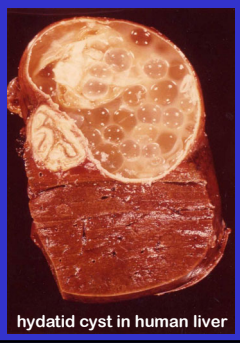
BioMedical Parasitology

Introduction

'armed' scolex of tapeworm



hydatid cyst in human liver

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Course description

- Study the complex interactions between parasites, their hosts & their environments;

  to explain disease incidence, distribution, morbidity and mortality.

- Development of molecular, cellular, organismal and population biology interventions for treatment and control.

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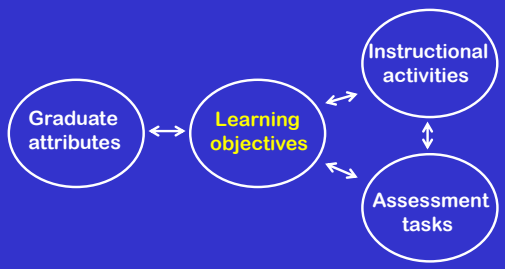
Electronic Course Profiles

www.courses.uq.edu.au



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Learning Objectives

You will learn to:

- differentiate major parasite assemblages;
- assess conventional and modern diagnostic methodologies;
- recognize patterns of parasitic infections and diseases;
- value fundamental knowledge of parasite life-cycle strategies;
- identify factors involved in the resurgence of parasitic diseases;
- understand molecular mechanisms of drug-resistance; and
- appreciate molecular biological approaches to parasite control.

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References

No single recommended text

Roberts & Janovy | Loker & Hofkin | Mims *et al.*

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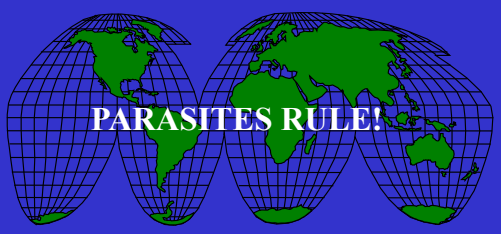
Three modes of existence on earth!

- aquatic (many species)
- terrestrial (some species)
- parasitic (overwhelming majority)



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PARASITISM?

Type of relationship	Organism 1 (usually larger)	Organism 2 (usually smaller)	Example
SYMBIOSIS ("living together") (direct contact between organisms) (usually long term)			
- mutualism	host benefits	symbiont benefits	ruminants/ciliates
- cleaning symbiosis	host benefits	cleaner benefits	fish/cleaner wrasse
- commensalism	host unaffected	commensal benefits	reptiles/trichomonads
- phoresis	host unaffected	phoront benefits	mollusc/anemone
- inquilinism	host unaffected	inquiline benefits	worm tubes/bacteria
- neutralism	host unaffected	symbiont unaffected	difficult to prove
- parasitism	host harmed	parasite benefits	humans/nematodes
- parasitoidism	host harmed	parasitoid benefits	caterpillar/wasp larva
- amensalism	unaffected	harmed	mould/bacteria

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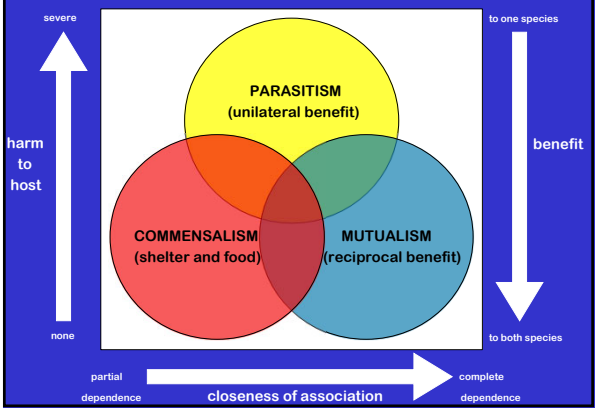
SYMBIOSES (living together)



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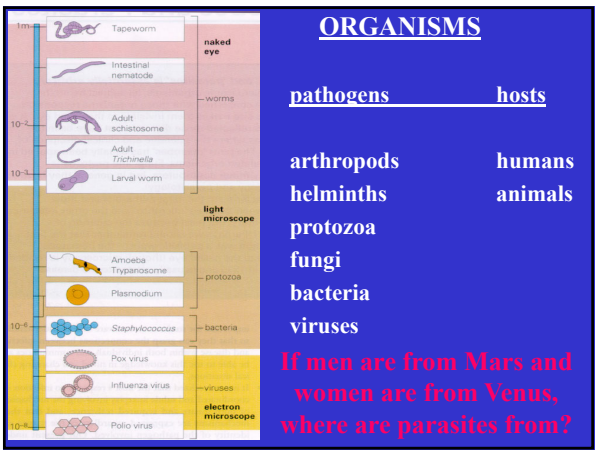

ORGANISMS

pathogens	hosts
arthropods	humans
helminths	animals
protozoa	
fungi	
bacteria	
viruses	

If men are from Mars and women are from Venus, where are parasites from?

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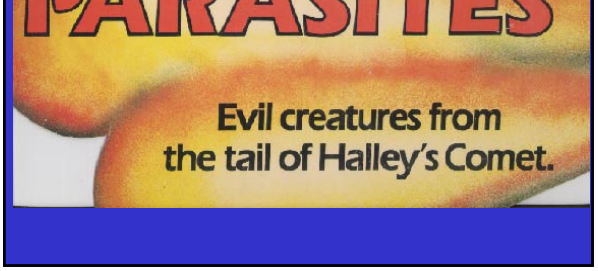

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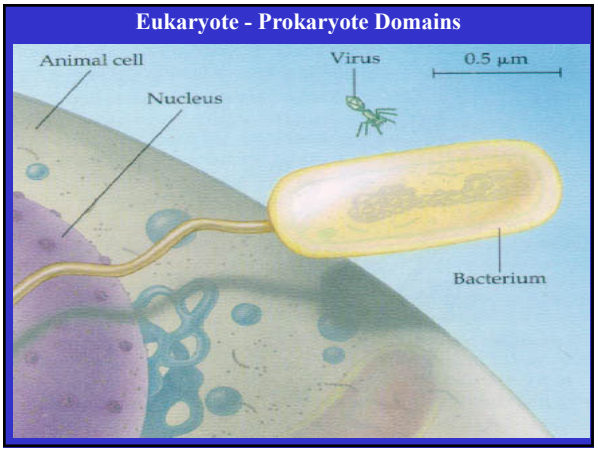

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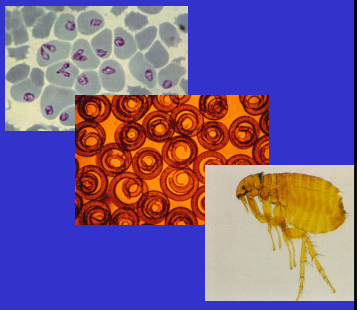
PARASITES

Pathogenic

- Protozoa
- Helminths
- Arthropods



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HOSTS

- Humans
  - medical health
- Animals
  - veterinary health plus zoonoses
- Vectors
  - transmission

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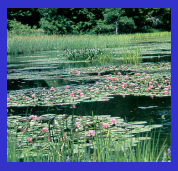
ENVIRONMENTS

- Physico-chemical
  - moisture
  - temperature
  - oxygen
- Sociological
  - developed countries
  - developing countries
  - human behaviours



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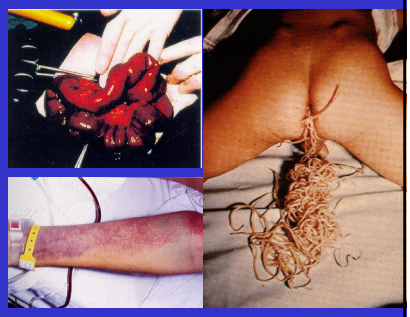
DISEASES

Infectious
- Enteric
- Blood
- Tissues
- Organs
- External



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Disease amelioration

Despite sensationalism of media & lecturers, parasitic diseases are limited in incidence due to:

Parasite Factors
- distribution/abundance
- host range/specificity
- pathogenicity/virulence

Host Factors
- resistance/susceptibility - innate
- protective immunity - acquired

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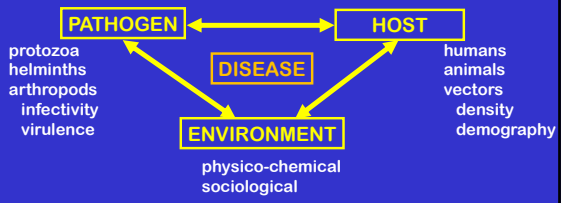
Concept map

symptoms/signs
gross/histo-pathology
development/transmission
treatment/control

epidemiology/epizootiology
morbidity/mortality
carrier/subclinical/clinical
acute/chronic/transient/persistent



= Disease Triangle (= Epidemiological Triad)
(interactions determine disease distribution/abundance/severity)

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Impact of Disease

Consequences
- mortality (death)
- morbidity (sickness)
- production losses (body weight)
- lesions (quality)

Scope
- individuals (personal medicine)
- cohabitants (family counselling)
- neighbours (community medicine)
- populations (WHO, CDC, etc)

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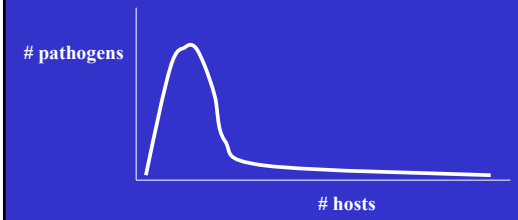
Parasite overdispersion

Simple truth - most infections remain asymptomatic

Many hosts have some parasites → no disease
Some hosts have many parasites → disease



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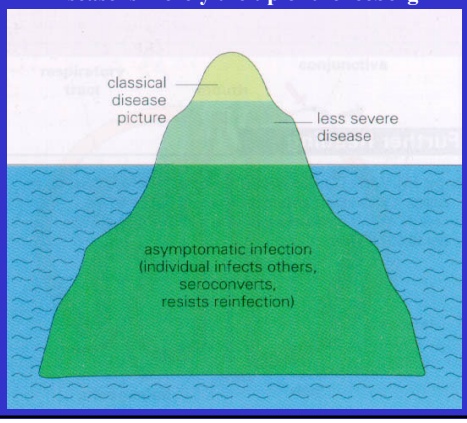
Disease is merely the tip of the iceberg



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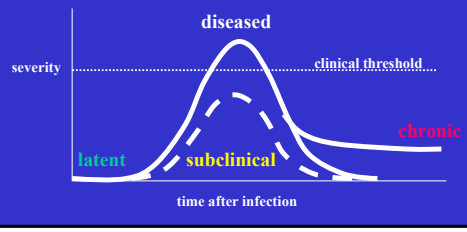
Clinical threshold

Disease related to severity of infection:

- latent infections (incubation period)
- chronic infections (concomitant/premunition)
- subclinical infections (asymptomatic)



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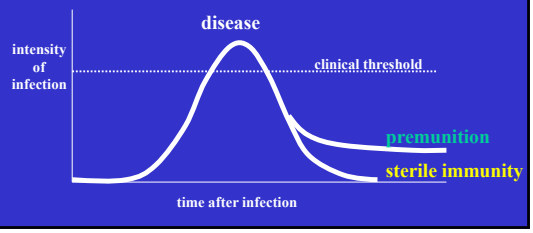
Immunity

Previous exposure confers immunity:

- sterile immunity (parasites eradicated)
- premunition (concomitant) (some parasites persist)



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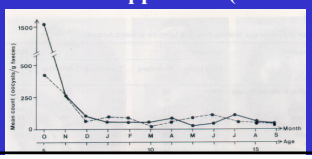
Infections confined to susceptible hosts

- age (young/old)
- gender (pregnant/lactating females)
- physiological state (malnourished, stressed...)
- immuno-competency
  - congenital immunodeficiencies (genetic deficits)
  - acquired immunodeficiences (infection)
  - immunosuppression (chemotherapy/transplants)



neonates especially vunerable

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WHO top 10 parasites

	Disease	Infections/yr	Deaths/yr
1.	Ascariasis	900 million	20,000
2.	Hookworm disease	800 million	55,000
3.	Malaria	800 million	1,500,000
4.	Trichuriasis	500 million	-
5.	Amoebiasis	480 million	75,000
6.	Filariasis	280 million	-
7.	Schistosomiasis	200 million	750,000
8.	Giardiasis	200 million	-
9.	Trypanosomiasis	25 million	65,000
10.	Leishmaniasis	1 million	1,000

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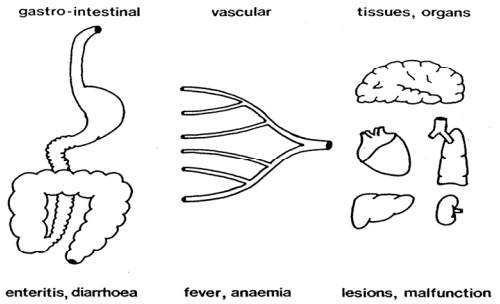
Site of infection and symptomatology



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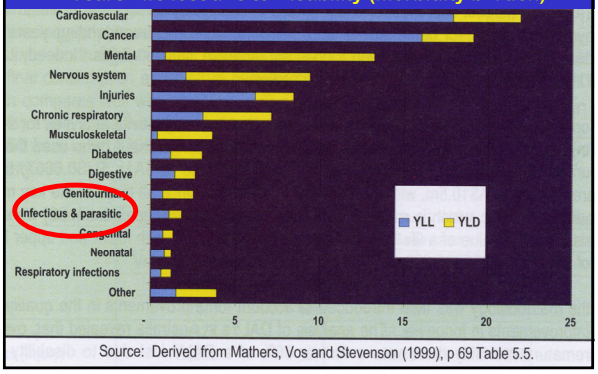
Disability Adjusted Life Years DALY = YLL + YLD
= Years Life Lost due to premature death (mortality burden) + Years Life lost due to Disability (morbidity burden)



Source: Derived from Mathers, Vos and Stevenson (1999), p 69 Table 5.5.

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How are hosts protected?

- natural resistance
  - genetically determined
  - inherited (basis of breeding programs)
- acquired immunity
  - humoral responses (extracellular parasites)
  - cell-mediated responses (intracellular parasites)

review three lines of defense

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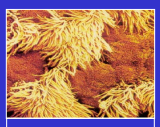
THREE LINES OF DEFENSE



first line
BARRIER

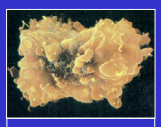
nonspecific

parasites encounter external coverings and their secretions

second line
INNATE

nonspecific

parasites penetrating barriers encounter phagocytes & inflammation



third line
ADAPTIVE
(ACQUIRED)

specific

surviving parasites encounter cell-mediated and humoral responses

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Co-evolution

Host-parasite interactions

- parasites with a long co-evolutionary history are less pathogenic (some are even border-line commensals or mutualists)
- parasites are poorly adapted to humans (cf. zoonoses) and are more likely to cause serious disease

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Relationships

organism - pathogen

infection - internal/external (infestation)

disease - pathology (abnormalities)

illness - symptoms (subjective = felt)
- signs (objective = seen)

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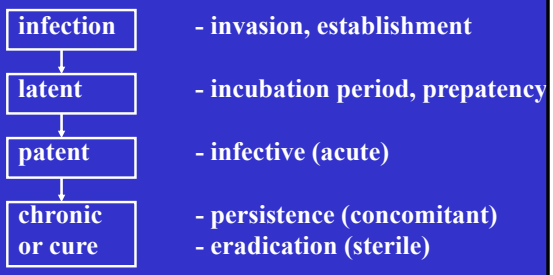
Infection kinetics



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Epidemiology

Study of disease distribution (temporal/spatial)
- prevalence (cross-sectional) single time point
- incidence (longitudinal) change over time
- intensity (parasite burden per host)

Diseases may be:
- established (endemic/enzootic)
- locally acquired (autochthonous)
- imported/introduced/exotic
- epidemic (outbreak)

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Virulence

Capacity to cause disease (morbidity/mortality)
- often measured as LD_{50} or ID_{50}

Virulence factors
- multiplication
- feeding
- cytotoxicity
- immuno-evasion
- tropism (tissue/cell)
- host specificity (ecological - sympatry)
  (ethological - behaviour)
  (physiological - molecular)

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Impact of pathogens

Viral pathogens
- cell death (lysis)
- metabolic disruption (persistent/latent)
- cell transformation (oncogenes/tumor)

Bacterial pathogens
- motility/attachment
- endotoxins (LPS)
- inflammation

Parasitic pathogens
- intracellular → cell destruction
- extracellular → tissue damage
- organ lesions/dysfunction
- immunopathology (hypersensitivity)

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