLL ST
ARGYLL STREET
ARGYLL PLACE
HANOVER SQUARE
HANOVER STREET
POLLEN ST
MADDOX STREET
GEORGE STREET
MILL STREET
MILL ST
PORTLAND STREET
PORTLAND MEWS
BENTINCK STREET
WORK HOUSE
ST ANNE COURT
RICHMOND BUILDINGS
RICHMOND MEWS
FRITH STREET
GREEK STREET
QUEEN STREET
EDWARD STREET
MARSHALL ST
MARSHALL STREET
DUFOURS PLACE
BROAD STREET
CARNABY STREET
TYLER STREET
KING STREET
CROSS STREET
NEW STREET
HOPKINS STREET
HUSBAND ST
PETER STREET
LITTLE WINDMILL STREET
GREAT PULTENEY STREET
BRIDLE STREET
LITTLE PULTENEY STREET
SILVER STREET
OLD COMPTON STREET
MEARDS COURT
CHURCH ST
KING ST
MACCLESFIELD ST
GEORGE YD
GERRARD ST
PRINCES STREET
LISLE STREET
LEICESTER STREET
RUPERT STREET
RICHMOND ST
ARCHER STREET
GREAT WINDMILL STREET
UP RUPERT ST
GOLDEN SQUARE
WARWICK STREET
BEAK ST
LOW JAMES ST
BREWER STREET
SHERRARD STREET
QUEEN STREET
ANGEL COURT
PANTON SQUARE
ARUNDEL ST
COVENTRY STREET
N COVENTRY ST
HAYMARKET
OXENDON STREET
PANTON STREET
JERMYN STREET
PICCADILLY
REGENT CIRCUS
REGENT STREET
REGENTS QUADRANT
AIR STREET
VINE STREET
SWALLOW STREET
SACKVILLE STREET
ALBANY
MARYLEBONE STREET
TICHBORNE STREET
GLASSHOUSE ST
VIGO STREET
BURLINGTON GARDENS
OLD BURLINGTON STREET
BURLINGTON STREET
NEW BURLINGTON STREET
NEW BURLINGTON MEWS
OLD BURLINGTON MEWS
BOYLE ST
SAVILLE ROW
CLIFFORD STREET
CORK STREET
CORK MEWS
HEDDON COURT
HEDDON STREET
LEICESTER ST
NEW BOND STREET
CONDUIT STREET
BRUTON ST
BARLOW MEWS
GRAFTON STREET
DOVER STREET
ALBEMARLE STREET
REGENT STREET
PUMP

DEATH'S DISPENSARY.

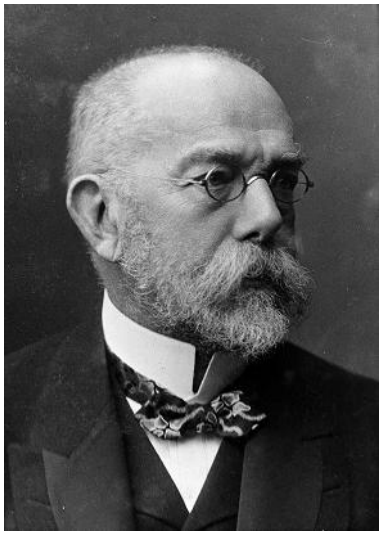
OPEN TO THE POOR, GRATIS, BY PERMISSION OF THE PARISH.



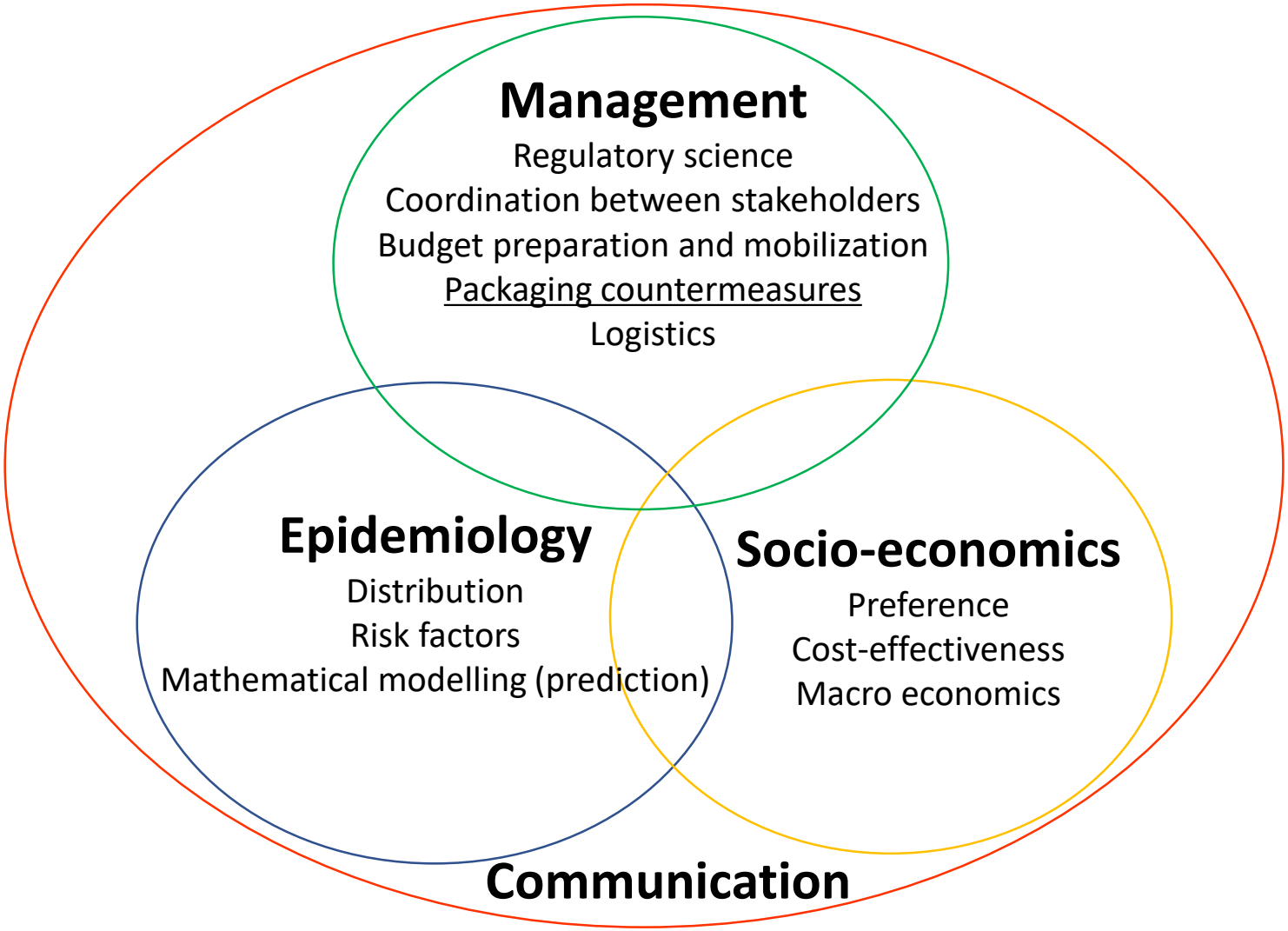

There was an independent pump in the work house
This pump was not used
WORK HOUSE
GREAT MARLBOROUGH STREET
BROAD STREET
PUMP
GOLDEN SQUARE
QUEEN STREET
SOHO SQUARE
OLD COMPTON
REGENT STREET
PORTLAND STREET
CARLISLE STREET
NEW BURLINGTON STREET
GREAT PULTENEY STREET
LITTLE PULTENEY STREET
RICHMOND BUILDINGS
QUEEN STREET

Removal of water pump handle stopped cholera

- A company distributed contaminated water
- It was 1884 when Robert Koch discovered *Vibrio cholerae*



Development of a disease control strategy



Sharing the same vision

It is important that stakeholders know the importance of epidemiology and collaboration

This is One Health!

1st International One Health Congress

Human Health, Animal Health, the Environment and Global Survival

Melbourne Convention Centre
Victoria, Australia
14 – 16 February 2011

Human

One Health

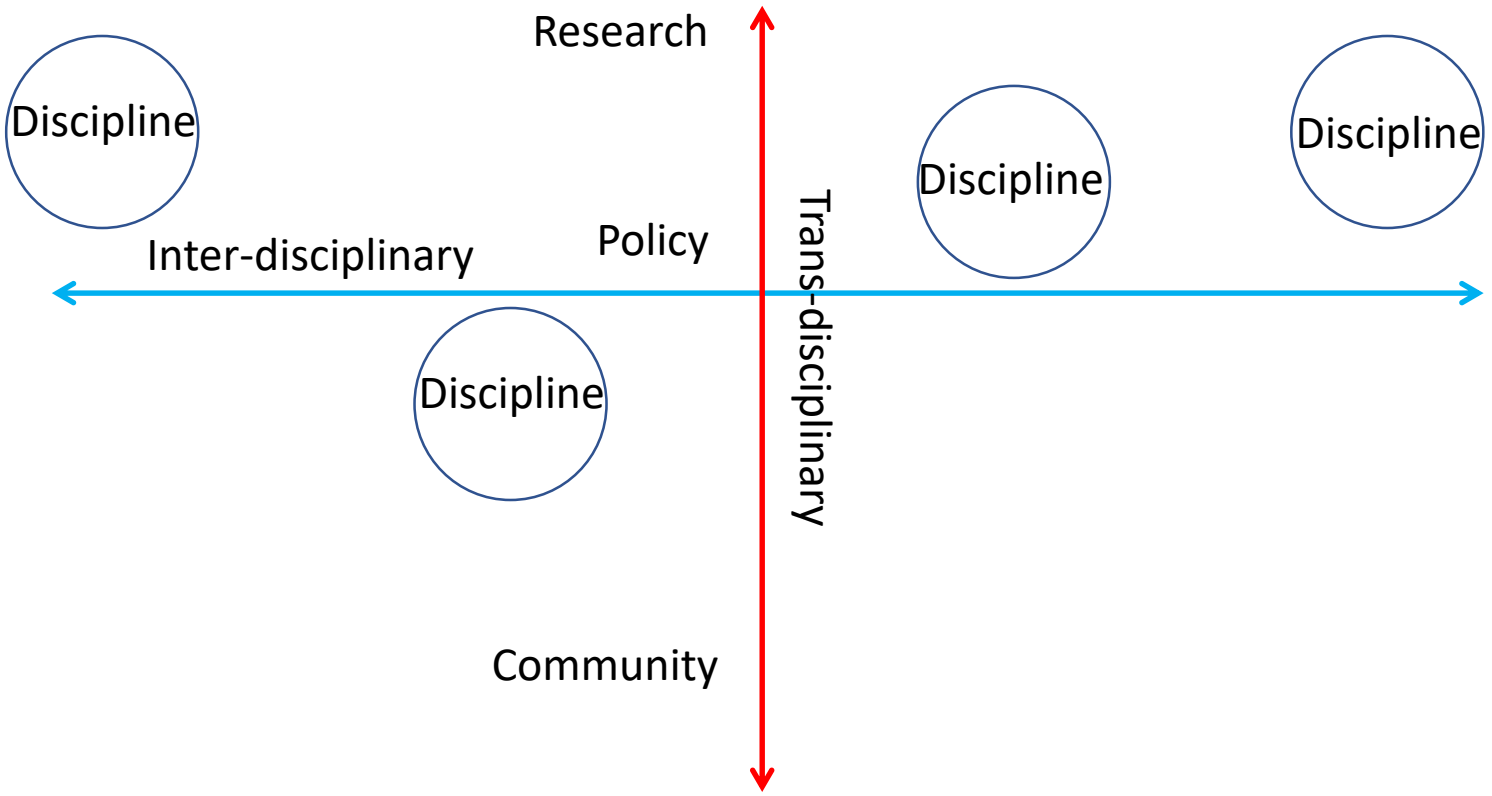
Animal

Environment

Ecohealth

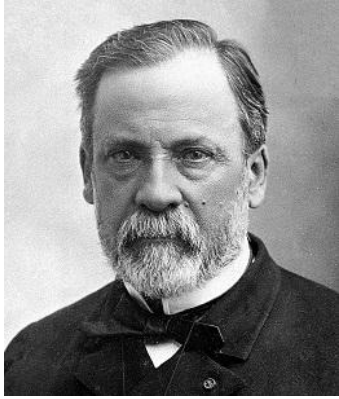
Inter-disciplinary (One Health) and trans-disciplinary (Ecohealth) approaches

Disciplines: medicine, veterinary medicine, environmental sciences, socio-economics…

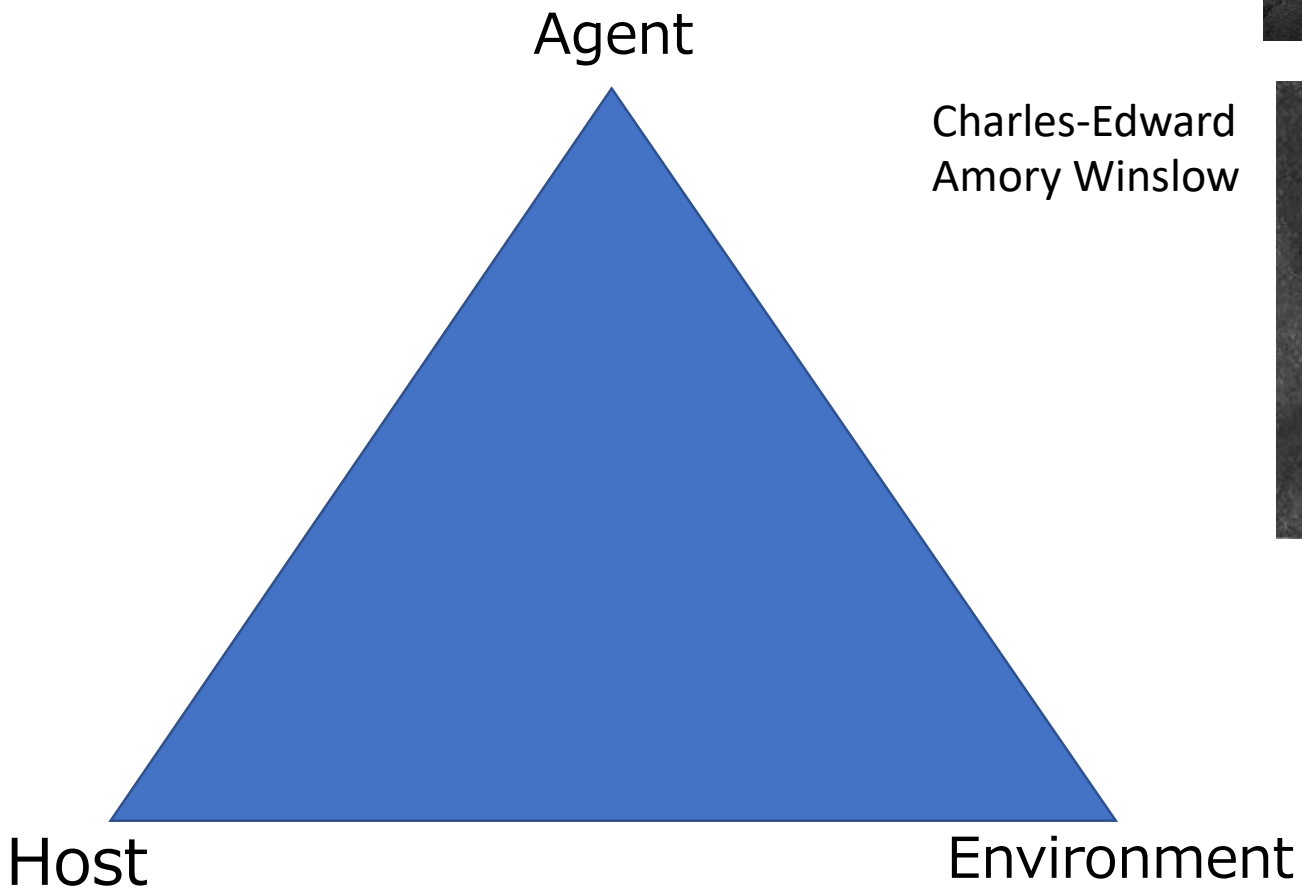


Multiple causality

Louis Pasteur



Charles-Edward
Amory Winslow



Epidemiological indicators

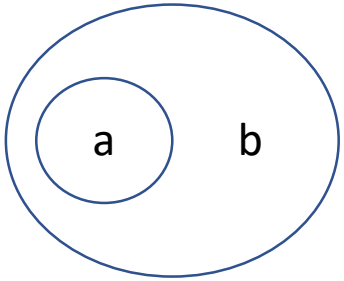
Before getting started..

Rate・Proportion・Ratio

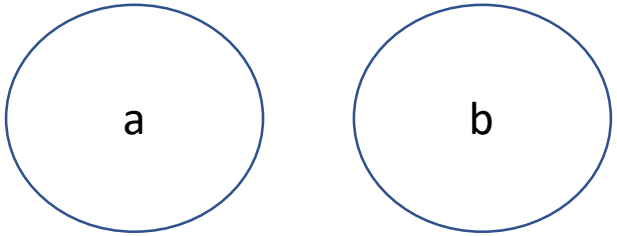
They are different!!

- Rate <speed>:
  - includes the concept of '**time**'

- Proportion:
  - does **NOT** include the concept of '**time**'



- Ratio:
  - the numerator is **NOT** a part of denominator （eg. sex ratio）



Incidence

The number of new cases

that occur in a known population

over a specific period of time

Incidence rate

Definition:

The **rapidity** with which new cases of disease develop over time

$$IR = \frac{\text{Number of new cases of disease that occur in a population during a particular period of time}}{\text{The sum, over all individuals, of the length of time at risk of developing disease}}$$

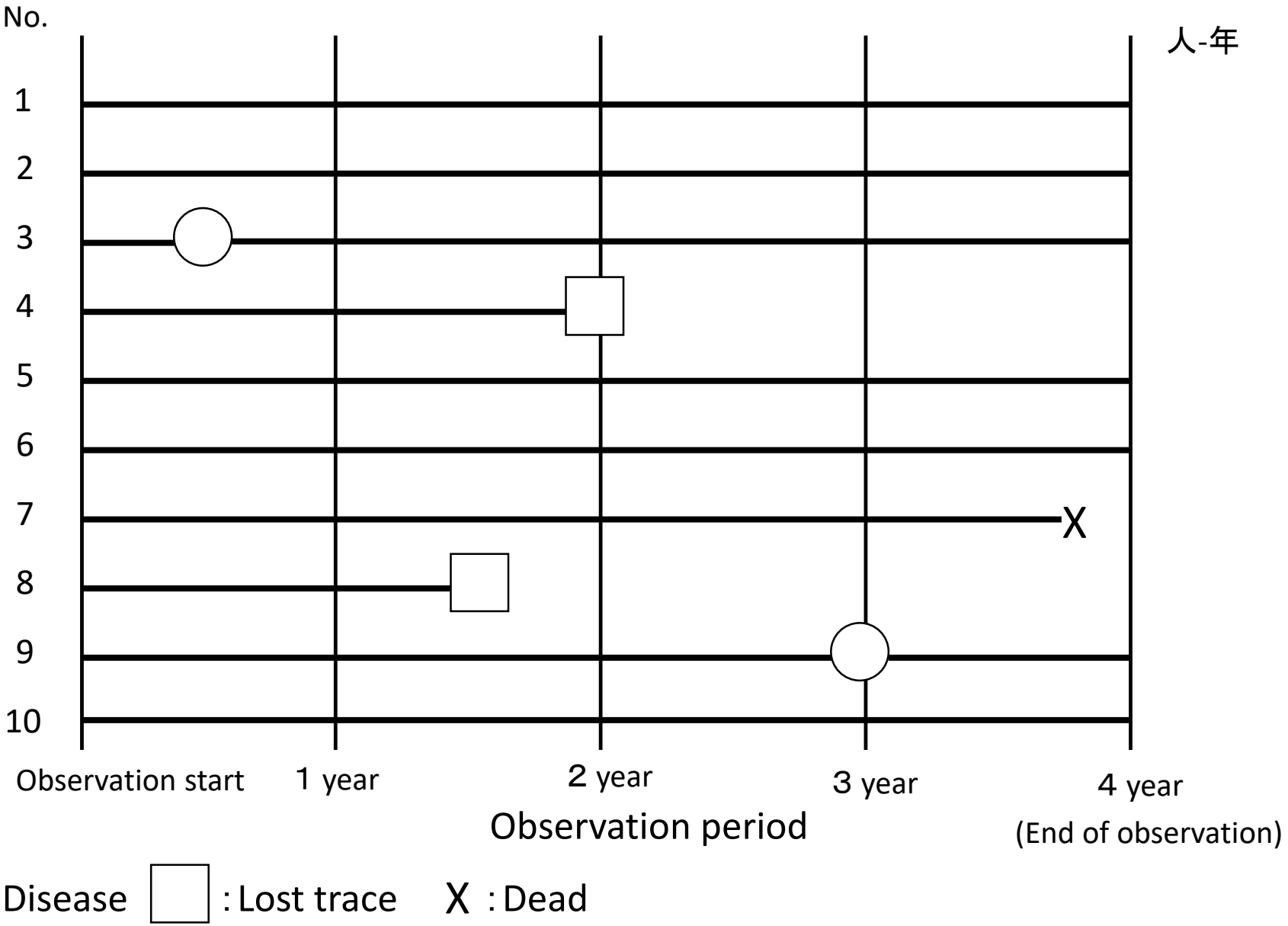
$$\text{Annual incidence rate} = \frac{\text{Number of new cases in a year}}{\text{Total number of individuals observed x 1 year}}$$

Human-year or animal-time

Animal-time

- Is equivalent to **person-year** in human epidemiology
  - Veterinary epidemiology requires **different time scale** from human's due to different life expectancy or pattern of occurrence in animals
  - Example: dog-year, cow-month
- Animal-time in case an individual became untraceable
  - Became untraceable at the middle of the year: 0.5 year
  - Became untraceable at the quarter of the year: 0.25 year
  - This means that information of animals left from the population during a period **can be** utilized

Question 1.1 Calculate the IR



Question 1.2

- Akabane Disease in cattle
  - 578 incidence in 1999
  - Total number of cattle in Japan was 4,658 thousands

- Answer the annual incidence rate

Left: *Culex tritaeniorhynchus*
Right: *Culicoides oxystoma*

Calf recurvature, deformity

Prevalence

The proportion of diseased individuals for a specific disease at a time point

$$\text{Prevalence} = \frac{\text{The number of diseased individuals}}{\text{The number of individuals in a population at the time of observation}}$$

Case fatality rate

The tendency for a condition to cause the death of affected animals in a specified time. Probability of death in diseased animals. CFR is used for acute diseases.

$$\text{CFR} = \frac{\text{Number of deaths}}{\text{Number of diseased animals}}$$

Relative risk

The ratio of the incidence of disease in exposed animals to the incidence in unexposed animals. RR shows how many times more likely to be diseased when exposed to the factor compared to not exposed to.

RR = 1: no association

RR > 1: risk factor

RR < 1: preventive factor

		Disease status		
		Diseased	Healthy	
Factor	Exposed	A	B	A+B
	Not exposed	C	D	C+D

$$\text{Relative risk} = \frac{\text{Incidence in exposed animals}}{\text{Incidence in unexposed animals}} = \frac{A/A+B}{C/C+D}$$

Odds ratio

- 'Odds' is an expectation, which is a ratio of a probability that a scenario occurs *p* over not occurs (1 - *p*)
- Odds ratio is a ratio of exposure odds of cases over that of controls in a case-control
- OR = 1: no association
- OR > 1: risk factor
- OR < 1: preventive factor

		Case	Control	
Factor	Exposed	A	B	A+B
	Not exposed	C	D	C+D

＊Case: Probability of exposure = A/ (A + C)
Probability of no exposure = C/ (A + C)
Exposure odds = {A/ (A + C)} / {C/ (A + C)} = A/C

＊Control: Probability of exposure = B/ (B + D)
Probability of no exposure = D/ (B + D)
Exposure odds = {B/ (B + D)} / {D/ (B + D)} = B/D

$$\textbf{Odds ratio (OR)} = \frac{\textbf{A/C}}{\textbf{B/D}} = \frac{\textbf{A} \times \textbf{D}}{\textbf{B} \times \textbf{C}}$$

Types of epidemiologic studies

- Descriptive epidemiology
- Analytic epidemiology
  - Ecological study
  - Cross-sectional study
  - Case-control study
  - Cohort study
- Intervention study
  - Clinical trial
  - Field trial
  - Community intervention trial
- Theoretical epidemiology

Observational study

Controlled experiment

Descriptive epidemiology

Descriptive epidemiology involves **observing** and **recording diseases** and **possible causal factors**.
It is usually the first part of an investigation.

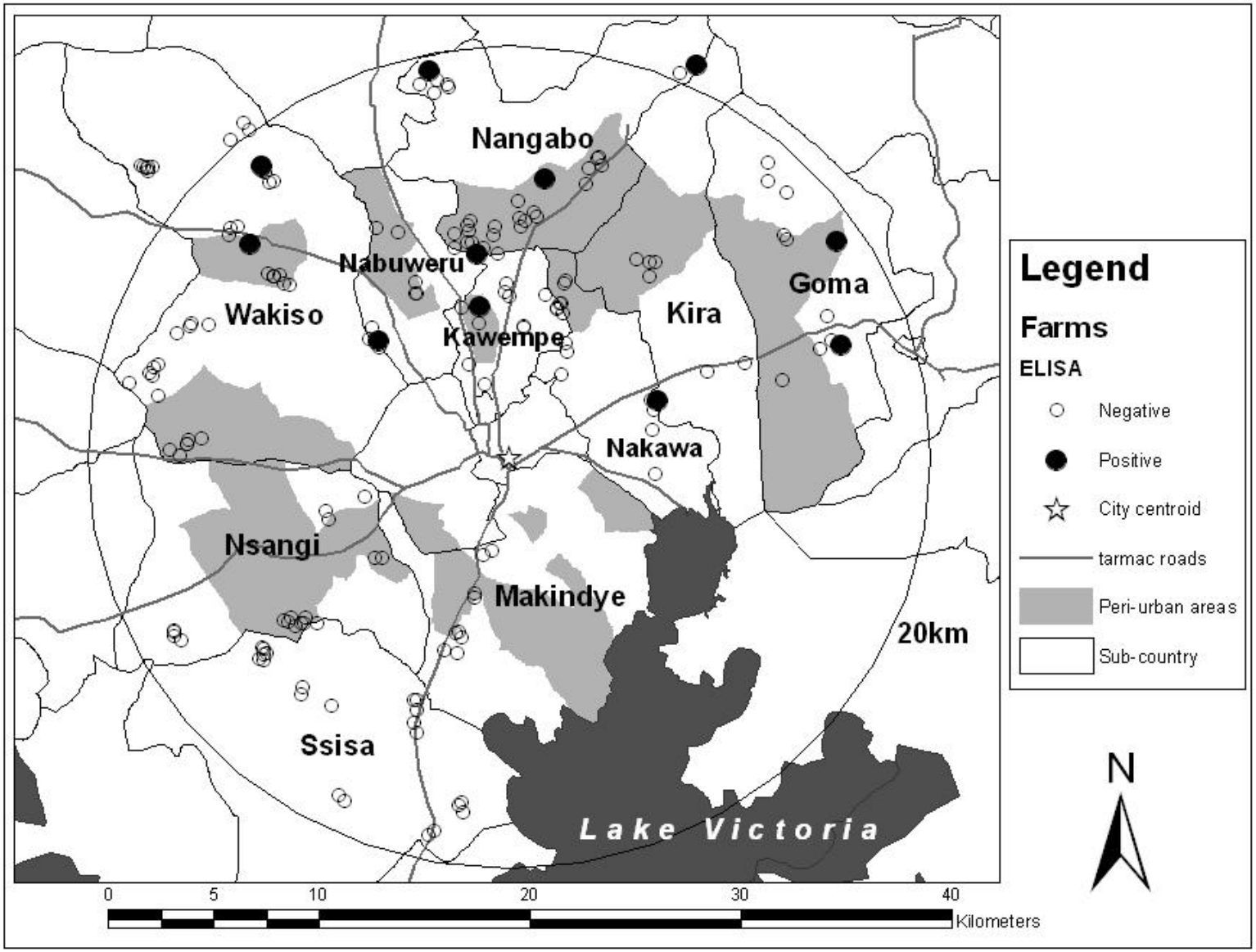
- Observation and recording of **frequency and pattern** of the disease occurrence, in terms of:
  1. Time (when)
  2. Place (where)
  3. Biological and sociological attributes of humans and/or animals (hosts) of interest (to whom)
- Formation of a **hypothesis** on causal factors

Brucella infected farms in Kampala

Makita K. (2009) PhD Thesis. The University of Edinburgh.

Any hypothesis?

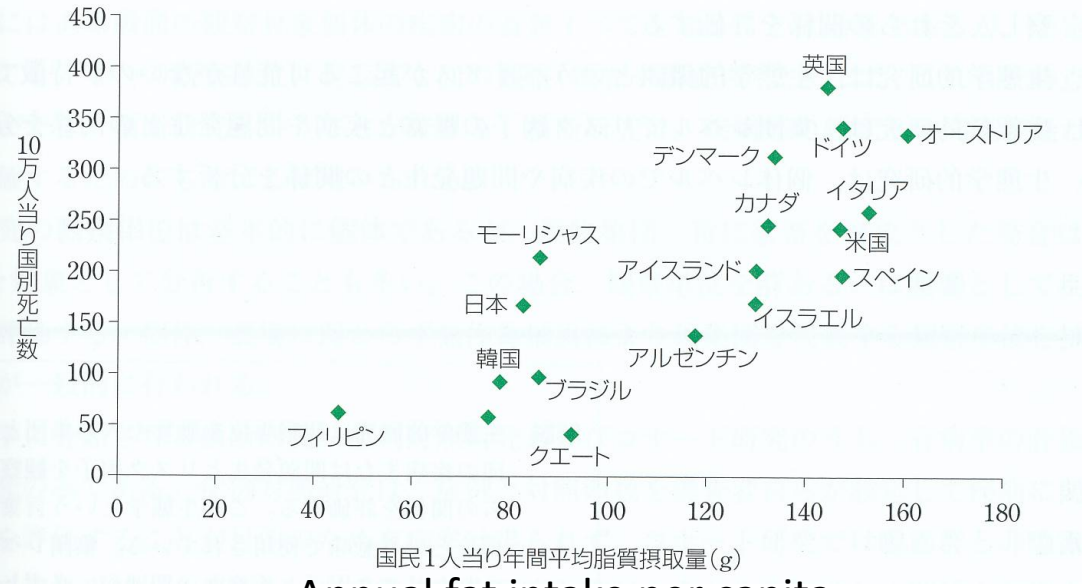
The answer was grazing



Ecological study

- Ecological study studies the characteristics of groups to understand the association between a factor and disease
- Hypothesis making for the relationship between disease or death and exposure to a factor
- Collect aggregate data (public data)
- Visualization or simple statistics, for confirming the relationship

Death per 100 thousands by country



Annual fat intake per capita

r=0.8; WHO1997

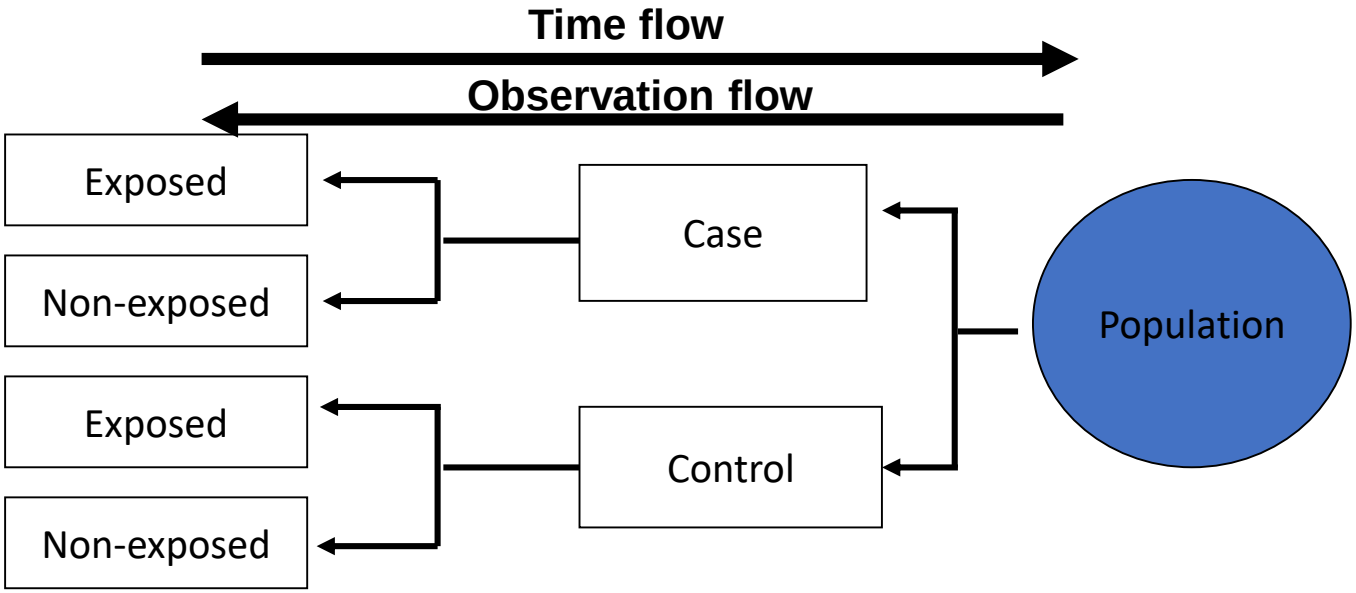
Cross-sectional study

Cross-sectional study is a study for the simultaneous presence or absence of disease, and hypothesized risk factor

- Cross-sectional study is called as ‘prevalence study’
- Prevalence can be at the individual or population level, such as farm level
- The association between causal factors and disease can be suggested

Case-control study

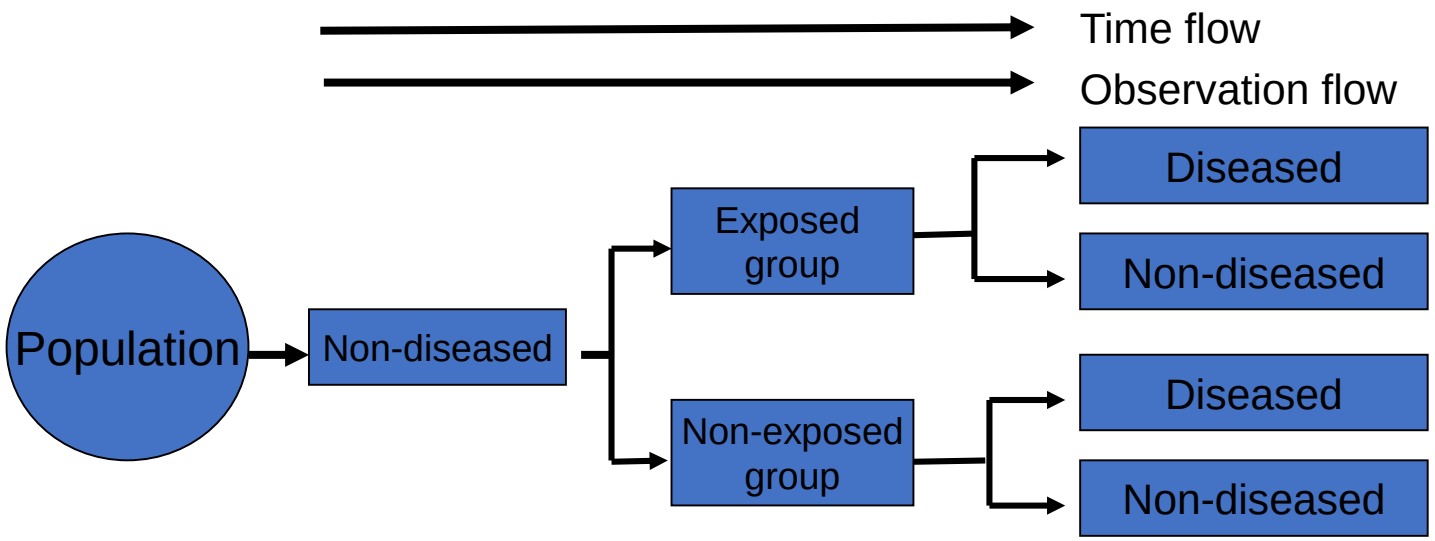
- A group of diseased individuals and another group of properly selected non-diseased individuals are compared for the proportions of exposed individuals to a hypothetical causal factor.
- As the exposure is investigated into the past, it is called as a 'retrospective study.'
- Particularly useful in the early phase of acute disease



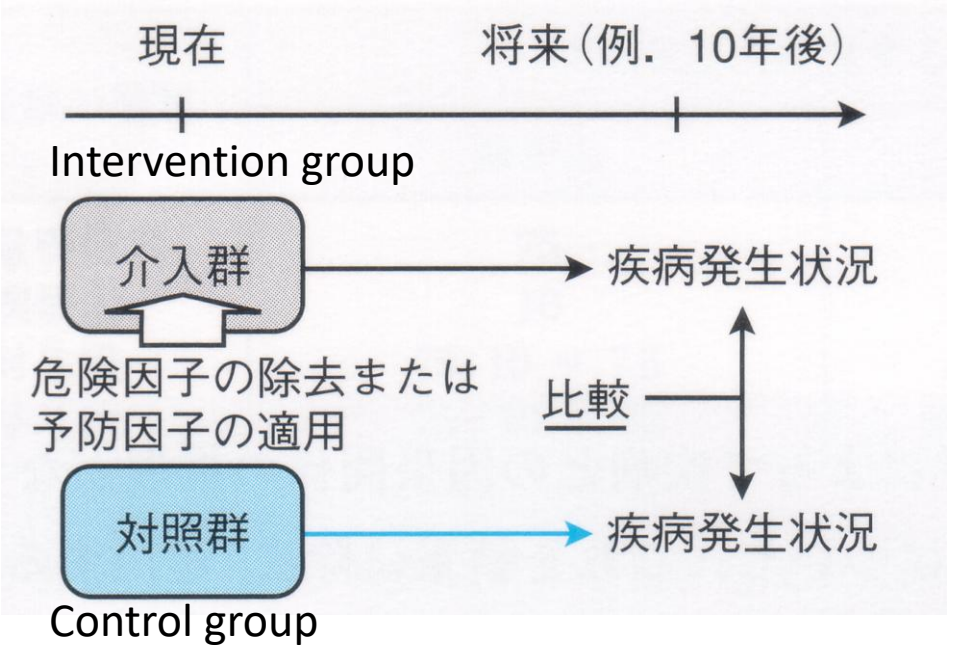
Cohort study

- A group (cohort) of animals **exposed** to an hypothesized risk factor, and a group **not exposed** to the factor are selected and observed to record **development of disease** in each group.
- The strength of the association between the factor and disease is shown using **relative risk**.

Note: In Roman era, a troop consisting of 300-600 solders used to be called as a cohort. In epidemiology, a cohort refers to a group of individuals with a common characteristics.



Intervention study



- An investigation involving **intentional change** in some aspect of the subjects (group or individuals
  - Introduction of a preventive, therapeutic, or husbandry regimen
- A study population is divided into (1) **intervention group**, (2) **control group**, or more, and the results are compared

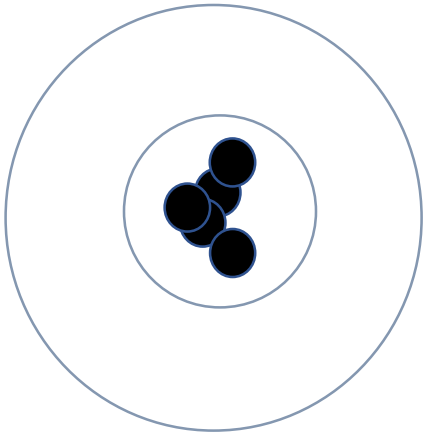
Reliability and validity in an epidemiological study

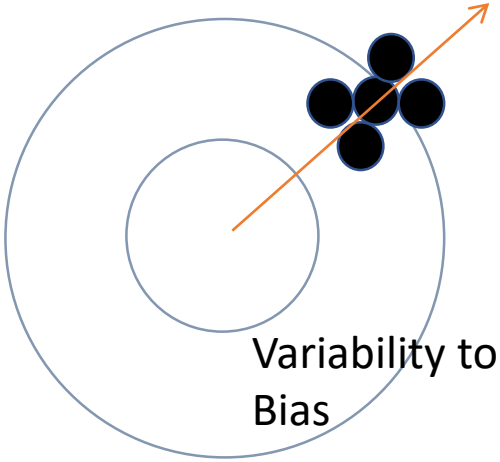
Validity Accuracy

High

Low

High

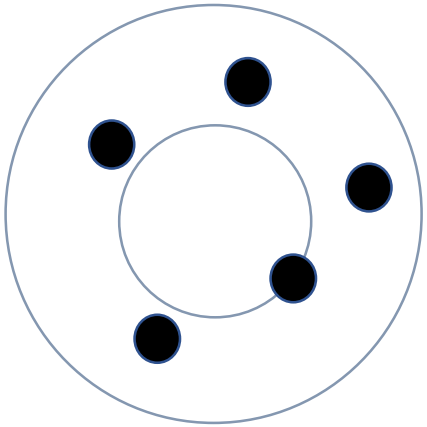


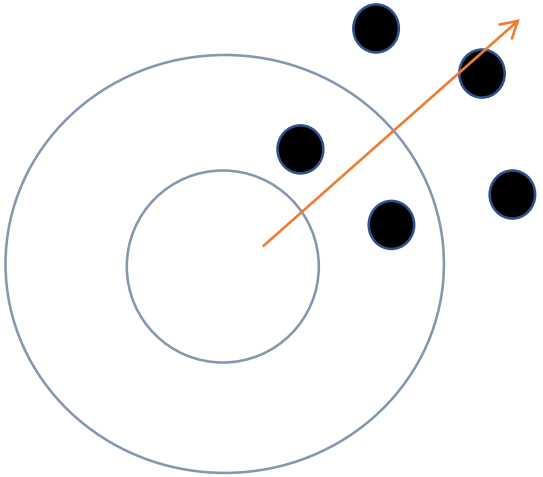


Variability to a direction:
Bias

Reliability
Precision

Low





Random error and bias

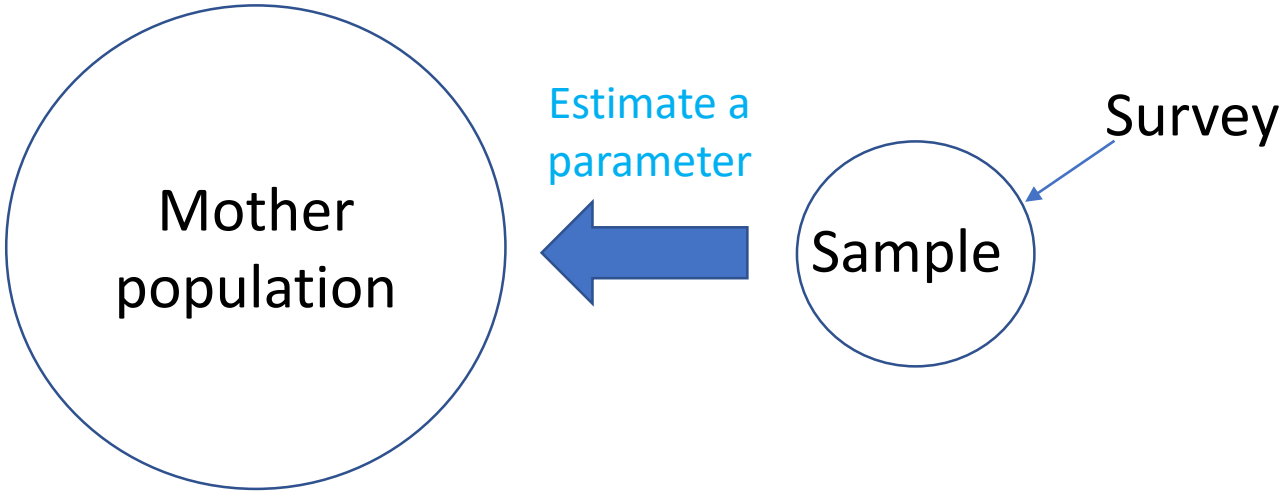
- Random error
  - Variation as a result of a chance, with no clear association with other factors or variables
  - A confidence interval shows magnitude of a random error
  - Random error can be reduced by an increase of precision, through increasing the sample size
- Systematic error
  - An error caused by a distortion towards a certain direction
  - It is called as **bias**
  - A systematic error cannot be removed by an increase of sample size or study frequency

Sampling

- Let’s imagine that you are going to the field for an epidemiological study!
- If it turns out that there is **no validity** in the study design after collecting samples, you will be disappointed.
- Therefore, you learn ‘sampling’ in this chapter.

What is ‘sampling’ in epidemiology?

- Census
  - In many cases, it is too costly to conduct a census
- Sample survey
  - A survey to estimate a parameter of the mother population by observing individuals selected from the mother population



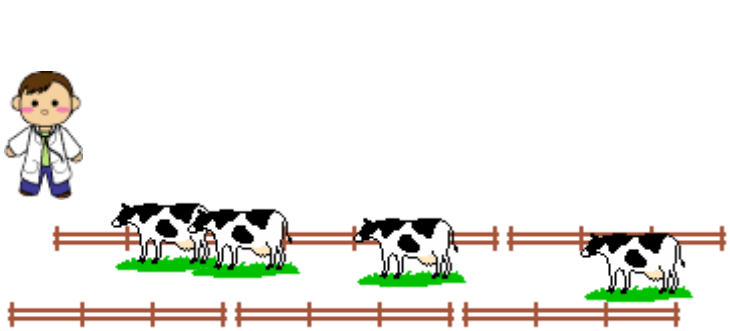
Sampling methods

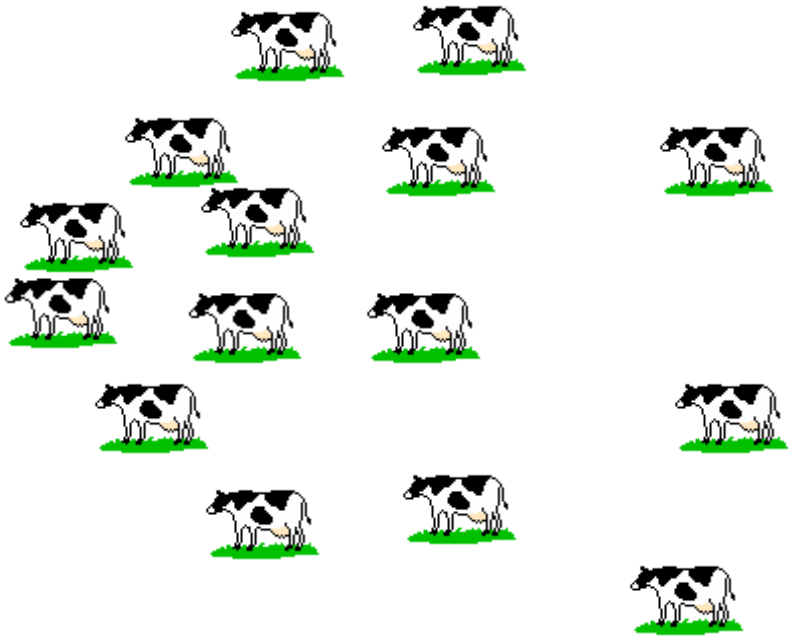
- Non-probability sampling methods
  - Convenience sampling
  - Purposive selection
- Probability sampling methods
  - Simple random sampling
  - Systematic sampling
  - Stratified random sampling
  - Cluster sampling
  - Multistage sampling

Source: Thrusfield M (2005) Veterinary Epidemiology 3rd Ed.

Convenience sampling

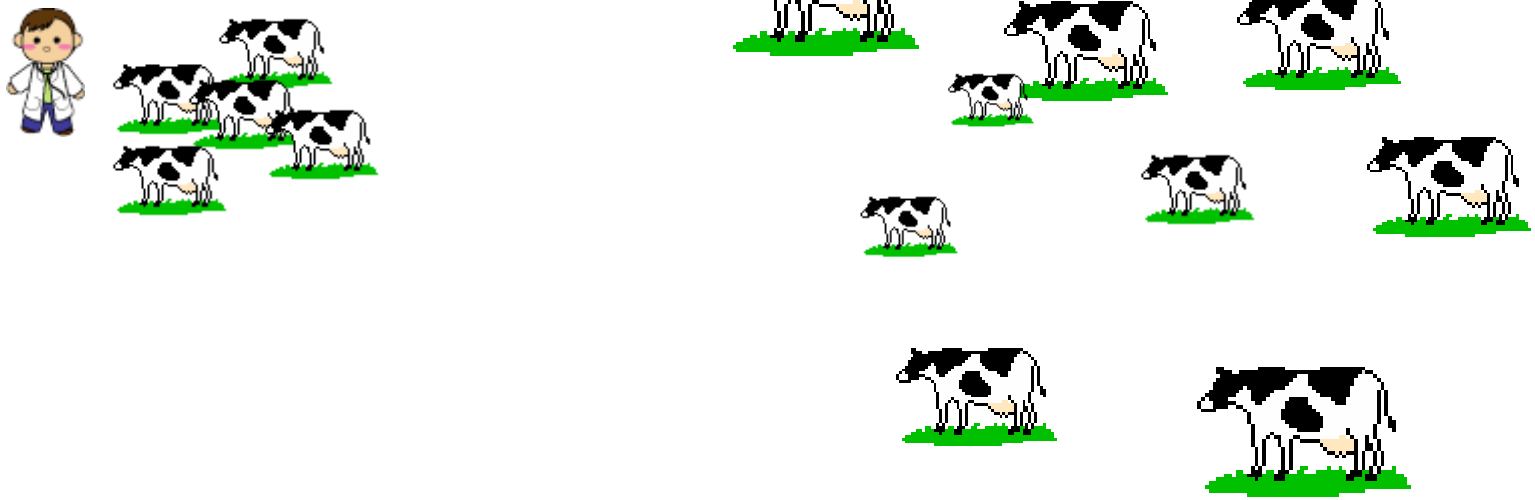
Select the samples as convenient
(not recommended)





Purposive selection

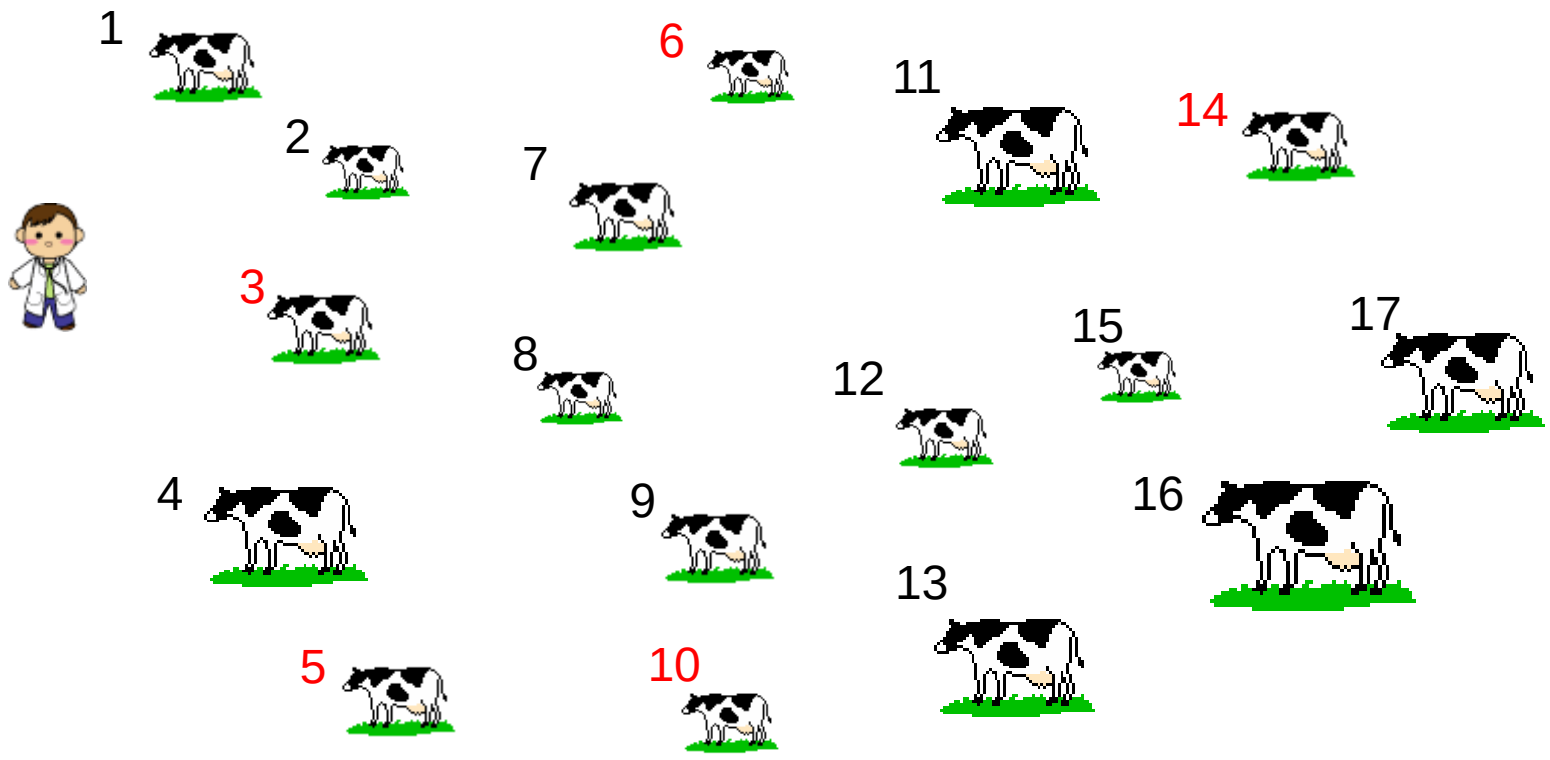
The selection based on the subjects possessing one or more attributes such as known exposure to a risk factor
(Sometimes it is effective, but representativeness is usually low)



Sample size 5/ population size 17

Simple random sampling

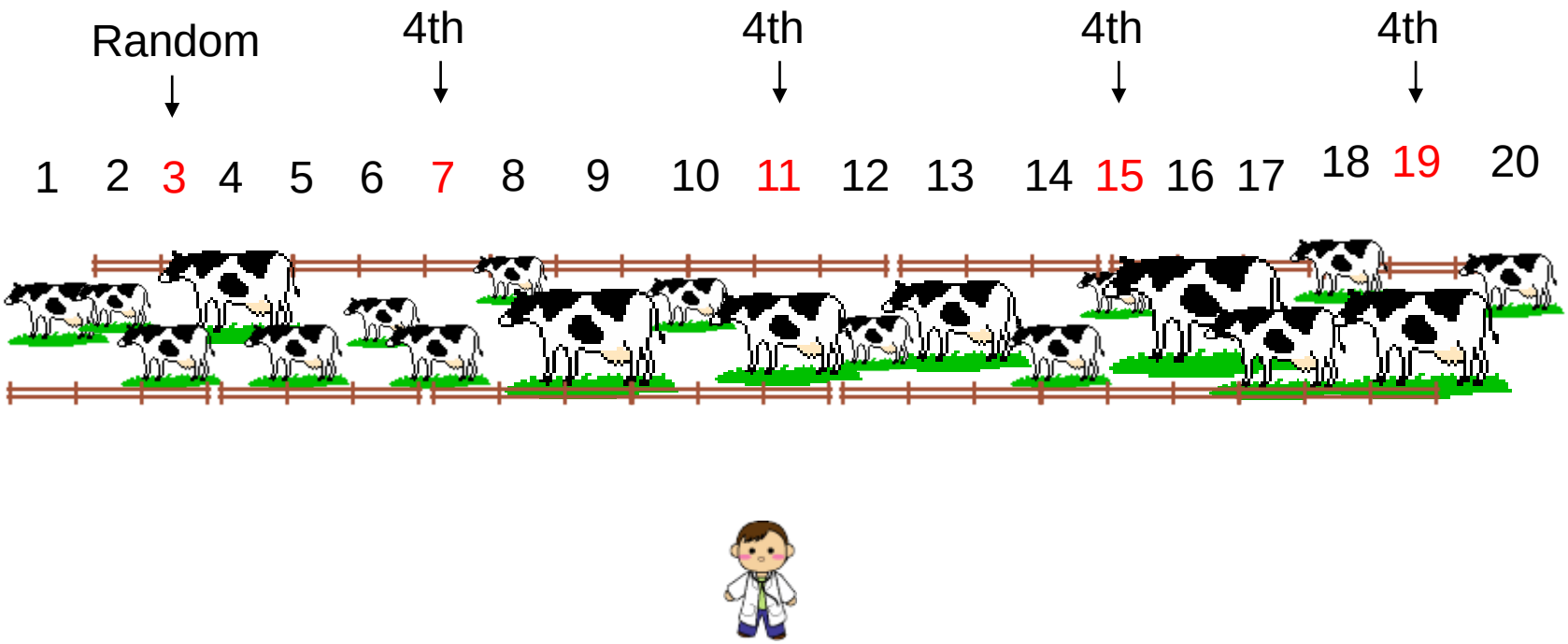
Every study subject in the population has an equal probability of being selected
(The most ideal process but difficult in a large population)



Sample size 5/ population size 17

Systematic sampling

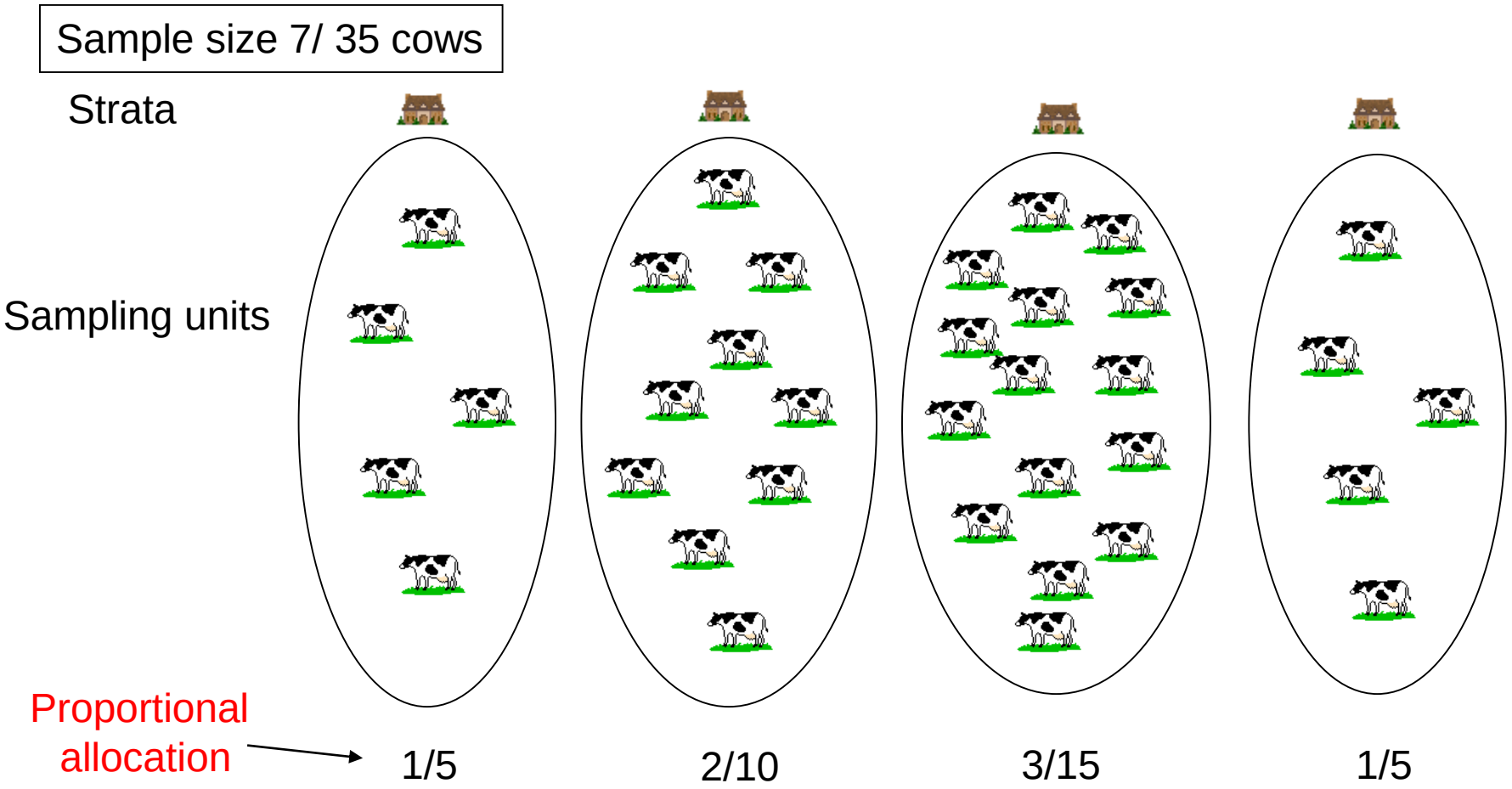
The first study subject is chosen randomly, and after that every *i*th subject (sampling interval) is included in the sample



Sample size 5/ 20, sample interval 4

Stratified random sampling

A population is divided into mutually exclusive strata, and subjects are chosen within these strata at an equal probability



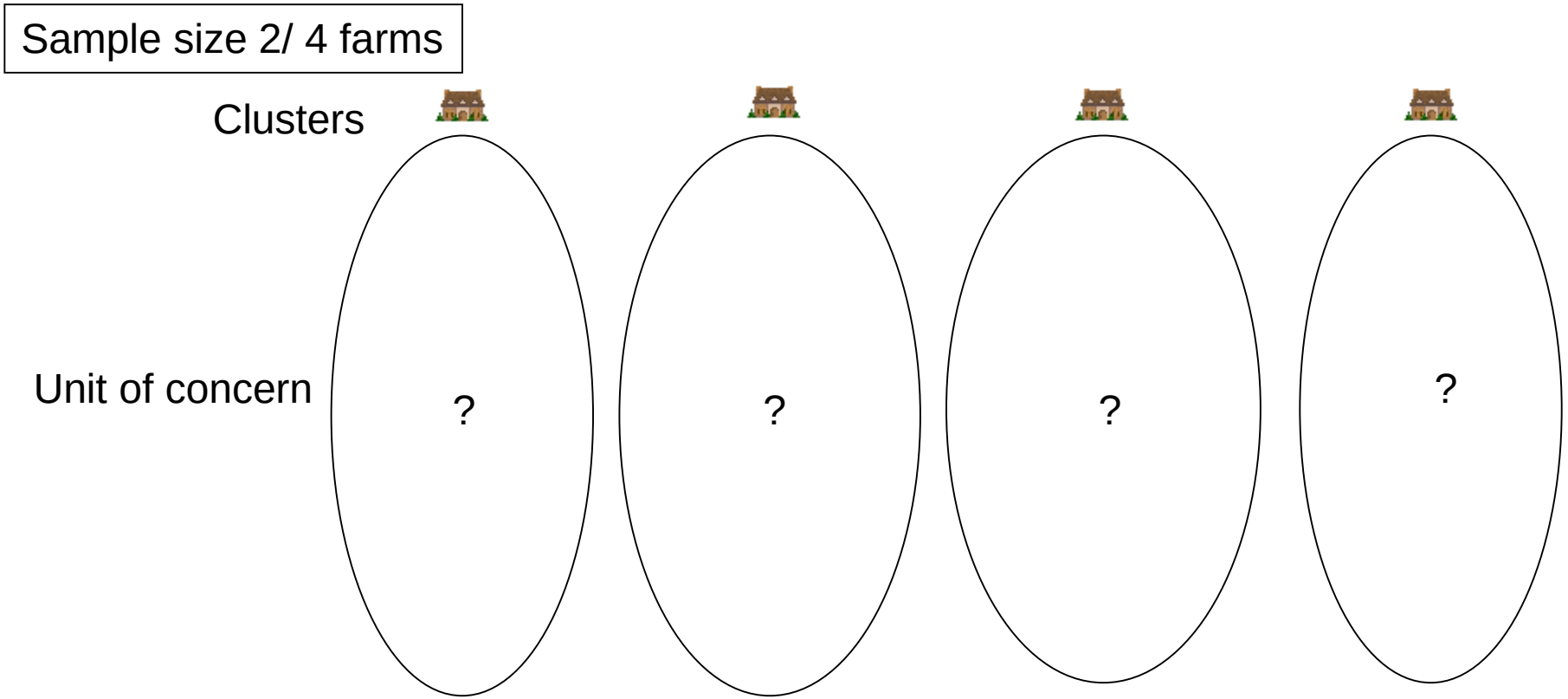
Stratified random sampling

Sampling 4% of clinical records

Dogs	Cats	Exotic animals
12/300	10/250	2/50

Cluster sampling

Out of the clusters (a farm or a city/town), all subjects belonging to the clusters chosen are sampled



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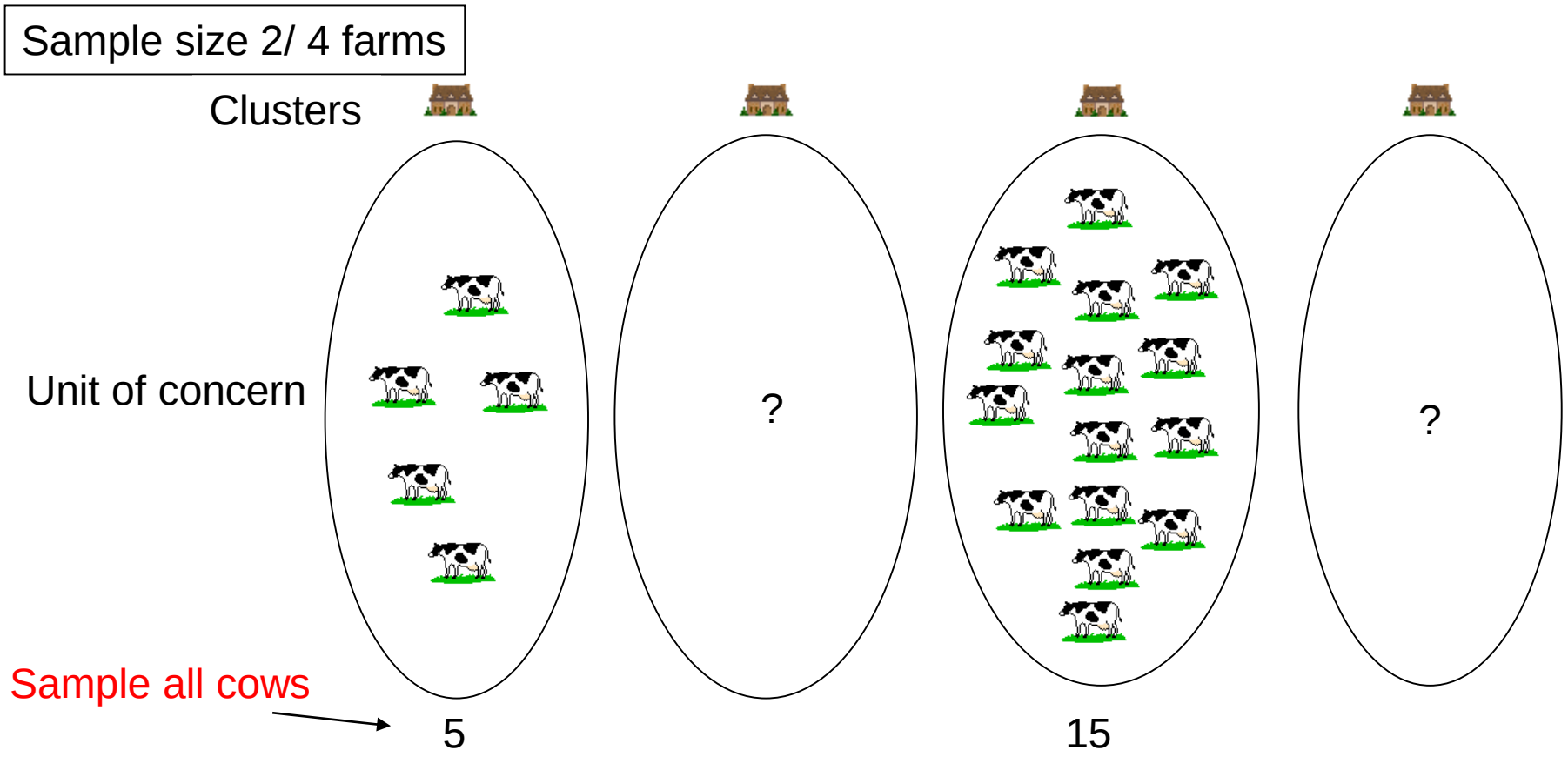
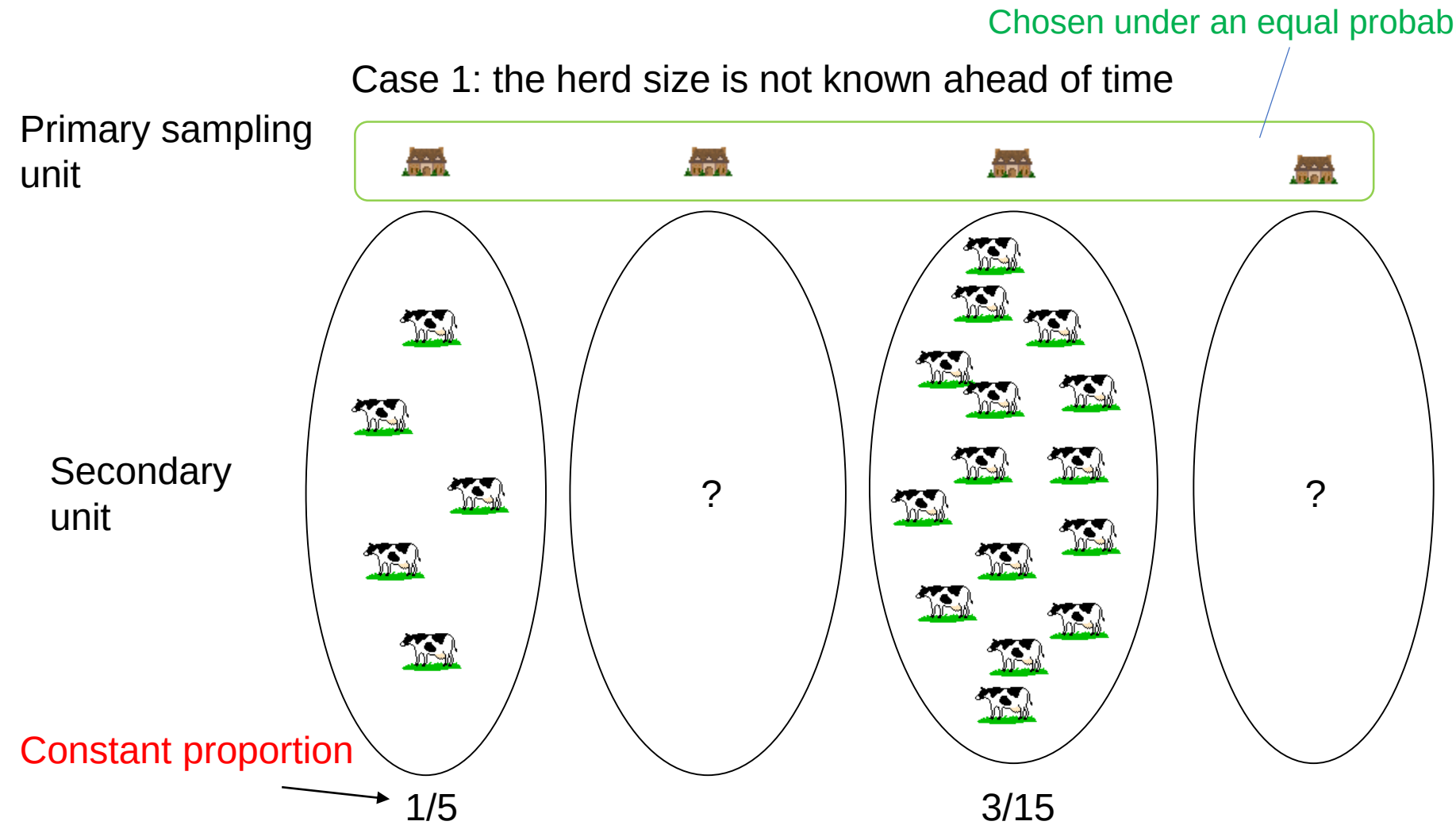


Multistage sampling 1

At first the largest populations (primary sampling units) are chosen, and among them, the next smaller populations (secondary sampling units) are chosen, and so on. More than two stages are involved in sampling.

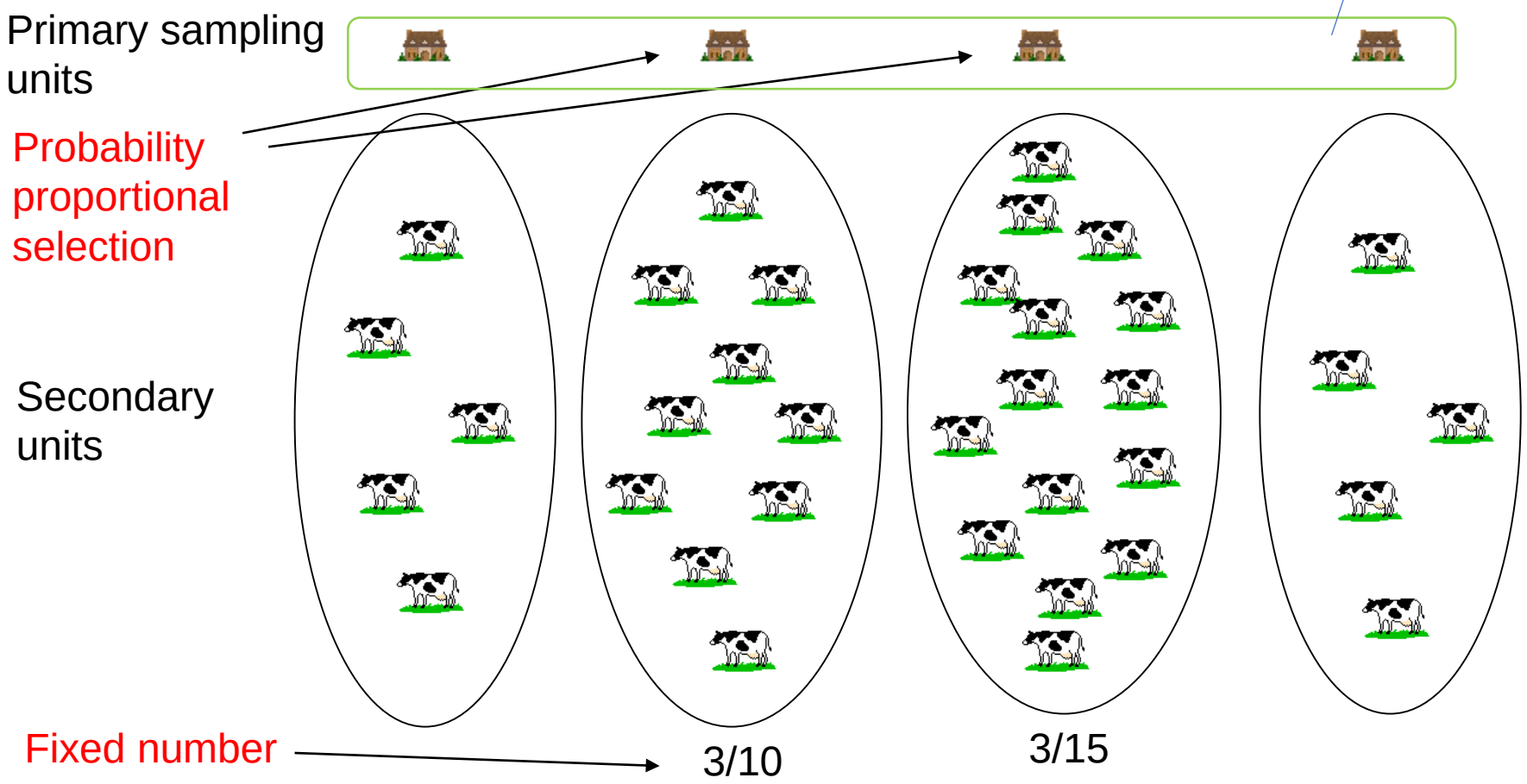


Multistage sampling 2

At first the largest populations (primary sampling units) are chosen, and among them, the next smaller populations (secondary sampling units) are chosen, and so on. More than two stages are involved in sampling.

Chose according to the size of secondary unit

Case 2: the herd size is known ahead of time



Sample size calculation is different depending on the purpose

- Estimation of a proportion
  - Different according to the sampling method
- Detection of a disease in a population
- Comparison of two means
- Comparison of two proportions

Any questions?