

## Class Outlines

(These are to be printed and brought to each class blank. We will complete them IN class. They will help us with activities during class. You should also take notes on here for studying. Besides these notes, you will want to log in to LC and review all activities/questions here.)

## Exploring Life and The Process of Science

### Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children

A J Wakefield, S H Murch, A Anthony, J Linnell, D M Casson, M Malik, M Berelowitz, A P Dhillon, M A Thomson, P Harvey, A Valentine, S E Davies, J A Walker-Smith

The Lancet, Volume 351, Number 9103 28 February 1998

### Summary

**Background** We investigated a consecutive series of children with chronic enterocolitis and regressive developmental disorder.

**Methods** 12 children (mean age 6 years [range 3-10], 11 boys) were referred to a paediatric gastroenterology unit with a history of normal development followed by loss of acquired skills, including language, together with diarrhea and abdominal pain. Children underwent gastroenterological, neurological, and developmental assessment and review of developmental records.

**Findings** Onset of behavioral symptoms was associated, by the parents, with measles, mumps, and rubella vaccination in 8 of the 12 children. All 12 children had intestinal abnormalities. Behavioral disorders included autism (nine), disintegrative psychosis (one), and possible postviral or vaccinal encephalitis (two).

**Interpretation** We identified associated gastrointestinal disease and developmental regression in a group of previously normal children, which was generally associated in time with possible environmental triggers (MMR vaccine)

→ "MMR vaccine causes autism" - is this a valid claim based off this paper?

"If MMR vaccine causes autism, then I don't want to vaccinate my child"

"If MMR vaccine causes autism, then ..."

- autism rates for whole POPULATION would have increased all @ once after vaccine release
- the onset symptoms for autism would have had to be only after vaccination
- (in a controlled experiment): there would have had to been lower rates of autism in the control group

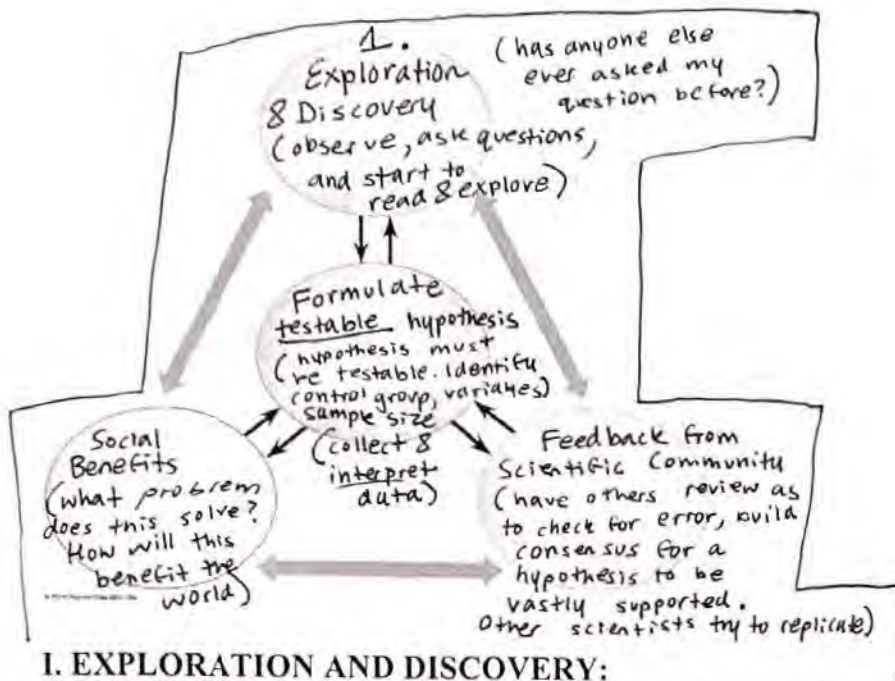
← NONE of these happened & paper was retracted

guy that did the paper was investigated & found to be dishonest too, & abused mentally developing children & lost his medical license

★ correlation ≠ causation ★

### Elements of research design & how they impact conclusions

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• large sample size</li> <li>• repeated trials</li> <li>• double blind experiments</li> <li>• random samples</li> <li>• peer review</li> <li>• randomization</li> </ul>	<ul style="list-style-type: none"> <li>• correlation = causation</li> <li>• not accounting for other possible causes</li> </ul>



## I. EXPLORATION AND DISCOVERY:

Insect development has been shown to be temperature dependent. This is true for caterpillars, as shown in controlled lab settings, in which growth rates and survival increase with increased temperatures. Very high temperatures lead to decreased growth and death. But controlled lab settings have limitations that don't model the field—such as the daily fluctuation of temperature as opposed to constant lab temperatures, the host plant's nutritional content and growth as temperature changes, behavior to avoid predators, etc. Extrapolating results from laboratory experiments to natural settings is therefore problematic. Climate change will bring rising temperatures to places where caterpillars develop. Field experiments have not been done and are necessary to identify how elevated temperatures influence insect development in a more natural, variable environment.

**Questions** –If the climate increases 4°C, as predicted by 2100, how will caterpillar development in nature be affected? → based on passage, caterpillars may be harmed and be more killed off in this warmer climate

~~hypothesis: if climate increases by 4°C, then~~

## II. FORMATION AND TESTING HYPOTHESES

• hypothesis is NOT an if-then statement  
 • if → then is a PREDICTION (what u think)

• hyp = explanation for what happened.

### COLLECTING DATA:

★ Hypothesis – proposed explanation for a set of ideas that leads to a testable prediction

↑ hypothesis: elevated temperatures in natural habitats decrease larvae development over time

Prediction of results: – If → Then (what you think will happen; comes AFTER hypothesis)

Experimental design:

The factor manipulated in an experiment is the independent variable (

The experimental and control group are compared to each other and differ how?

Control – held steady, while experimental – given a stimuli & response is compared to "norm"

The factor(s) affected by the independent variable in an experiment, or what is "measured" –

dependent variable(s)

Actual results:

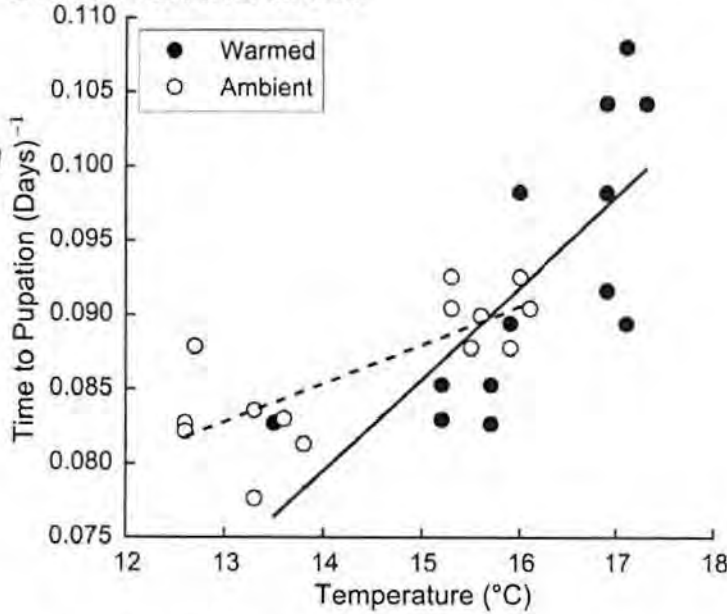
a. experimental group- group exposed to the independent variable

b. control group - comparison group, not exposed to independent variable

c. independent variable - factor manipulated in the experiment

d. dependent variable - factor that is affected by independent variable then measured  
(can have multiple)

### INTERPRETING DATA:



sample bias - when you are generalizing from a subset it does not represent the whole.

- how to avoid sample bias:
- random sampling (randomly assign things/pp1 to control group vs. experimental)
  - large sample (less probability for outliers)

units (days)<sup>-1</sup> so higher on y-axis actually means less time

### III. FEEDBACK FROM SCIENTIFIC COMMUNITY

↳ publish work & receive feedback from scientific community

### IV. SOCIETAL BENEFITS AND OUTCOMES

• If climate change is shifting phenology for one organism, how are the others (those who eat it) affected? Also negatively affected.

- Law: description of a phenomenon
- Hypothesis: geared toward specific experiment
- Theory: explanation supported by vast amount of evidence

II. What is a Scientific Theory vs. a Hypothesis vs. a Law?

A LAW is descriptive. But a THEORY and a HYPOTHESIS seek to explain.

What makes science--science? Science is **★TESTABLE★** (able to form some type of measurement → quantitative OR qualitative)

With your neighbors, discuss the next two questions:

Q: Did humans and dinosaurs co-exist?

- What tools/evidence do you need to answer this question?
- What evidence exists?

Q: Have humans changed (evolved) over time?

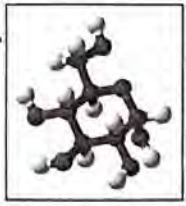
- What tools/evidence do you need to answer this question?
- What evidence exists?

↳ looked for if fossils of humans + dinosaurs lay in the same layer of Earth  
 ↳ never found dinosaur bones & human bones in the same level

↳ skulls from different layers of Earth from diff years, different shapes & human-like characteristics but not humans → points to evolution

★ Scientific Process is NOT linear → back & forth between steps

**Life's common themes:** Throughout the course, we'll look for examples of these themes. We'll expect overlap too—one topic we are learning about may provide examples of all/many themes.



**Transformations of Energy and Matter**

- matter can't be built or broken down without energy
- energy often changes forms during reactions which change matter



**Structure and Function**

- the structure of an organism's anatomy is a good fit for job it performs



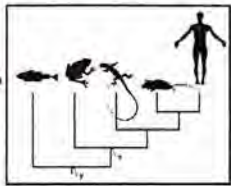
**Interactions within and between systems**

- systems have hierarchy (group of cells = tissue, group of tissues = organ....)
- At each new level, a new function emerges as they work together



**Flow of Information**

- how different systems are directed to diff things
- how Y-chromosome = male development & how 1 protein defect = cystic fibrosis



**Evolution**

- life's unity & life's diversity are explained by evolution
- Different hierarchical levels of life

**Match one statement to the theme it matches to best:**

- (A) Red pandas share characteristics with giant pandas and raccoons but new evidence suggests they should be classified as their own family.
- (B) Millions of microbes live within your gut, secreting a variety of proteins that may have multiple effects on your brain physiology.
- (C) As glucose breaks down into smaller molecules within your cells, some amount of heat is lost to the environment.
- (D) At the end of chromosome 4 is a gene called huntingtin that when mutated causes a mutant protein to be made that has lethal effects on neurons.
- (E) The bladder is able to hold large amounts of urine because it is an expandable sac.

Plants:

for energy storage: starch

for structure: cellulose (cell walls)

Animals:

for energy storage: glycogen (stored in liver)

# Macromolecules Structure & Function

## Class discussion

I. Recap. List the four major macromolecules (biological polymers) in the cell.

1. Carbohydrates
2. Lipids
3. Proteins
4. Nucleic Acids

Under each group is one word, find other words to group with this word and explain why. There are lots

monosaccharide	lactose	cholesterol	waxes	polymer	nucleotide
cellulose	nitrogenous base	enzyme	triglyceride	glycogen	starch
glucose	amino acid	disaccharide	hydrophilic	deoxyribose	chitin
phospholipid	ribose	monomer	protein	glycerol	RNA
DNA	peptide bond	fatty acid	hydrolysis	polysaccharide	hydrophobic

of right ways to group words, as long as you can explain your logic.

Grouping 1:

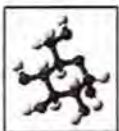
hydrophobic

Grouping 2:

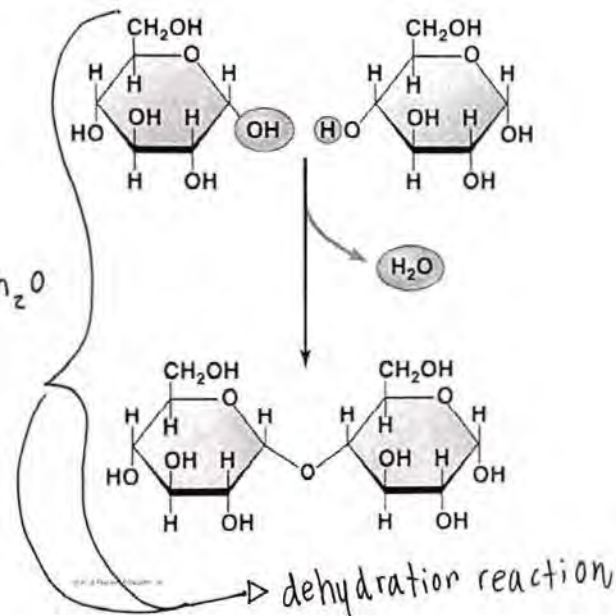
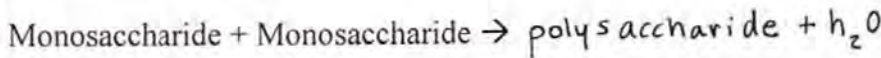
glycogen

Grouping 3:

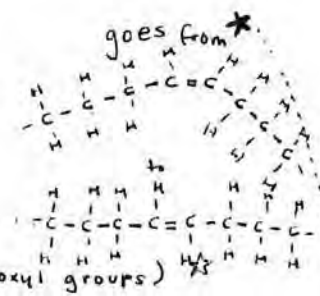
peptide bond



## II. Carbohydrates-



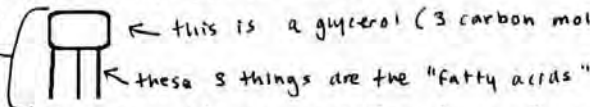
monomers of a triglyceride = 3 fatty acids + 1 glycerol



### III. Lipids-

#### A. Triglyceride (a type of "fat") -

whole thing = a triglyceride molecule



← this is a glycerol (3 carbon molecule w/ hydrogens & hydroxyl groups)  
 ← these 3 things are the "fatty acids"

#### SATURATED FATS



• no double bonds  
 • no bends

#### UNSATURATED FATS (healthy ones)



• hydrocarbon chain contains at least 1 double bond  
 • bends

#### TRANS FAT



• yes double bonds, but the process that converts unsaturated fats into trans fats straightens them out

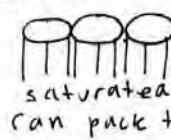
Draw a representation designed to teach someone how several unsaturated triglycerides pack together differently compared to several saturated triglycerides. Be sure your drawing shows the difference in their individual structures too.



• liquid @ room temp

unsaturated can't pack tight

vs.



• solid @ room temp

saturated can pack tightly

The table below was taken from a study in which scientists randomly tested adults in 2000 and in 2009 for four different trans fatty acids in their blood.

A. In one sentence: what do you conclude from the data below?

more adults ate trans fatty acids in 2000 than 2009

**Table 2.** Levels of *trans*-Fatty Acids in Fasting Non-Hispanic Whites Aged 20 Years or Older<sup>a</sup>

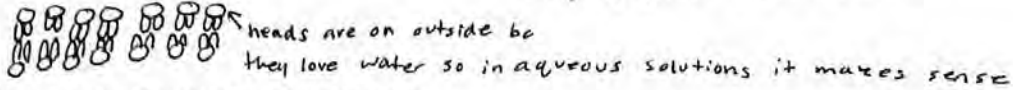
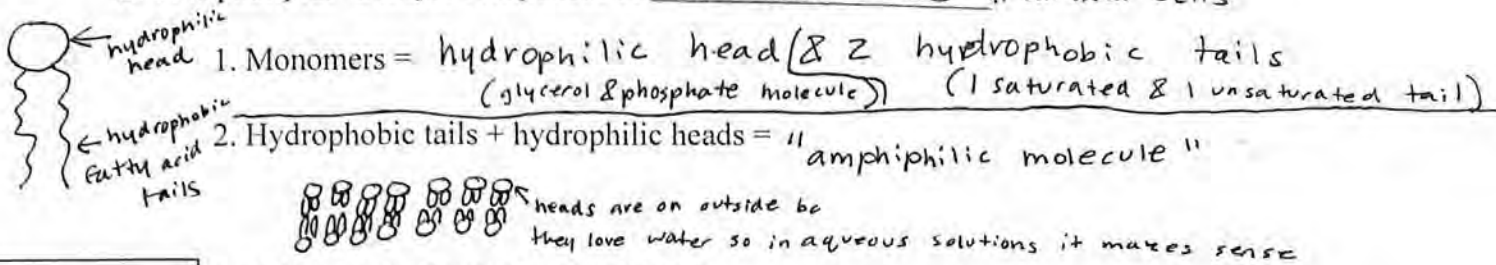
	NHANES 2000		NHANES 2009	
	No.	Geometric Mean (95% CI), $\mu\text{mol/L}$	No.	Geometric Mean (95% CI), $\mu\text{mol/L}$
Vaccenic acid	229	43.7 (39.1-48.2)	291	19.4 (16.9-21.9)
Elaidic acid	229	38.2 (33.0-43.4)	292	14.0 (11.6-16.3)
Palmitelaidic acid	229	7.9 (7.3-8.5)	291	4.0 (3.6-4.5)
Linolelaidic acid	227	2.6 (2.2-2.9)	290	1.3 (1.2-1.5)
Sum of <i>trans</i> -fatty acids	229	93.1 (82.5-103.6)	292	39.0 (33.7-44.3)

B. If you were writing a discussion in this scientific paper, speculate why these results were seen:

\* ppl realized how bad trans fats were for  $\heartsuit$  health  
 \* science impacted a public policy & many trans fats were banned

another type of lipid besides triglycerides

B. Phospholipids- a major component of cell membranes in animal cells

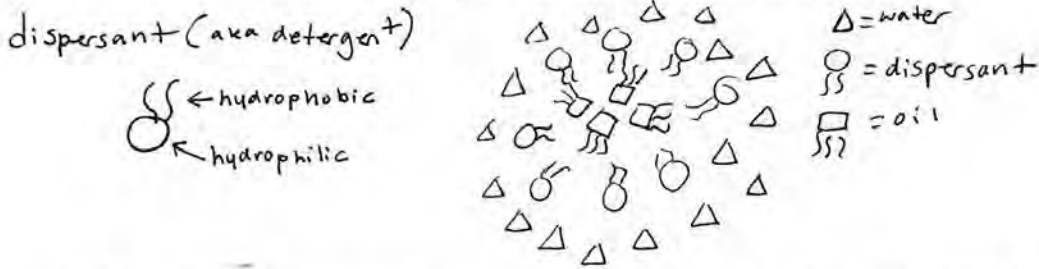


LIPIDS APPLICATION QUESTION:

a. Detergents surround oil in water and form a protective layer so that the oil molecules cannot "clump" together. The detergents "disperse" the oil into small droplets and in the water, such as when you use soap to wash an oily dish. What kind of properties would the detergent have to have to interact with both water and the lipid? Draw what you think the dispersant molecule looks like:

dispersant → needs properties to interact w/ both water & lipids. hydrophobic & hydrophilic parts  
 ↳ must be amphiphilic

Now draw a model of the oil, dispersant, and water mixed together:



b. What did the dispersant/detergent, Corexit, do to help during the 2006 BP oil spill? (Over 800,000 gallons of dispersants had been applied to Gulf waters mainly via helicopter, but also includes 100,000 gallons that were injected deep underwater.)

Corexit = a dispersant that helped disperse the oil into small droplets instead of keeping it as one big spill

c. How might a dispersant be useful in the human digestive system? → We produce bile, which does same job as dispersants @ breaking up oil. Bile = amphiphilic molecules

IV. Protein Structure

monomer

Amino acid + Amino acid = DIPEPTIDE

amino acids are unique based on their R-GROUPS (can be hydrophobic, hydrophilic, big, small, pos, or neg, or neutral...)

-How many unique dipeptides can be made? (e.g. Arg-Leu or Ala-Pro etc...)

400 → (2 unique "positions" in a dipeptide)

Unique tripeptides?

8000 → 3 unique "positions" → 20 x 20 x 20 = 8000

How big is a protein?

anywhere from a couple amino acids to a few thousand.

creates \*VARIATION\* in the primary sequence

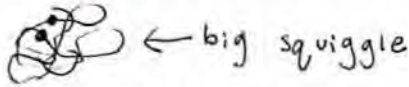
Allows lipid digesting enzymes can then hydrolyze the triglycerides into monomers for absorption into gut.

only monomers can be absorbed into the gut intestine





-You have been hired as an illustrator for a new introductory biology textbook. The authors want you to draw a picture to demonstrate how two amino acids far apart in primary structure can interact in their tertiary structure. What does your rough sketch look like? Compare with and critique your partner's sketch. Draw a second sketch demonstrating what a mutation in one amino acid might do to your tertiary structure.



B. What holds a protein's structure together? What can disrupt this structure?

- R-GROUPS INTERACTING W/ R-GROUPS! some are covalent bonds, some are hydrogen bonds, etc.
- If one amino acid is MUTATED, & isn't what its supposed to be, the tertiary structure can be ruined or even non-existent w/ one mutated (misfolding & wrong folds)  
Egg video: what did you learn?

- ↳ heat changes structure of proteins in egg ← denature?
- ↳ they denaturalize, or unravel
- ↳ egg hardens & turns white

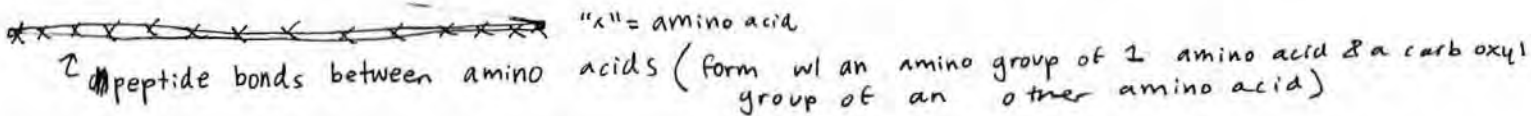
this STRUCTURE issue would negatively impact the FUNCTION of the protein

- sickle cell disease = an example of an amino acid mutation

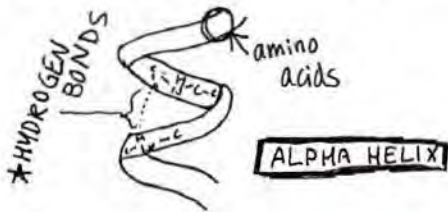
We eat food for 2 reasons:

1. Raw organic material for building our own macromolecules
2. Energy for cellular work

PRIMARY STRUCTURE OF PROTEIN → just the sequence of the amino acids in order



SECONDARY STRUCTURE → hydrogen bonds BETWEEN the amino end of one amino acid & carbonyl group of another amino acid



TERTIARY STRUCTURE → overall 3D shape of polypeptide due to R group interactions between amino acids



↳ the interactions between the R groups CAUSE the folded structure

QUATERNARY STRUCTURE → (not all proteins have this) but = multiple proteins in tertiary structure coming together & interacting. also held together by R-group interactions

