2026 DISEASE DETECTIVES (B,C)

KAREN LANCOUR
National Bio Rules Committee Chairman

Karen Lancour
My Science Olympiad History

Founding member of Science Olympiad (Sharon Putz & I are the two remaining founding members)

Michigan positions - Member of the Regional Board which worked with Delaware to bring Science Olympiad to the National Level, Coach, Regional & State Event Supervisor Regional Director, State Board Member

Science Olympiad National Positions - National Event Supervisor, National Rules Committee Member, National Rules Committee Chairman for Life Science

Science Olympiad Educational Involvement

Prepared training materials for the Life Science Events since 1984

Taught Regional, State, and National Workshops since 1984.

Dr. Gerard Putz & I

when SO was founded

Disclaimer

- This presentation was prepared using draft rules.
- There may be some changes in the final copy of the rules.

Event Rules – 2026

BE SURE TO CHECK THE 2026 EVENT RULES FOR EVENT PARAMETERS AND TOPICS FOR EACH COMPETITION LEVEL

Disease Detectives

Part 1 – Background & Surveillance

Part 2 – Outbreak Investigation

Part 3 – Patterns, Control & Prevention

Event Rules – 2026

- Disease Detectives emphasizes the process of investigating health-related events
- When specific events are being analyzed, competitors should not be expected to know facts such as latency or incubation periods or causative agents about diseases or conditions.
- These should be provided in background information or the body of the question.
- They will then be expected to apply this information to a given situation.

TRAINING MATERIALS

Training Power Point – content overview

3 Training Handout – Parts 1,2 & 3

Practice Activities – to help learn the process

Sample Tournament – sample problems with key

Event Supervisor Guide – prep tips, event needs, and scoring tips

SO WEBSITE TRAINING MATERIALS

EVENT RESOURCES – the Science Olympiad website www.soinc.org

under Event Information-will be posted throughout the fall

- **Training Power Point – content overview**
- **Training Handouts – overview, general principles**
- **Sample Tournament – sample problems with key**
- **Event Supervisor Guide – prep tips, event needs, and scoring tips**
- **Internet Resource – links to good resources for learning content**

Training PDFs – the Science Olympiad Store at www.soinc.org

- **Biology-Earth Science (BECD) – current year topics for all bio events with training materials and extra resources**
- **Disease Detectives (DDCD) – all content, extra resources, exams from invitational, regional, state & national competitions**

On-line Text Books

***Principles of Epidemiology* 3rd edition from CDC**

http://www.cdc.gov/osels/scientific_edu/SS1978/SS1978.pdf

***Basic Epidemiology 2ND edition* from the World Health Organization**

http://whqlibdoc.who.int/publications/2006/9241547073_eng.pdf

9241547073_eng.pdf (who.int)

Game Plan

1. Use the *POWERPOINT* for an overview
2. Study the *HANDOUTS* – for background information and content
3. Use the *INTERNET RESOURCES* and *PDFs* for more help – see the Science Olympiad National website at www.soinc.org under event information and the Science Olympiad store
4. Prepare a *RESOURCE BINDER* and use *OTHER TOOLS* to LEARN THE CONTENT AND PROCESS SKILLS
5. Prepare your *ONE PAGE OF NOTES* for effective use in competition
6. Do *PRACTICE ACTIVITIES* to prepare for doing a competition
7. Do the *SAMPLE TOURNAMENT* under timed conditions to experience being timed in competition.
8. Prepare and do *PRACTICE STATIONS, OLD TESTS*, and *INVITATIONALS* –to master knowledge, teamwork, and using your notes effectively under timed conditions.

Event Makeup

Format and material of the Division B and C event is similar except that the level of reasoning and math skills should be consistent with the grade level.

Differences between the two levels should be reflected in both the type of questions asked and the scoring rubrics.

Types of skills needed

- Recognize risk factors for health problems
- Know the components of the scientific method used in investigating a disease outbreak to real-life situations affecting health
- Understand and interpret the basic concepts of mathematics (rates & proportions as attack rate, relative risk & odds ratio) used to assess health risks
- Recognize an epidemiological case definition
- Know the different types of study designs used by epidemiologists and be able to recognize them from written accounts

PART ONE: BACKGROUND & SURVEILLENCE

- Clinical Approach vs. Public Health Approach
- History of Epidemiology & Population Health
- Components of Public Health
- Epidemiology & Public Health
- Natural History & Spectrum of Disease
- Public Health Surveillance

Clinical vs. Public Health Approaches

	Public Health	Clinical Medicine
Primary Focus	**Populations**	**Individuals**
Emphasis	Prevention	Diagnosis
	Health Promotion	Treatment
	Whole Community	Whole Patient
Paradigm	Interventions aimed at Environment, Human Behavior and Lifestyle, and Medical Care	Medical Care
Organizational Lines of Specialization	Analytical (Epidemiology);	Organ (Cardiology);
	Setting and Population (Occupational Health);	Patient Group (Pediatrics);
	Substantive Health Problem (Nutrition);	Etiology, Pathophysiology (Oncology, Infectious Disease)
	Skills in Assessment, Policy Development, and Assurance	Technical Skill (Radiology)

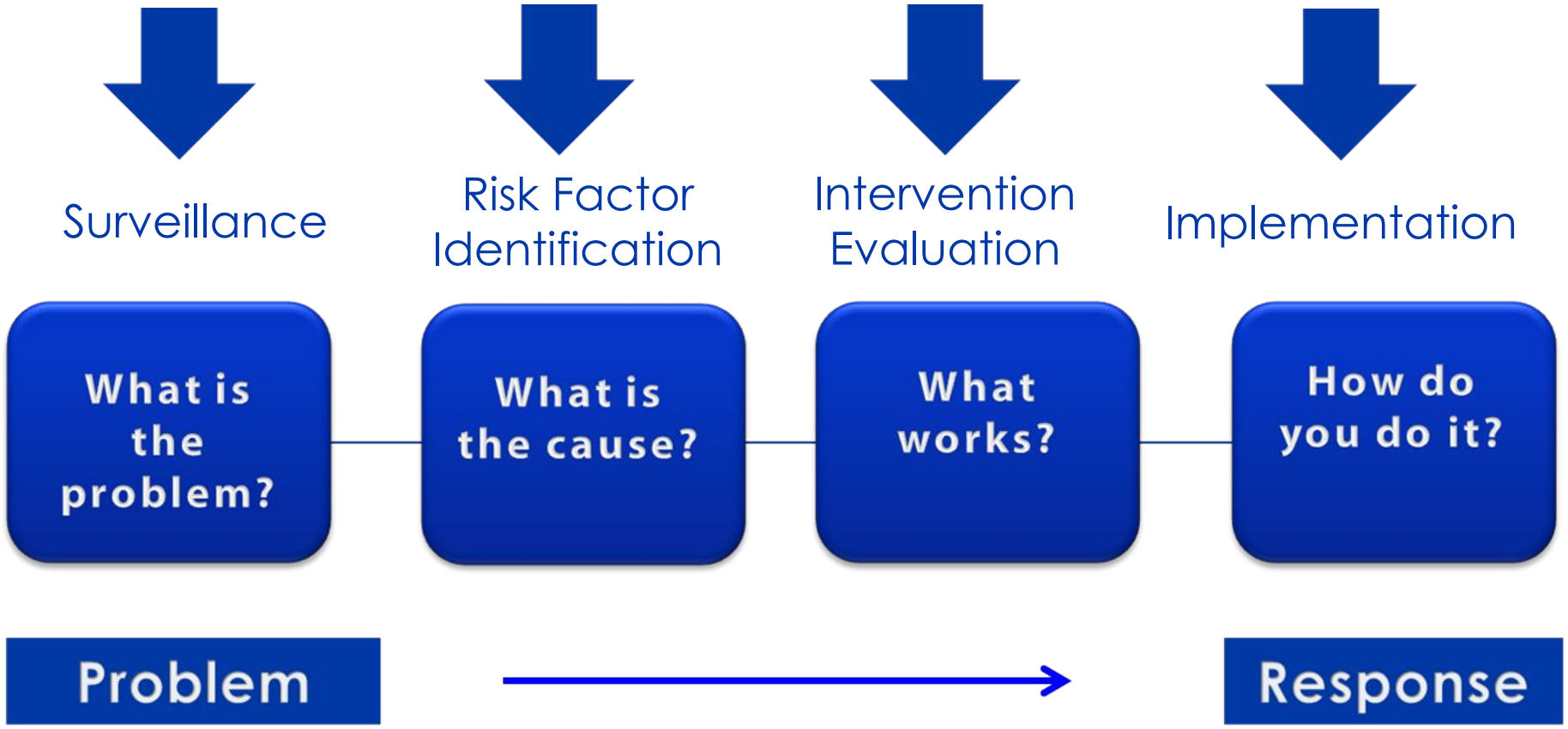
History of Public Health & Epidemiology

John Gaunt – analysis of mortality rates- 1662.

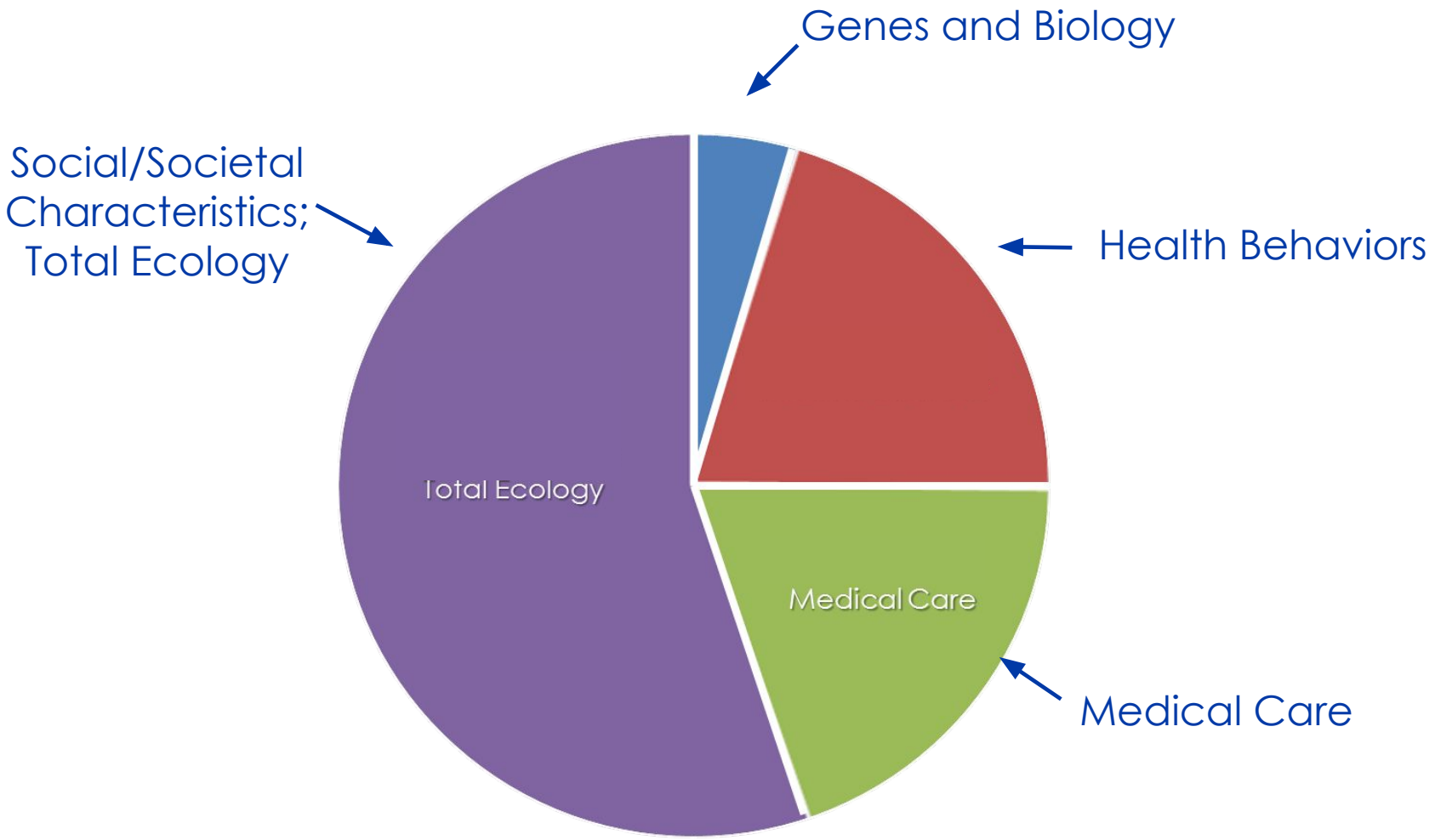
William Farr – father of vital statistics & surveillance - 1800

John Snow – father of field epidemiology – cholera in London 1850s

A Public Health Approach

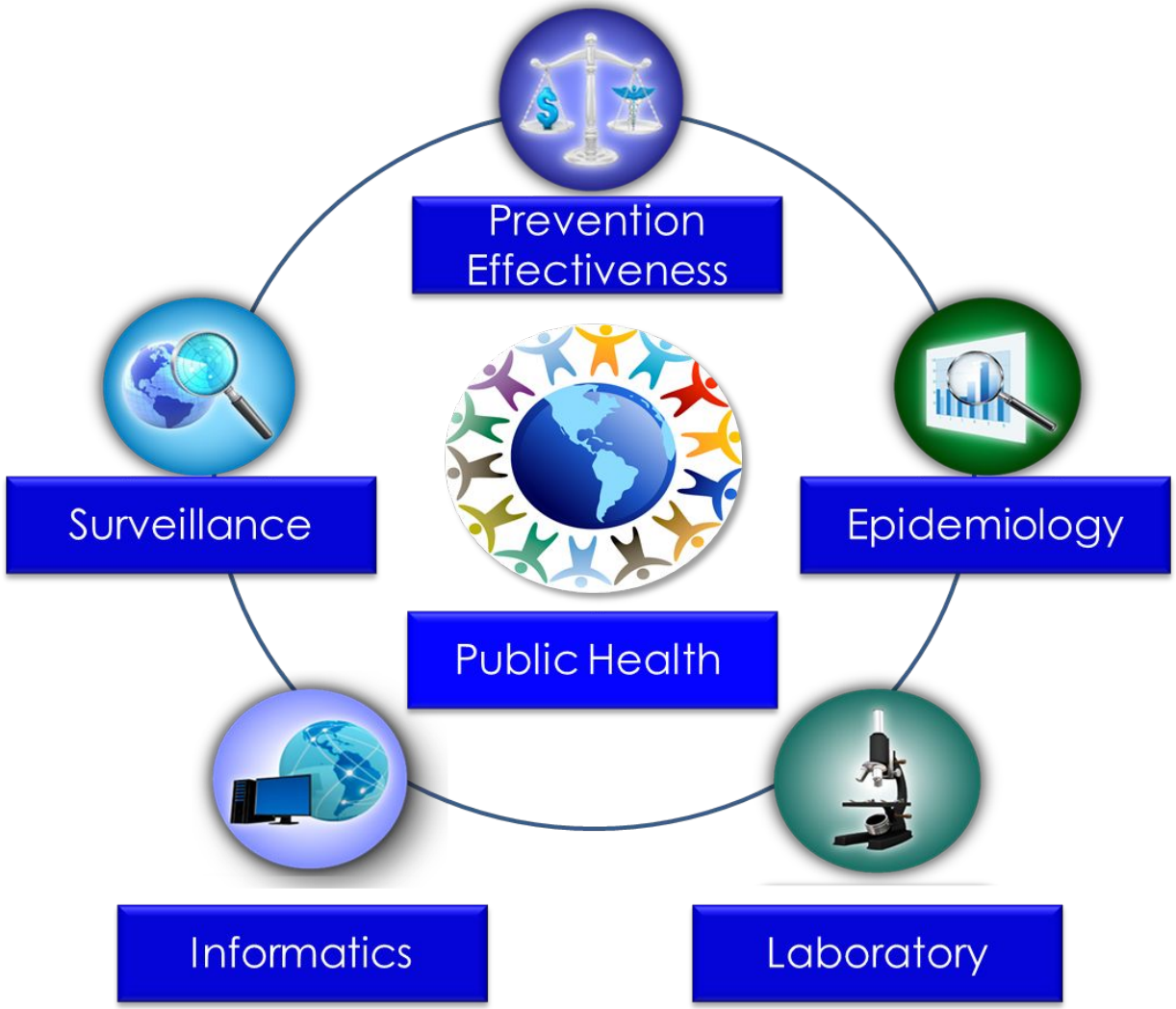


What Determines the Health of a Population?



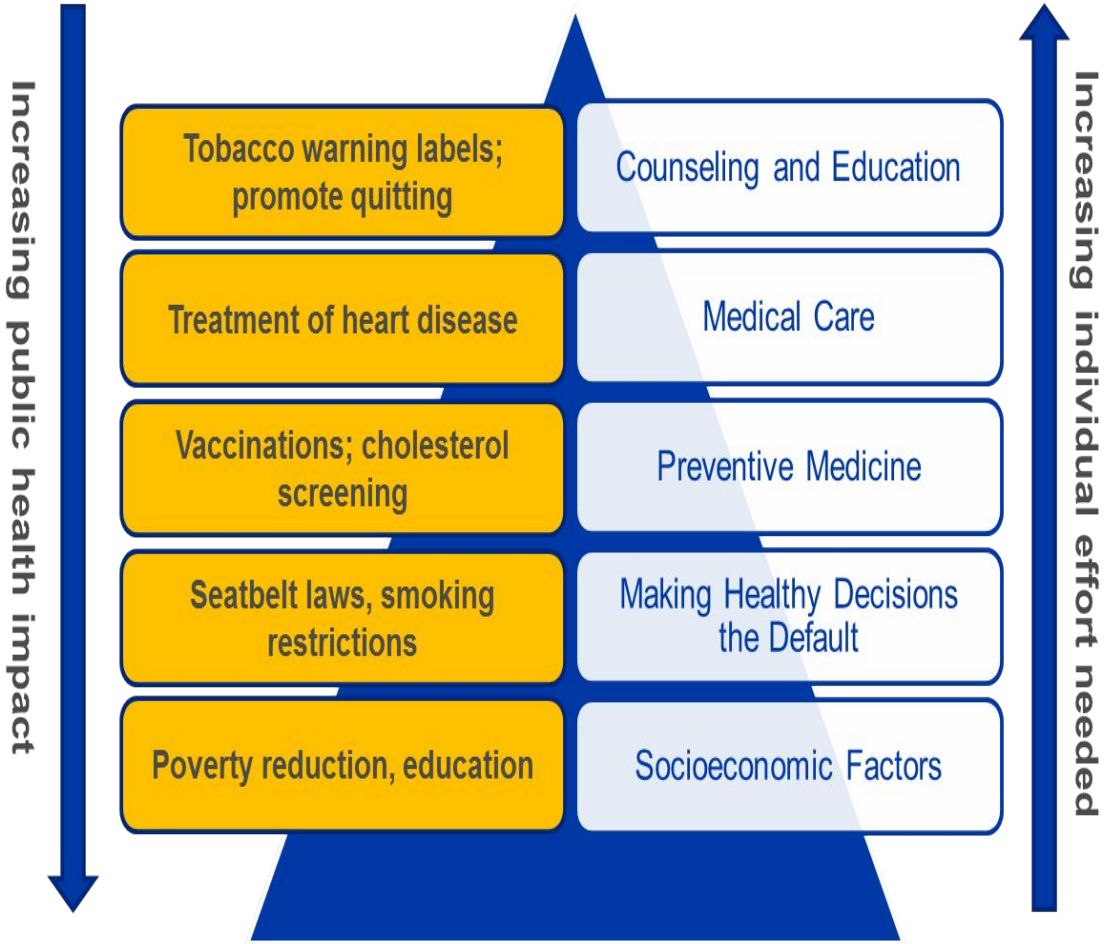
Centers for Disease Control and Prevention. Social determinants of health. http://www.cdc.gov/socialdeterminants/FAQ.html.

Public Health Core Sciences



Types of Public Health Issues

- Alcohol-related harms
- Food safety
- Healthcare-associated infections
- Heart disease and stroke
- HIV
- Motor vehicle injury
- Nutrition, physical activity and obesity
- Prescription drug overdose
- Teen pregnancy
- Tobacco use



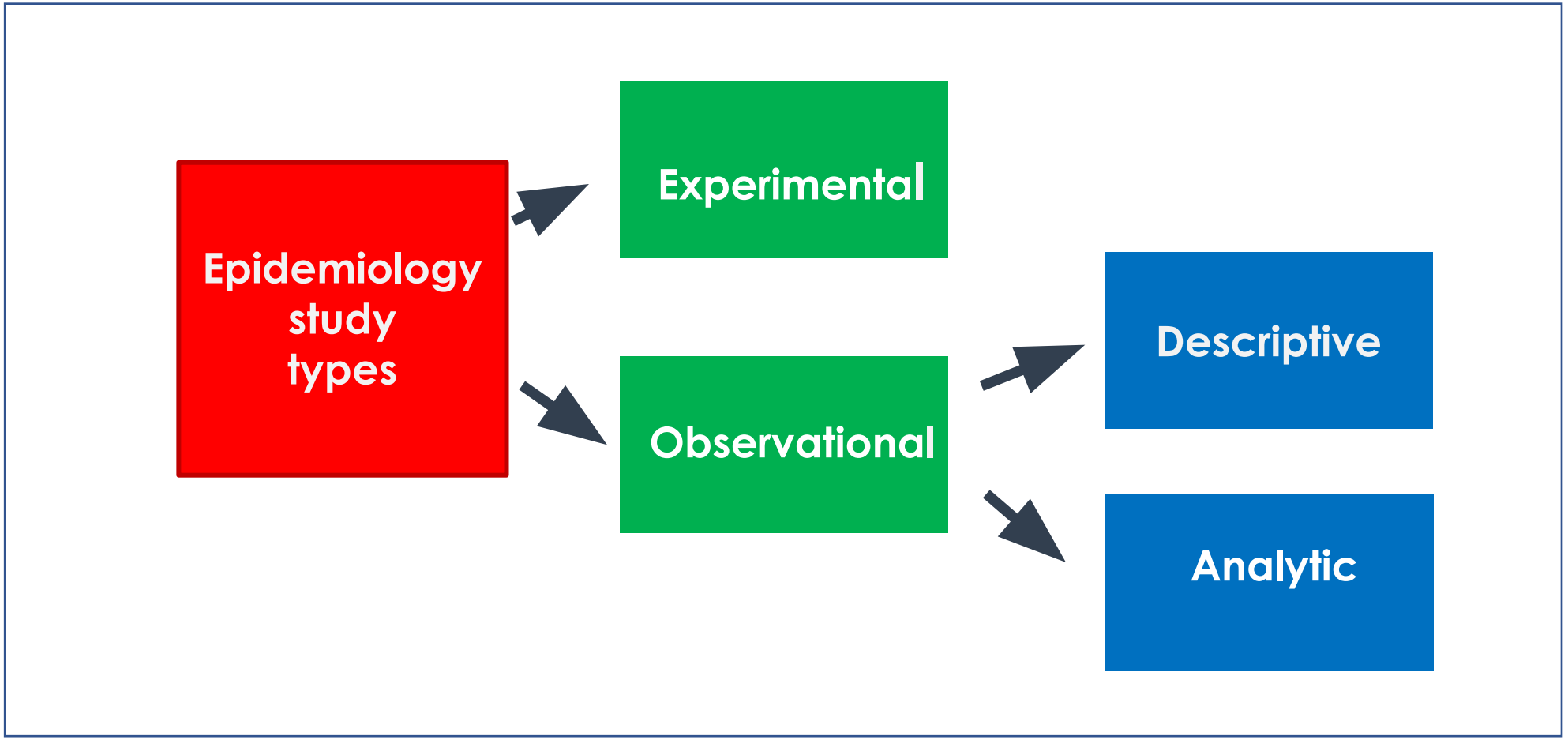
EPIDEMIOLOGY

- Scientific Method – organized problem solving
- Distribution and determinants of disease in human populations
- Prevent and control those diseases
- Health-related events:
  - chronic diseases
  - environmental problems
  - behavioral problems
  - injuries
  - infectious diseases

Descriptive and Analytic Epidemiology

Descriptive epidemiology	Analytic epidemiology
When was the population affected?	**How was the population affected?**
Where was the population affected?	**Why was the population affected?**
Who was affected?	

Epidemiology Study Types



KEY TERMS

Endemic – disease or condition present among a population at all times

Outbreak – (localized epidemic) – more cases of a particular disease than expected in a given area or among a specialized group of people over a particular period of time.

Epidemic – large numbers of people over a wide geographic area affected.

Pandemic -An epidemic occurring over a very wide area (several countries or continents) and usually affecting a large proportion of the population.

Cluster –an aggregation of cases over a particular period esp. cancer & birth defects closely grouped in time and space regardless of whether the number is more than the expected number. (often the expected number of cases is not known.)

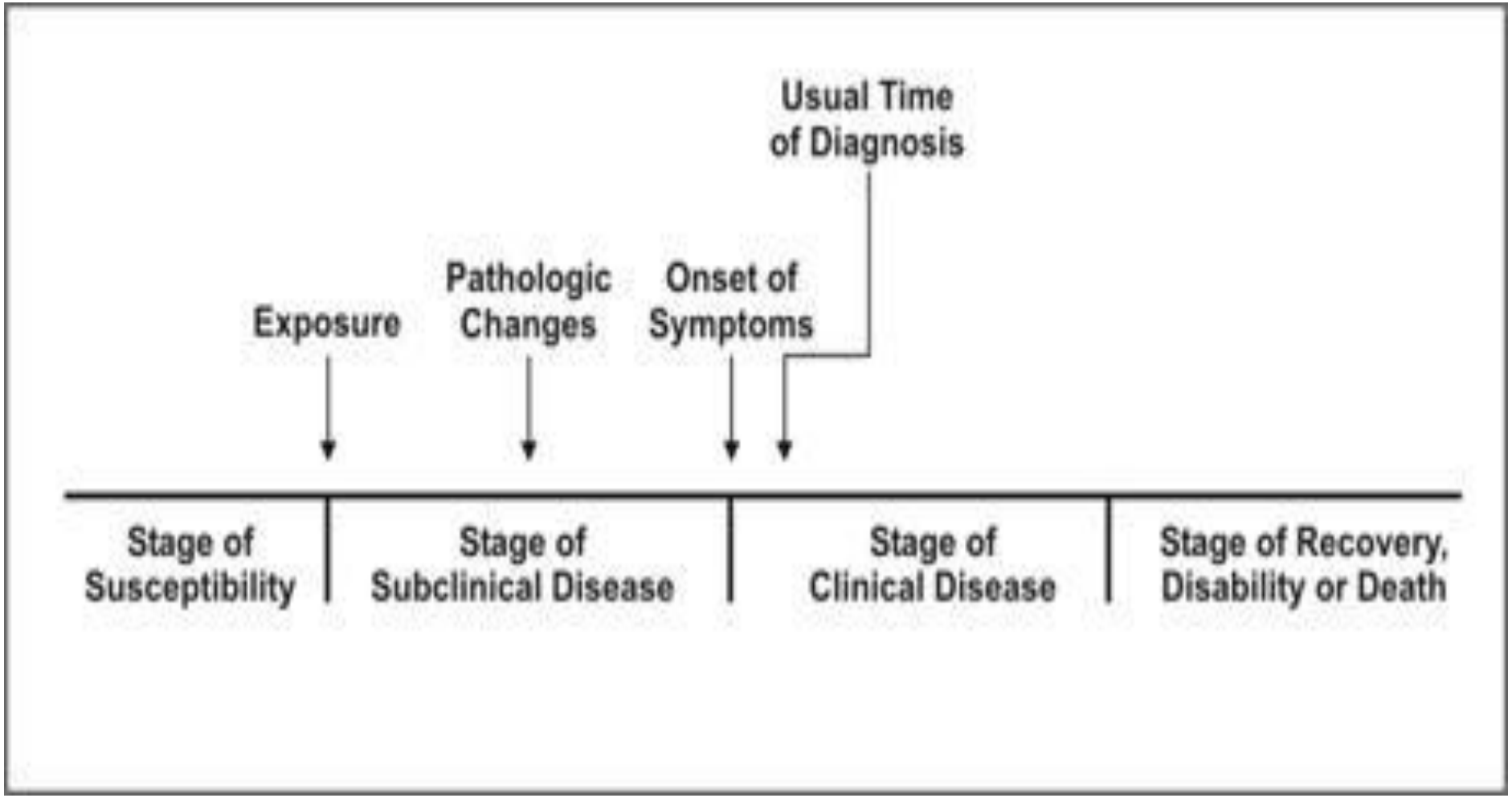
Sporadic – a disease that occurs infrequently and irregularly

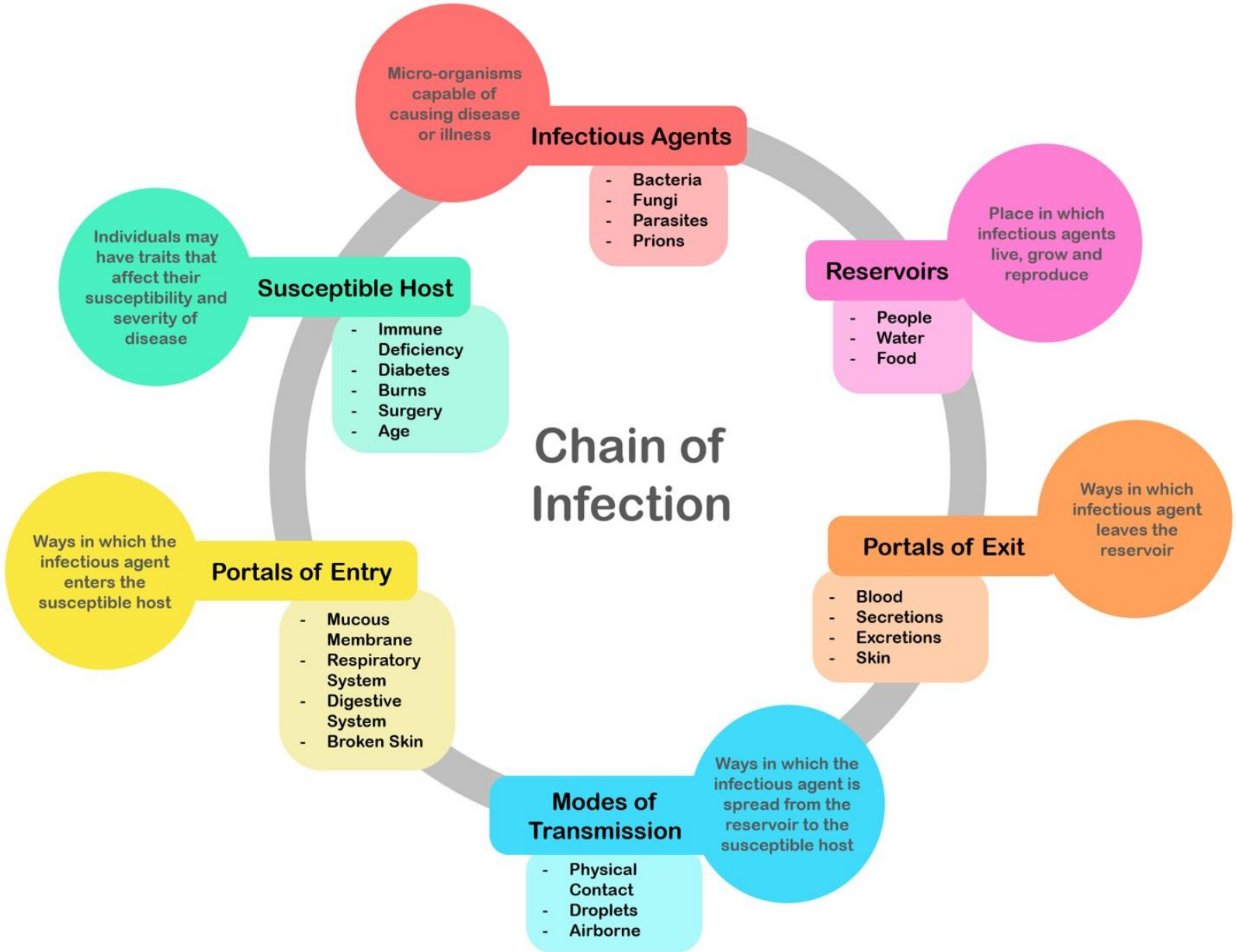
ENDEMIC

EPIDEMIC

PANDEMIC

NATURAL HISTORY & SPECTRUM OF DISEASE




Chain of Infection
Micro-organisms capable of causing disease or illness
Infectious Agents
- Bacteria
- Fungi
- Parasites
- Prions
Place in which infectious agents live, grow and reproduce
Reservoirs
- People
- Water
- Food
Ways in which infectious agent leaves the reservoir
Portals of Exit
- Blood
- Secretions
- Excretions
- Skin
Ways in which the infectious agent is spread from the reservoir to the susceptible host
Modes of Transmission
- Physical Contact
- Droplets
- Airborne
Ways in which the infectious agent enters the susceptible host
Portals of Entry
- Mucous Membrane
- Respiratory System
- Digestive System
- Broken Skin
Individuals may have traits that affect their susceptibility and severity of disease
Susceptible Host
- Immune Deficiency
- Diabetes
- Burns
- Surgery
- Age

Objectives of Surveillance

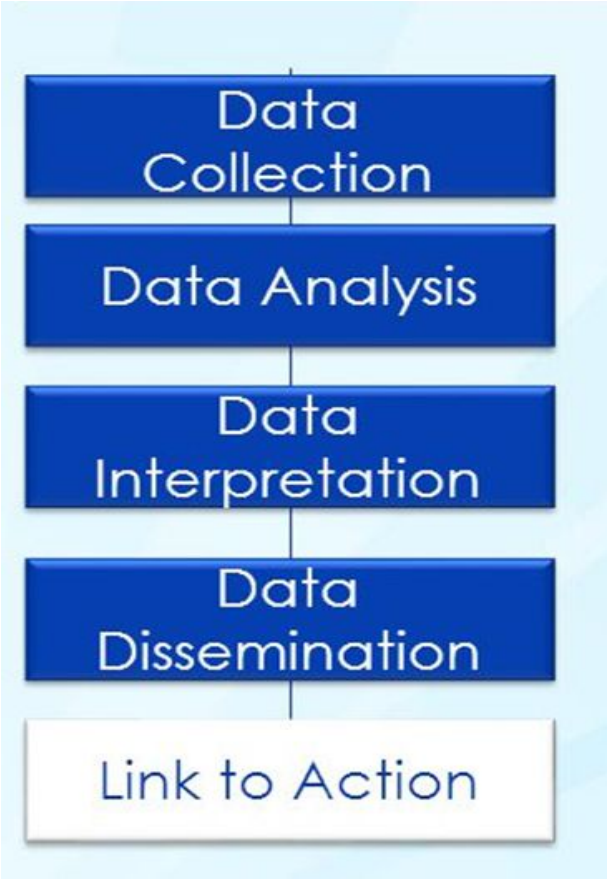
The main objectives of surveillance are:

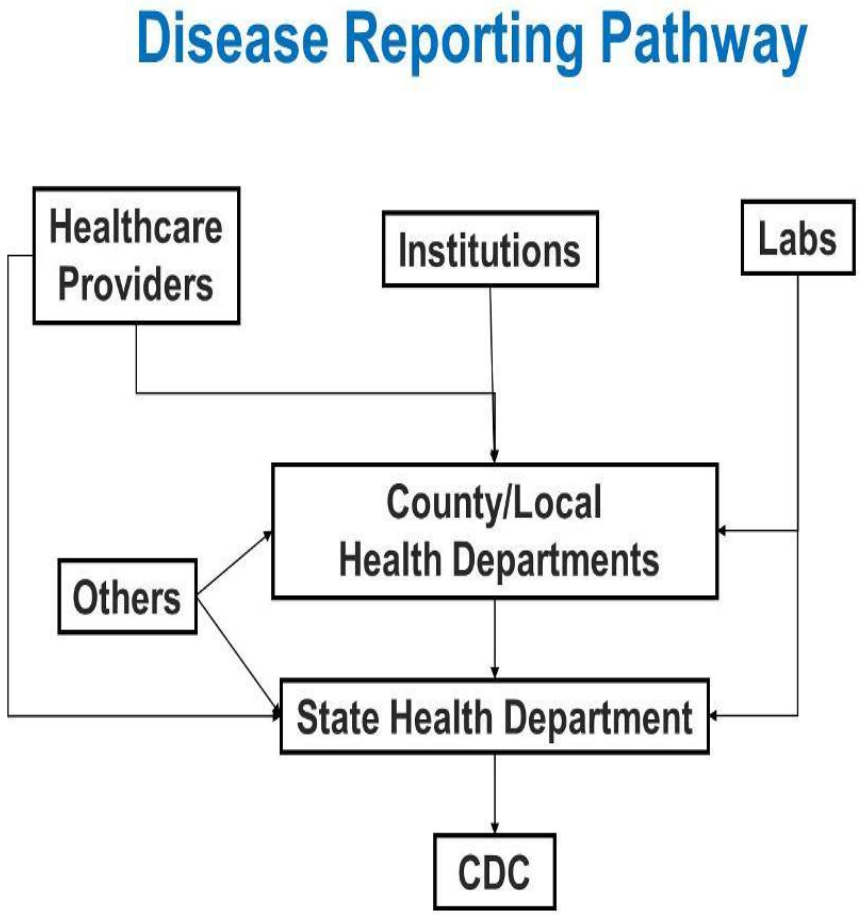
- to provide information about new and changing trends in the health status of a population, e.g., morbidity, mortality, nutritional status or other indicators and environmental hazards, health practices and other factors that may affect health

- to provide feed-back which may be expected to modify the policy and the system itself and lead to redefinition of objectives

- provide timely warning of public health disasters so that interventions can be mobilized

SURVEILLANCE PROCESS





Types of Surveillance

- **Passive Surveillance – diseases reported by health care professional as reporting case of measles**
- **Active Surveillance – health agencies contact health providers seeking reports as searching for other cases of measles to identify potential outbreak**
- **Sentinel Surveillance – involves only a limited network of carefully selected reporting sites targeting a particular disease**
- **Syndromic Surveillance – focuses on one or more symptoms to detect or anticipate outbreaks as influenza causing symptoms and absentee increases**

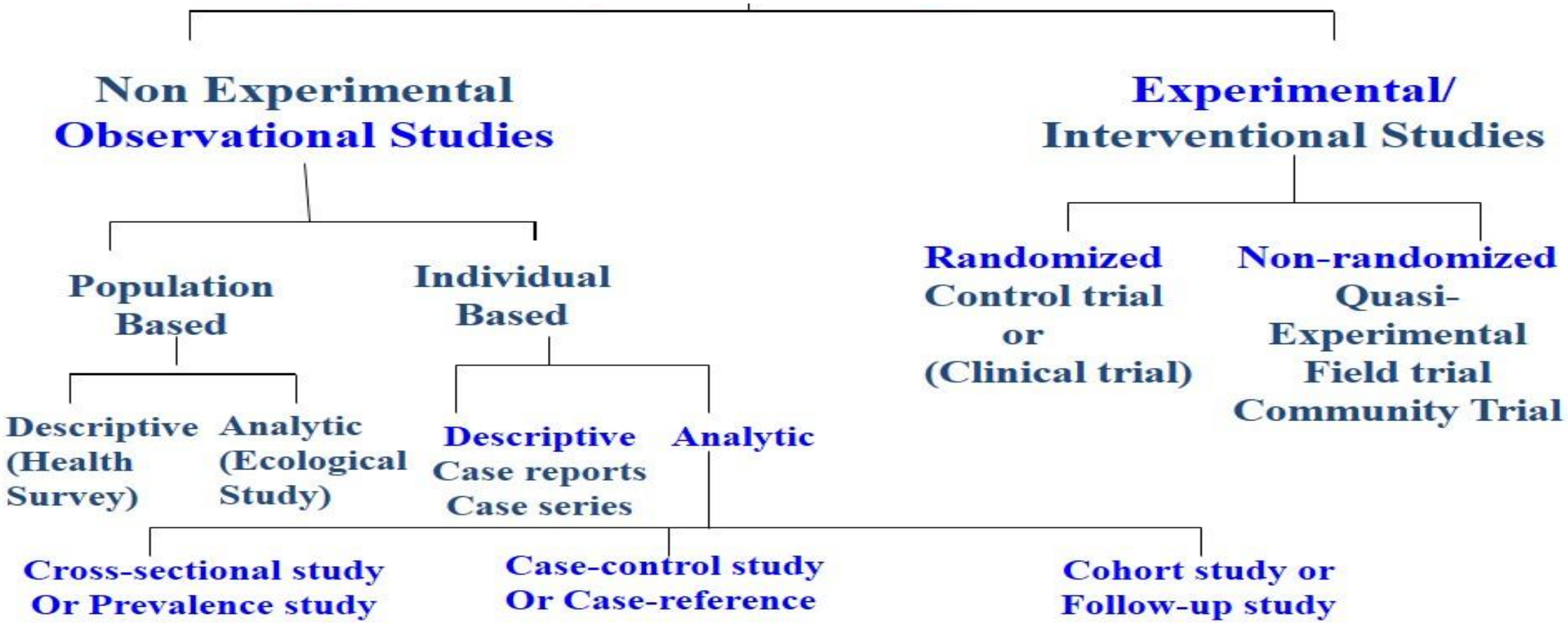
PART 2: OUTBREAK INVESTIGATION

Steps in Solving Health Problems

- Step 1-Collect Data – Surveillance, determine Time/Place/Person triad
- Step 2- Assessment- Inference
- Step 3- Hypothesis testing – Determine how and why
- Step 4- Action-Intervention

Note: Students will analyze an outbreak study.

EPIDEMIOLOGICAL STUDIES



Scientific Method
as related to Disease Detectives

- Obtain Background Information
- Define the Problem
- Formulate Hypothesis
- Develop a Study to Test the Hypothesis
- Collect Data and Observations
- Evaluate Results
- Determine if Hypothesis is true/modify
- Formulate Conclusions
- Report Results

Compare these steps to 13 Steps in Outbreak Investigation

Step 1: Prepare for Field Work

1. **Research, supplies & equipment** – research the disease or situation and gather needed supplies & equipment to conduct the investigation

2. **Administrative arrangements** – make official administrative and personal travel arrangements

3. **Local contacts** - follow protocol

Step 2: Establish the Existence of an Outbreak

1. **Expected # of cases for area** – use records as health dept., hospital records, death records, physician records, doctor survey to determine expected # for the area in a given time
2. **Other factors in play** – numbers may exceed normal due to factors such as better reporting, seasonal fluctuations, population changes

Step 3: Verify the Diagnosis

1. **Proper diagnosis** - verify the procedures used to diagnose the problem and check methods used for identifying infectious and toxic chemical agents
2. **Not lab error** – be sure that the increase number of cases are not due to experimental error
3. **Commonality** – interview several persons who became ill to gain insight concerning possible cause, source, and spread of disease or problem

Step 4: Construct a Case Definition

Case definition – establish with the 4 components or standard criteria for determining who has the disease or condition

a. **Clinical information** – about the disease or condition

b. **Characteristics** - of the affected people

c. **Location or place** - as specific as possible as restaurant, county, or several specific areas

d. **Time sequence** - specific time during which the outbreak or condition occurred

Case Definition for Influenza-like (ILI)

- *A case of influenza-like illness (ILI) or influenza* is defined as a person with fever of 37.8°C (100°F) or greater orally or 38.3°C (101°F) rectally PLUS cough during the influenza season (October 1 through May 31).
- A person with laboratory confirmed influenza is also considered a case even if the person does not have cough and fever.

Identifying cases

Identification of specific cases – kind & number – count specific cases

Confirmed – have diagnosis with case definition plus lab verification

Probable – many factors point to diagnosis but may lack lab verification

Possible – some factors point to diagnosis

Note: Initial reports may be only a small sampling of the total problem. Be sure to expand search to determine the true size and extent of the problem

Line Listing

Line Listing – chart of specific cases including information about each case

- **Identifying information - ID or case # - left column + name or initials**
- **Clinical information – diagnosis, symptoms, lab results, hospital – death?**
- **Descriptive: time – date & time of onset + date of report**
- **Descriptive: person – age, sex, occupation, other characteristics**
- **Descriptive: place – street, city or county + specific site**
- **Risk factors & possible causes – specific to situation (disease) and outbreak setting**

Sample Line Listing

Sample Line Listing from six case report forms on a wedding reception outbreak

ID #	Initials	Date of Onset	Diagnosis	How Confirmed	Age	Sex	County	Physician	Wedding
1	KR	7/23	probable trichinosis	Not done	29	M	Columbia	Goodman	Yes
2	DM	7/27	trichinosis	Biopsy	33	M	Columbia	Baker	Yes
3	JG	8/14	probable trichinosis	Not done	26	M	Columbia	Gibbs	Yes
4	RD	7/25	trichinosis	Serologia	45	M	King	Webster	Yes
5	NT	8/04	trichinosis	Not done	27	F	Columbia	Stanley	Yes
6	AM	8/11	R/Otrichinosis	Pending	54	F	Clayton	Mason	Yes

Step 5: Find cases systematically and record information

- Identifying information
- Demographic information
- Clinical information
- Risk factor information
- Reporter information

Types of Descriptive Studies

Types of Descriptive Studies – Study the distribution of a problem by cases or outcome, frequency in population, exposure, time pattern or environmental factor

(Studies without a control group can be used for descriptive purposes!)

a. **Case report/case series** – case report = detail report of a single patient from one or more doctors while case series = characteristics of several patients

b. **Correlative studies** – correlates general characteristics of the population with health problem frequency with several groups during the same period of time

Time series analysis – correlate within the same population a different point in time

Ecologic relations – correlate relative to specific ecologic factors as diet

c. **Cross sectional** - a survey of a population where participants are selected irrespective of exposure or disease status

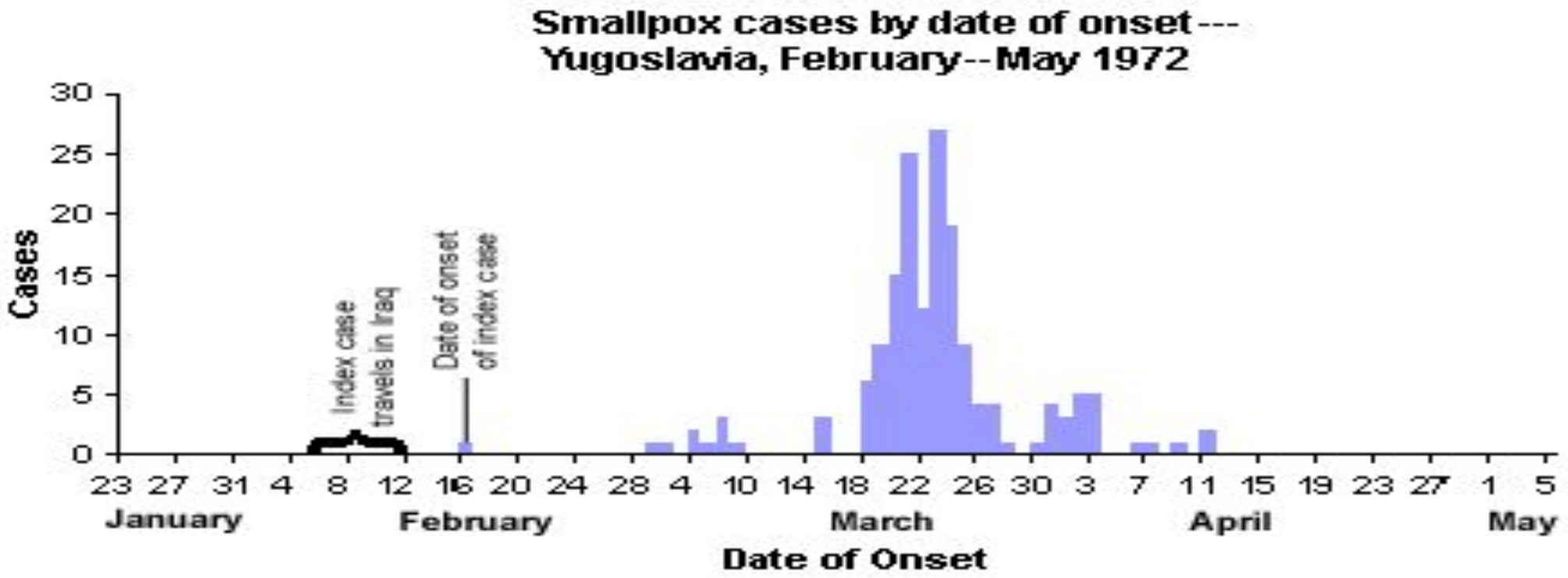
Step 6: Describe in terms of Time, Place and Person Triad

- **TIME** – a histogram showing the course of the disease or outbreak to identify the source of the exposure **Epidemic Curve or Epi curve** (Begin early & update often)

- **PLACE** – geographic extent plus spot map of cases to identify groups specific to a location or environmental factors

- **PERSON** – identify the affected population by type of person or by exposures as age, sex, high risk exposure as with AIDS

EPI Curve (Epidemic Curve)



x axis= units of time equal to 1/4 to 1/3 incubation time and **y axis** = # of cases

Note: a single point or source will have only one peak, a plateau will show a continuous common source, several uniform peaks will indicate a propagated outbreak spread from person to person

Step 7: Develop Hypothesis (Agent/Host/Environment triad)

1. **Agent /host /environment** = agent capable of causing disease & its source host or persons susceptible to agent + environment allowing them to get together

   Infectious Groups: viruses, bacteria, protistans (protozoa), fungi, animals (worms)

2. **Testable** – hypothesis must be in a form that is testable

3. **Current knowledge & background** – it should be based upon current knowledge and be updated or modified as new information is uncovered!!!

Step 8: Evaluate Hypothesis
(Analytical Studies = Control Group)

1. **Compare with established fact – these are used when evidence is strong and clear cut**
2. **Observational Studies: (Study determinants of health problems – how & why)**

   Cohort – Based upon *exposure status* whether or not they have outcome (illness) *works forward from exposure*

   Case-Control - Works *backward from effect or illness* to suspected cause.

3. ***Must have lab verification to validate hypothesis*.**

Cohort Study – Exposure

- **Both groups** have a known exposure and are checked for future outcomes or illness.
- **retrospective:** (historic cohort) starts at exposure in past & moves forward to outcome
- **prospective:** starts a present exposure and moves forward in time to outcome

Sample Cohort Study using 2 X 2 table

400 people attended a special awards dinner

Some persons became ill.

The suspected culprit was the *potato salad*. The population at the dinner was then surveyed to determine who became ill.

	Disease Yes	Disease No
Exposed (Ate salad)	150 (a)	30 (b)
Unexposed (no salad)	50 (c)	170 (d)

Calculating Attack Rate & Relative Risk

	Disease Yes	Disease No
Exposed (Ate salad)	150 (a)	30 (b)
Unexposed (no salad)	50 (c)	170 (d)

- *Attack rate* – the rate that a group experienced an outcome or illness

  = number sick ÷ total in that group **(Look for high attack rate in exposed & low rate in unexposed)**

  exposed = a ÷ (a+b) = 150 ÷ 180 = 80%

  unexposed = c ÷ (c + d) = 50 ÷ 220 = 20%

- *Relative risk* = [a ÷ (a+b)] / [c ÷ (c+d)] =

  80% ÷ 20% = 4

Interpreting Results of Cohort Study

- **Relative risk** estimates the extent of the association between an exposure and a disease. It estimates the likelihood of developing the disease in the exposed group as compared to the unexposed group.
- **A relative risk >1.0** indicates a positive association or an increased risk. This risk increases in strength as the magnitude of the relative risk increases.
- **A relative risk = 1.0** indicates that the incidence rates of disease in the exposed group is equal to the incidence rates in unexposed group. Therefore the data does not provide evidence for an association.
- **Relative risk** is not expressed in negative numbers.

Case Control - Illness

- Works *backward from effect or illness* to suspected cause.
- Control group is a selected group who has similar characteristics to the sick group but is not ill.
- They are then checked for similar exposures.
- It is often hard to select the control group for this type of study.
- *Odds Ratio* is calculated to evaluate the possible agents & vehicles of transmission

Sample Case-Control Study

Sample:

Several patients were diagnosed with Hepatitis A.

- **The local Restaurant A was thought to be the source of the infection.**
- **40 case patients and a similar disease free group or control were contacted to determine if they ate at Restaurant A.**

2 X 2 table of data

Ate	Case patients	Controls	Total
Yes	a = 30	b = 36	66
No	c = 10	d = 70	80
Total	40	106	146

Calculating Odds Ratio

2 X 2 table of data:

Ate	Case patients	Controls	Total
Yes	a = 30	b = 36	66
No	c = 10	d = 70	80
Total	40	106	146

Odds Ratio =

$$\frac{\text{Odds of exposure in cases}}{\text{Odds of exposure in controls}} = \frac{a/c}{b/d} = \frac{a\,d}{b\,c} = \frac{30 \times 70}{36 \times 10} = 5.8$$

This means that people who ate at Restaurant A were 5.8 times more likely to develop hepatitis A than were people who did not eat there.

a = # of case patients exposed b = # of control exposed

c = # of case patients unexposed d = # of control unexposed

Potential Types of Error in Data Collection - Division C

- False Relationships
  - **Random Error** - the divergence due to chance alone, of an observation on sample from the true population value, leading to lack of precision in measurement of association
  - **Bias** - systematic error in an epidemiologic study that results in an incorrect estimation of the association between exposure and health-related event

Potential Types of Error in Data Collection – Div. C

Non-Causal Relationships

Confounding – occurs when the effects of two risk factors are mixed in the occurrence of the health-related event under study - when an extraneous factor is related to both disease and exposure

Step 9: As necessary, Reconsider, Refine, and Re-evaluate Hypotheses

No confirmation of hypothesis - analytical studies do not confirm hypotheses. May need to look for a new vehicle or mode of transmission

More specific – May need to be more specific in make up of case patients & controls

Bradford Hill Criteria for Verifying the Cause of the Health Problem

1. **Temporality** – cause/exposure must precede effect/outcome
2. **Consistency** – observation of association must be repeatable in different populations at different times
3. **Coherence, 1-1 relationship** – exposure is always associated with outcome/ outcome is always caused by the specific exposure
4. **Strength of association** – relationship is clear and risk estimate is high
5. **Biological plausibility** – biological explanation makes sense
6. **Dose/response (biologic gradient)** – increasing risk is associated with increasing exposure

Step 10: Compare and Reconcile with laboratory an/or environmental studies

- Verify with environmental/laboratory studies
  - Verification with control conditions is very important
- Laboratory evidence can confirm the findings *LAB VERIFICATION IS NEEDED TO VALIDATE A HYPOTHESIS*
- Environmental studies are equally important
  - Examination of the area of an outbreak can provide evidence and clues used in laboratory analysis

Step 11: Implement Control and Preventative Measures

1. As soon as source is known – people are sick or hurting and need he must know agent & source of agent + susceptibility of host+ chain of transmission
2. Aim at chain of agent-source-host – break the chain of transmission at any of its 3 points
3. May interrupt transmission or exposure – with vehicles as isolation
4. May reduce susceptibility – with immunization, legal issues and/or education

Step 12: Initiate or Maintain Surveillance

- Once control and prevention measures have been implemented, they must continue to be monitored
- If active surveillance was initiated as part of case finding efforts, it should be continued to determine whether the prevention and control measures are working

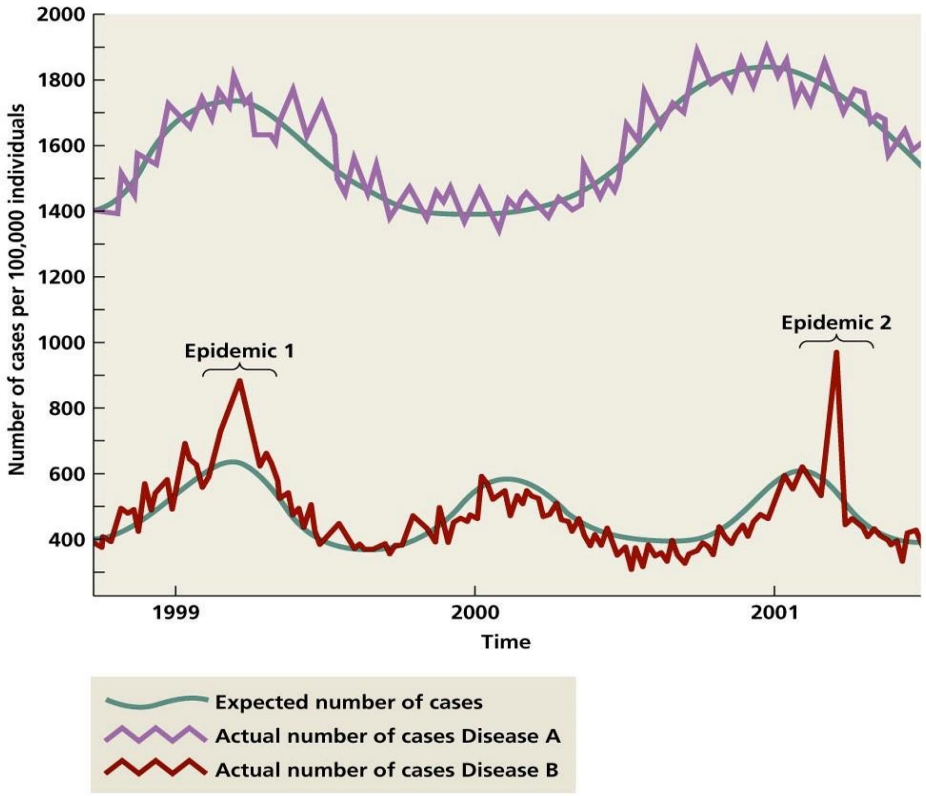
Step 13: Communicate Findings

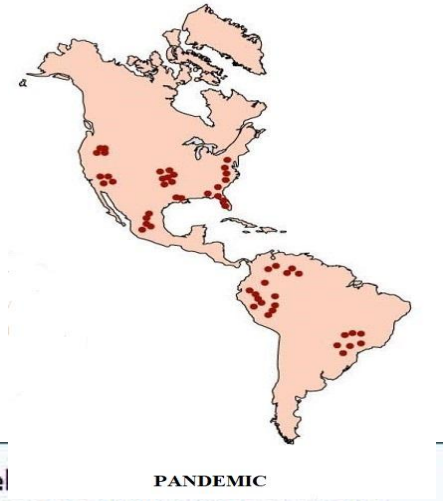
1. **Oral briefing** – inform local health officials or other need-to-know groups as soon as information is available
2. **Written report** – usually done in scientific format for future reference, legal issues, and education

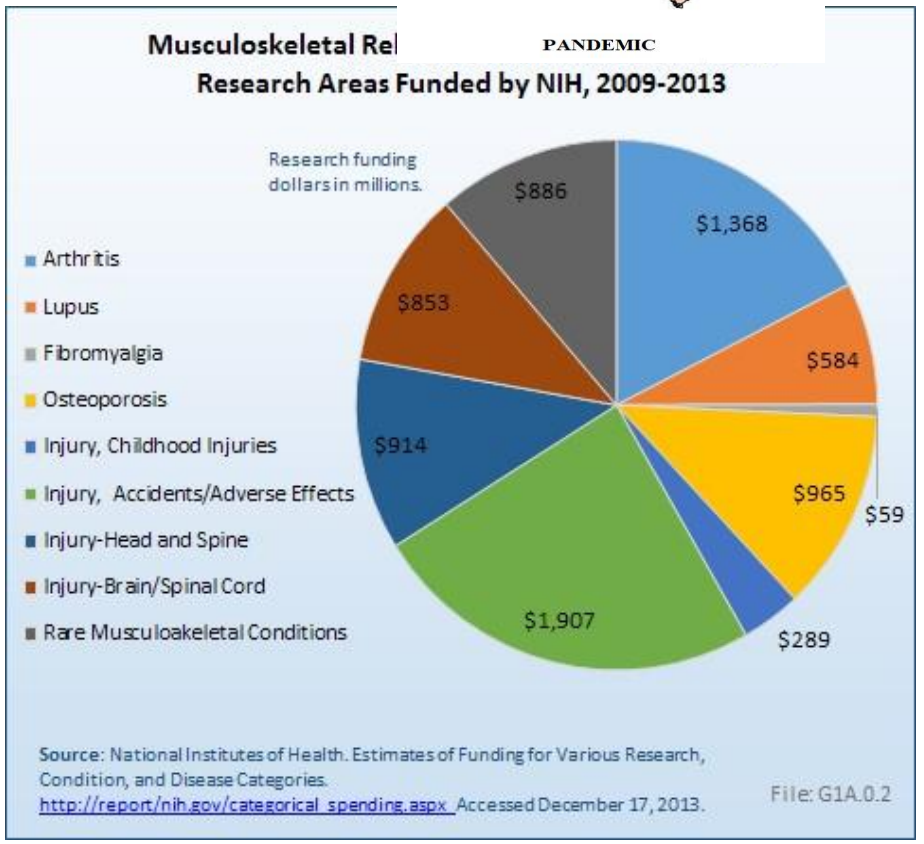
PART 3: PATTERNS, CONTROL & PREVENTION

- Interpret Tables, Charts & Graphs
- Determine Measures of Disease Frequency-risk, rates, ratios, proportions – Div. C
- Control Strategies
- Prevention Strategies
- Div. C – National Challenges

Interpreting Data Tables Charts & Graphs







Determining & Interpreting Measures of Frequency

Epidemiological measures include:

- **counts** – absolute number of persons who have a disease or characteristic of interest
- **risk** - The probability that an individual will be affected by, or die from, an illness or injury within a stated time or age span.
- **rate** – number of cases occurring ***during a specific period***; always dependent on the size of the population during that period.

$$\text{Rate (\%)} = \frac{\text{number of cases}}{\text{population at risk}} \times 100$$

- **ratio** – value obtained by dividing one quantity by another – a ratio often compares two rates.

$$\frac{\text{Number or rate of events, items, persons, etc. in one group}}{\text{Number or rate of events, items, persons, etc. in another group}}$$

- **proportion** – the comparison of a part to the whole as the number of cases divided by the total population – ***does not have a time dimension***, It can be expressed as a decimal, a fraction, or a percentage

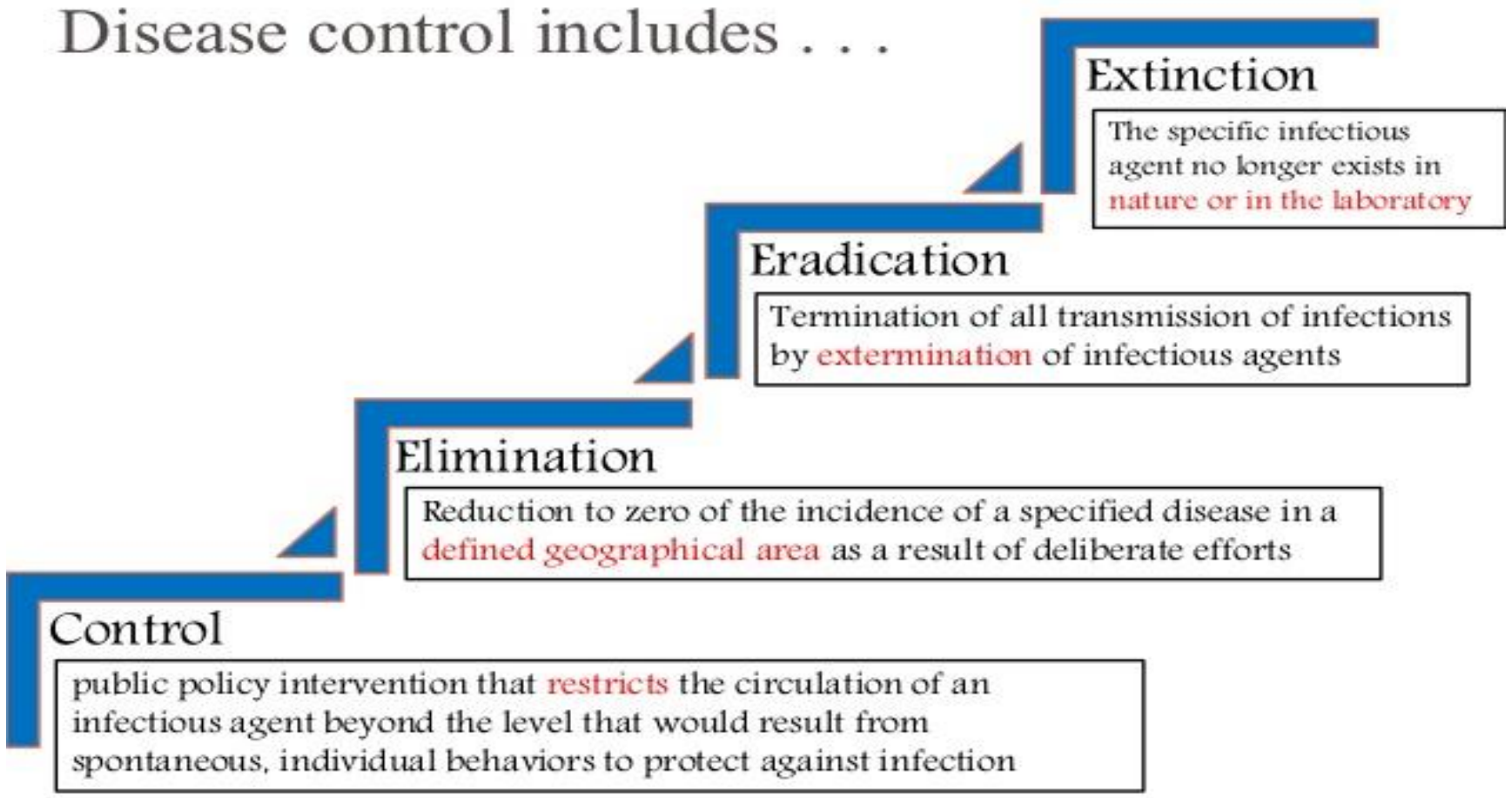
$$\frac{\text{Number of persons or events with a particular characteristic}}{\text{Total number of persons or events, of which the numerator is a subset}} \times 10^n$$

Disease Control

Concept of control: disease control describes ongoing operations aimed at reducing

- The incidence of disease
- The duration of disease and consequently the risk of transmission
- The effects of infection, including both the physical and psychosocial complications
- The financial burden to the community

Disease Control Process



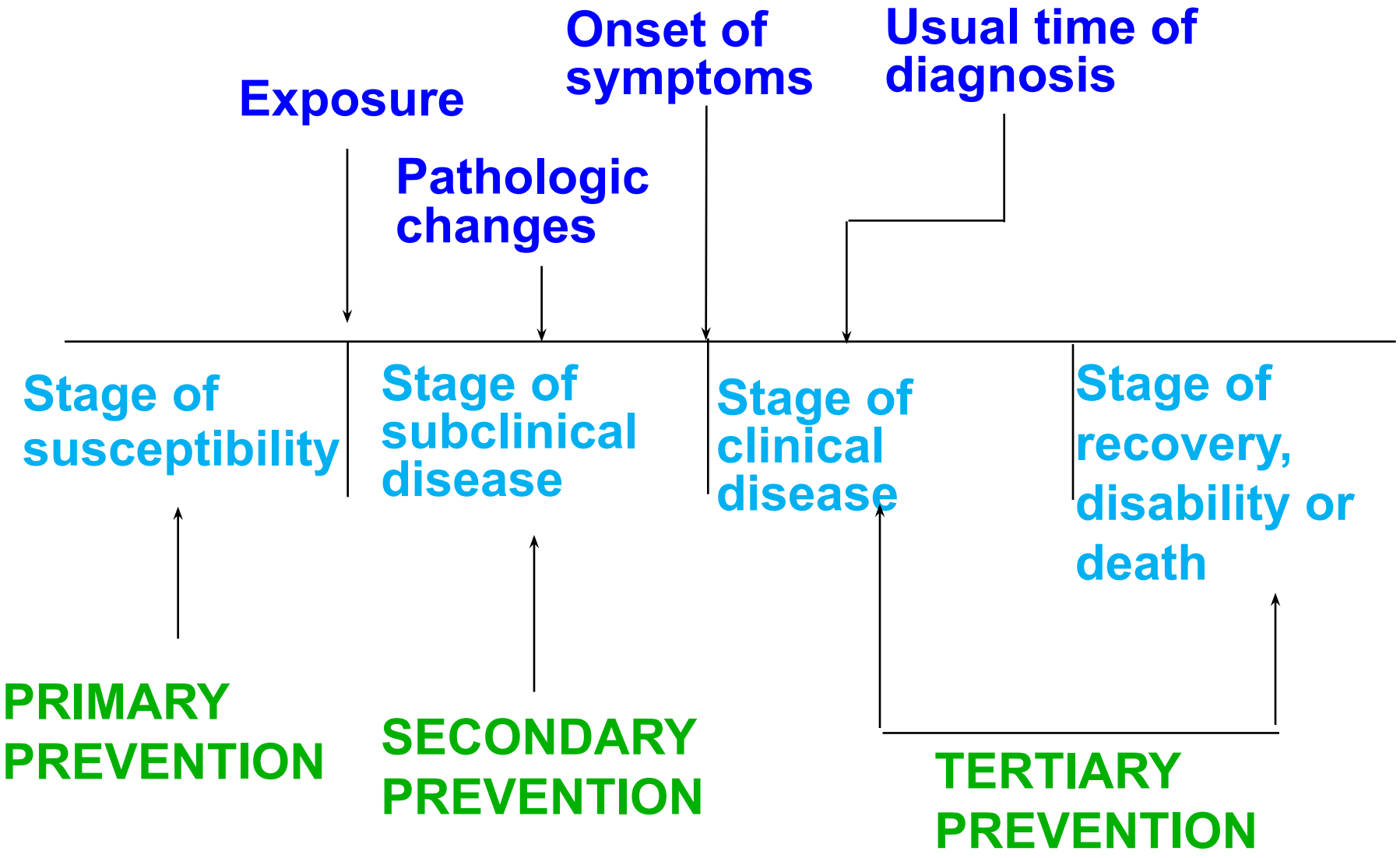
Preventable Causes of Disease

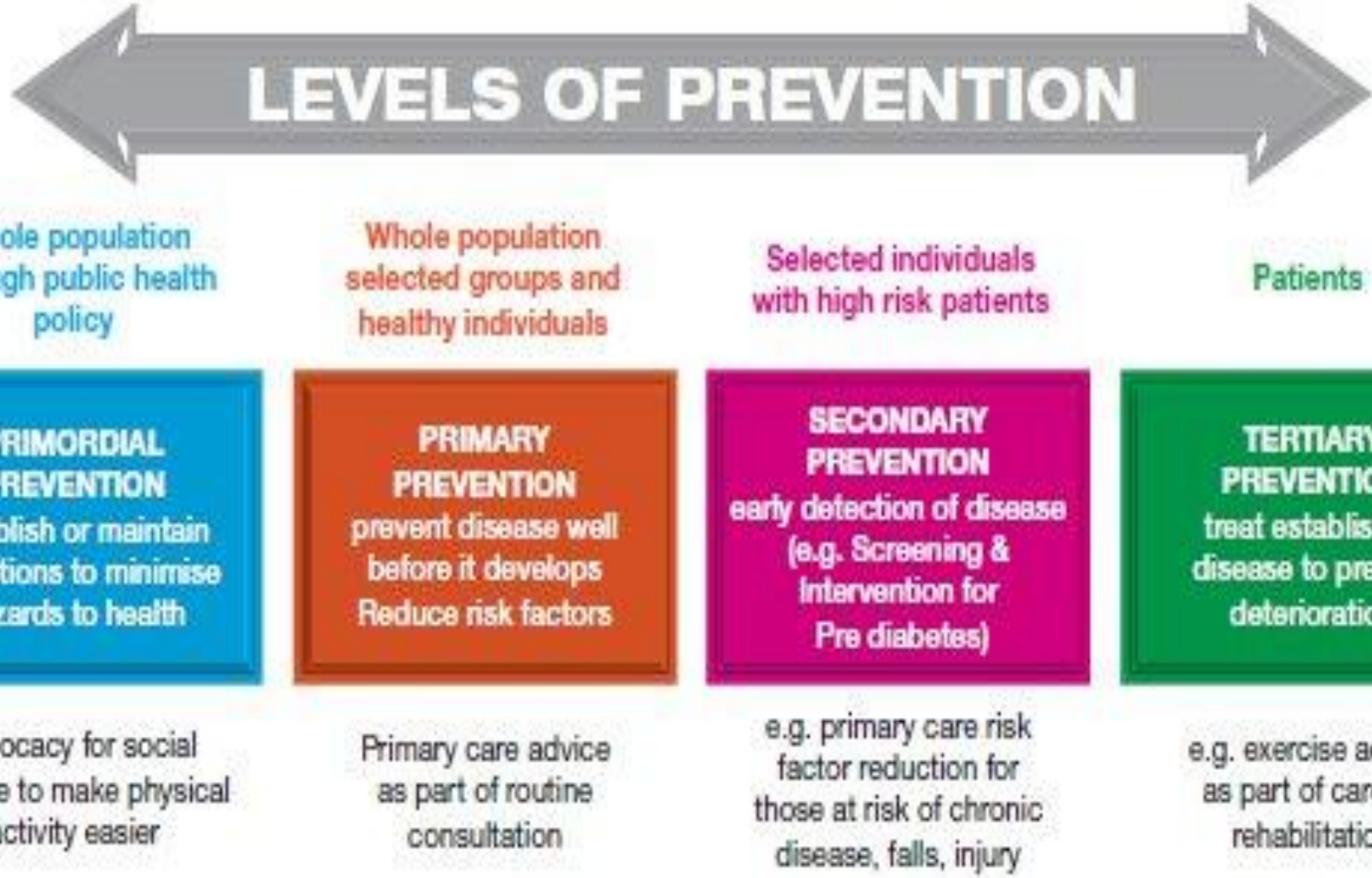
BEINGS

- Biological factors and Behavioral Factors
- Environmental factors
- Immunologic factors
- Nutritional factors
- Genetic factors
- Services, Social factors, and Spiritual factors

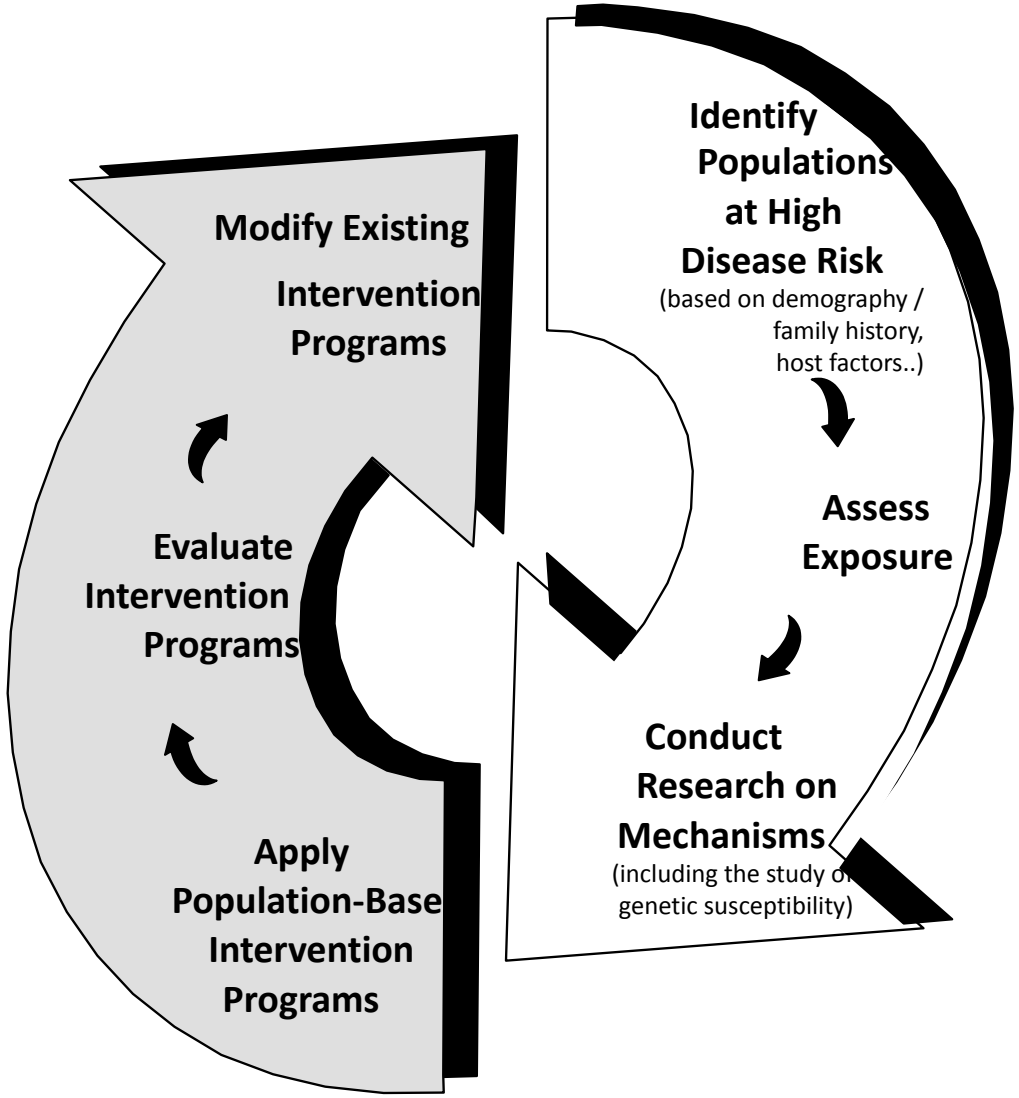
[JF Jekel, Epidemiology, Biostatistics, and Preventive Medicine, 1996]

Natural History of Disease




LEVELS OF PREVENTION
Whole population through public health policy
Whole population selected groups and healthy individuals
Selected individuals with high risk patients
Patients
PRIMORDIAL PREVENTION
establish or maintain conditions to minimise hazards to health
PRIMARY PREVENTION
prevent disease well before it develops
Reduce risk factors
SECONDARY PREVENTION
early detection of disease (e.g. Screening & Intervention for Pre diabetes)
TERTIARY PREVENTION
treat established disease to prevent deterioration
Advocacy for social change to make physical activity easier
Primary care advice as part of routine consultation
e.g. primary care risk factor reduction for those at risk of chronic disease, falls, injury
e.g. exercise advice as part of cardiac rehabilitation

Strategy for Prevention



PREVENTION APPROACHES

Population-Based Approach:

- Preventive measure widely applied to an entire population (public health approach)
- Strive for small absolute change among many persons
- Must be relatively inexpensive and non-invasive

PREVENTION APPROACHES

High-Risk Approach:

- Target group of individual at high risk
- Strive for strong risk factor control
- Often times requires clinical action to identify the high risk group and to motivate risk factor control

Monitoring

- The performance and analysis of routine measurements aimed at detecting changes in the environment or health status of population" (Thus we have monitoring of air pollution, water quality, growth and nutritional status, etc.)

- It also refers to ongoing measurement of performance of a health service or a health professional, or of the extent to which patients comply with or adhere to advice from health professionals.