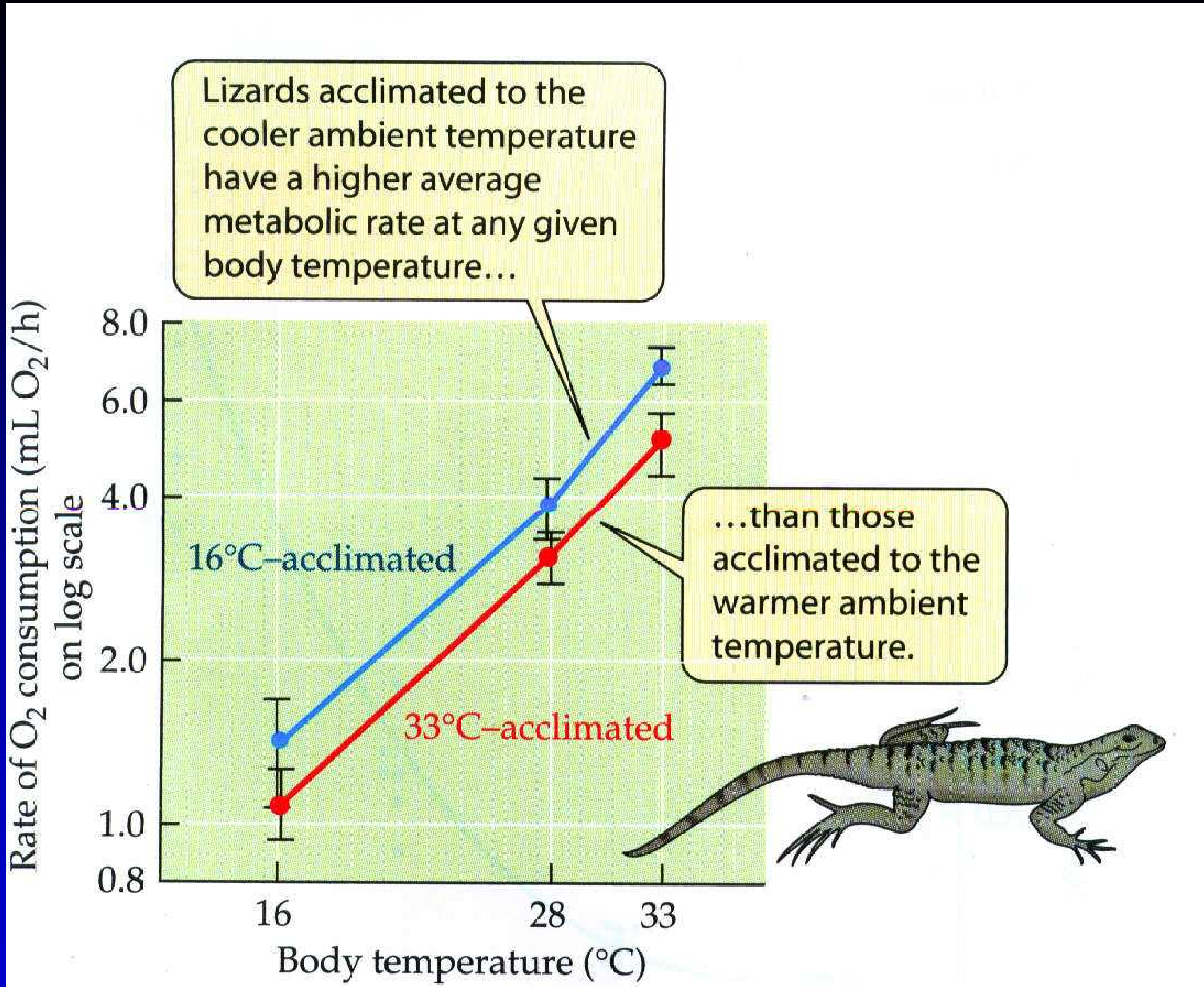
Adaptation Terminology

Acclimation

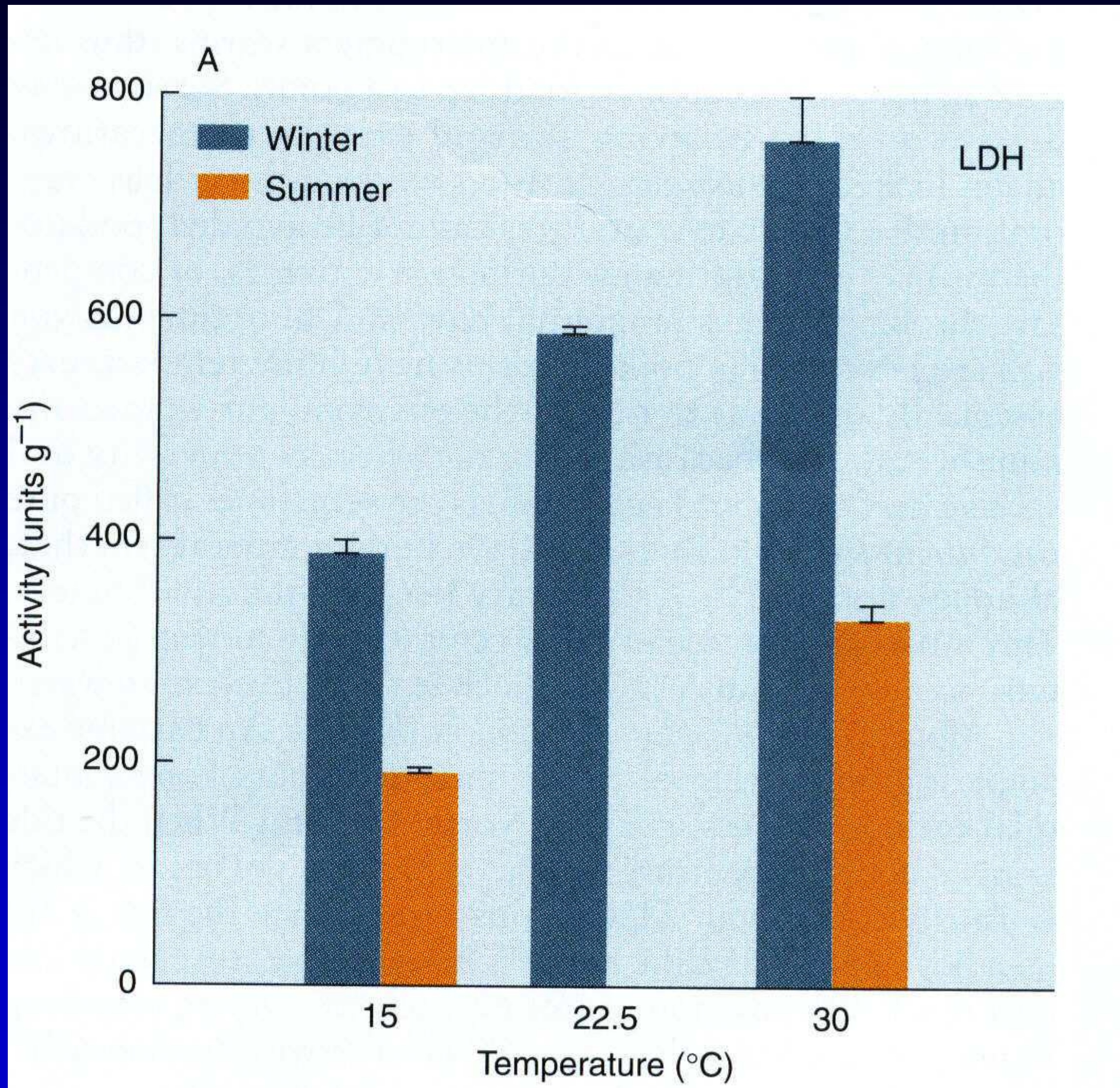
- functional compensation over a period of a days to weeks in response to <u>single</u> factor only
- often restricted to changes induced under lab conditions
- varying temperature is usual factor, can have acclimation to other factors (e.g., pH, salinity)



Lizards acclimated to the cooler ambient temperature have a higher average metabolic rate at any given body temperature…
…than those acclimated to the warmer ambient temperature.
Rate of O2 consumption (mL O2/h) on log scale
8.0
6.0
4.0
2.0
1.0
0.8
16°C–acclimated
33°C–acclimated
16
28
33
Body temperature (°C)

Acclimatization

- functional compensation over period of days to weeks in response to complex of environmental factors
- seasonal or climatic changes (i.e., changes that occur under natural conditions)
- multiple parameters can vary


A
Winter
Summer
LDH
800
600
400
200
0
Activity (units g⁻¹)
15
22.5
30
Temperature (°C)

Adjustments to Altered Temperature Regimes

- Animals function best at their “preferred” temperature

- If this temperature changes, they will attempt to adjust their physiology to compensate

- Compensational changes can occur at all levels of biological function

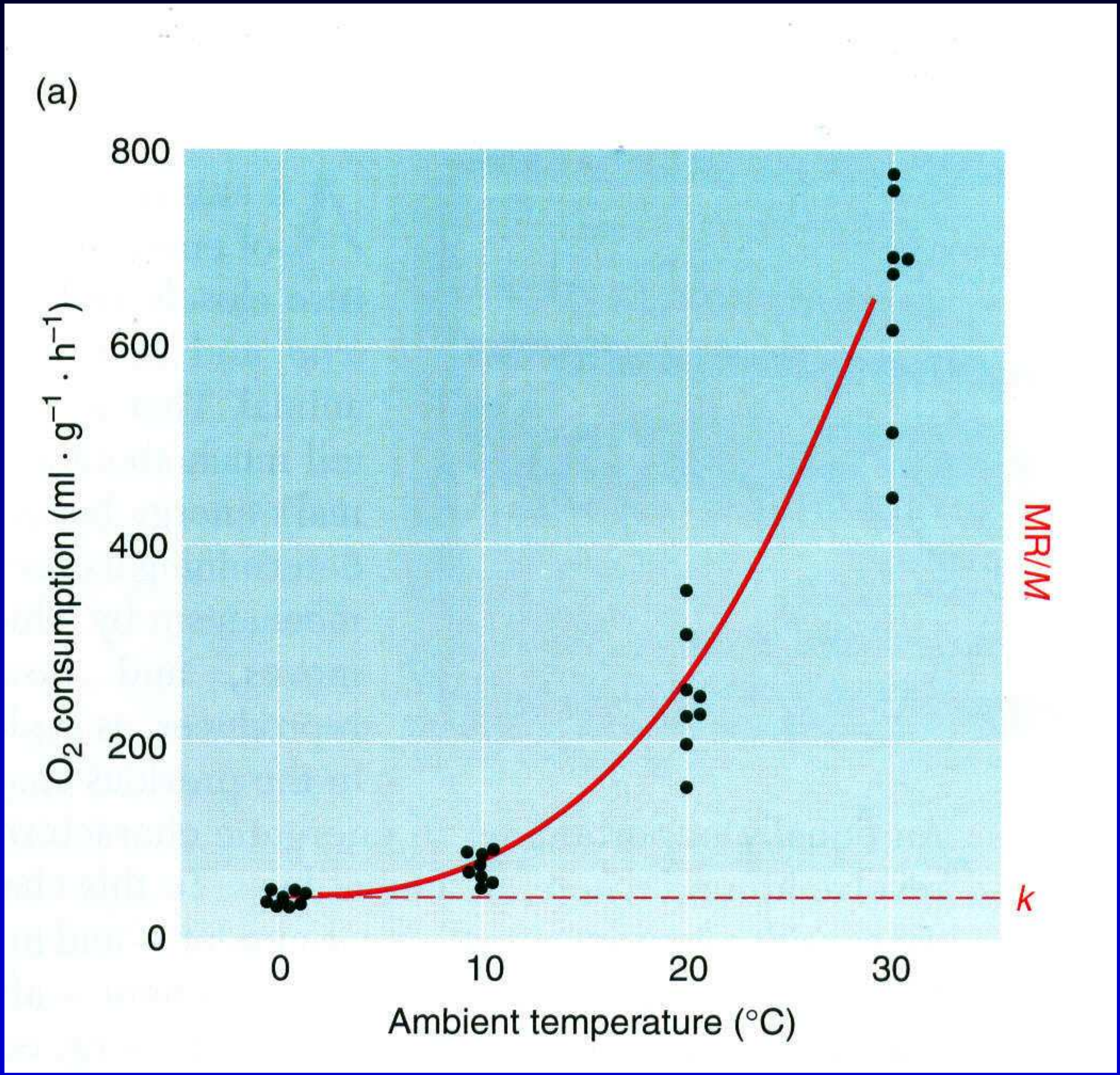
Temperature and Biological Function

Examine two features in more detail

1. Effects on rate functions

2. Animal adaptations to thermal changes/extremes
   A) at the organ/system level
   B) at the cellular/molecular level

O_2 Consumption of Tiger Moth Caterpillar



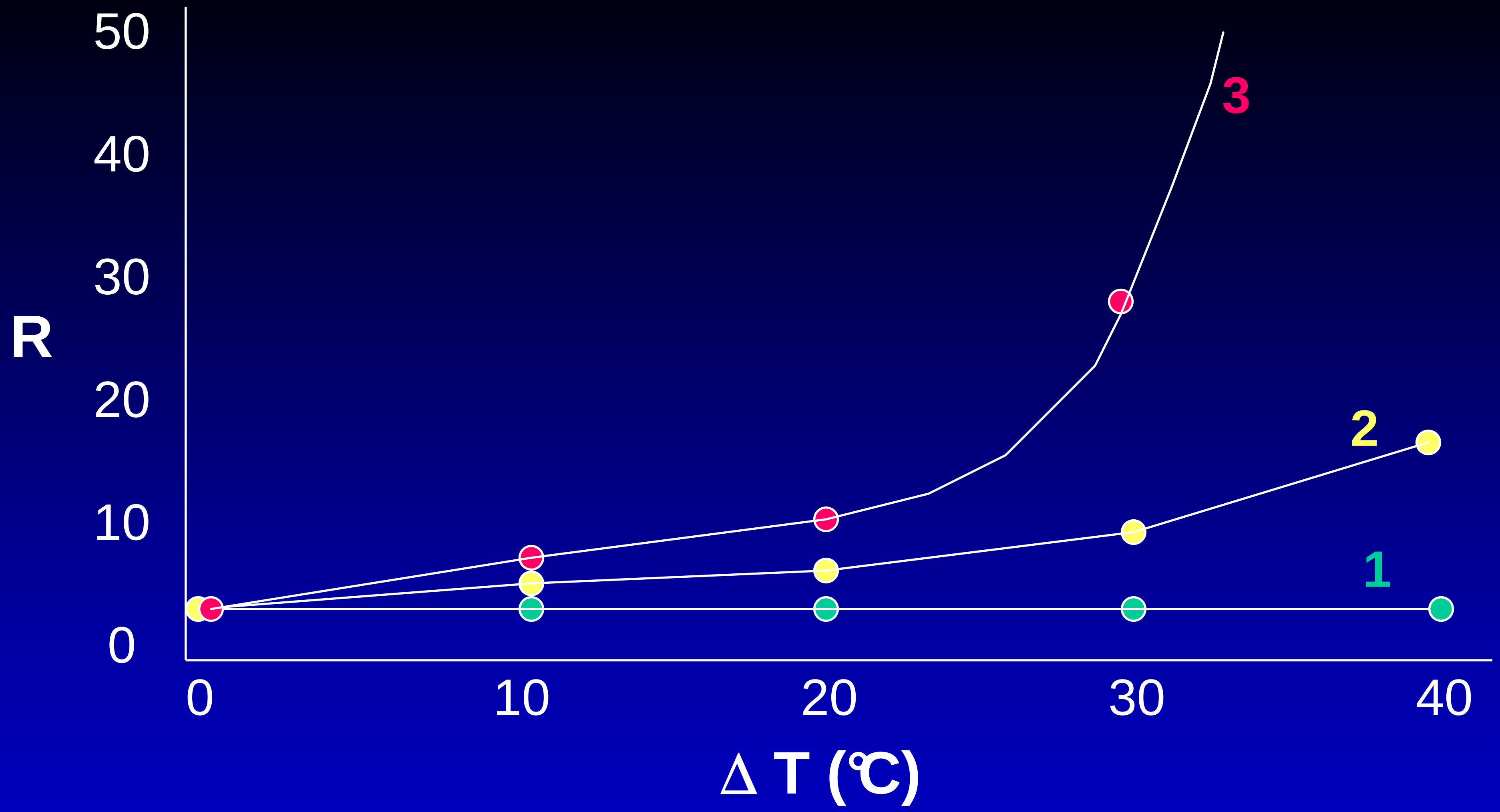
Calculating Q_{10} = Temperature Coefficient

Simple procedure if rate change is determined over a 10^{o} C range:

$$Q_{10} = R_2 / R_1$$

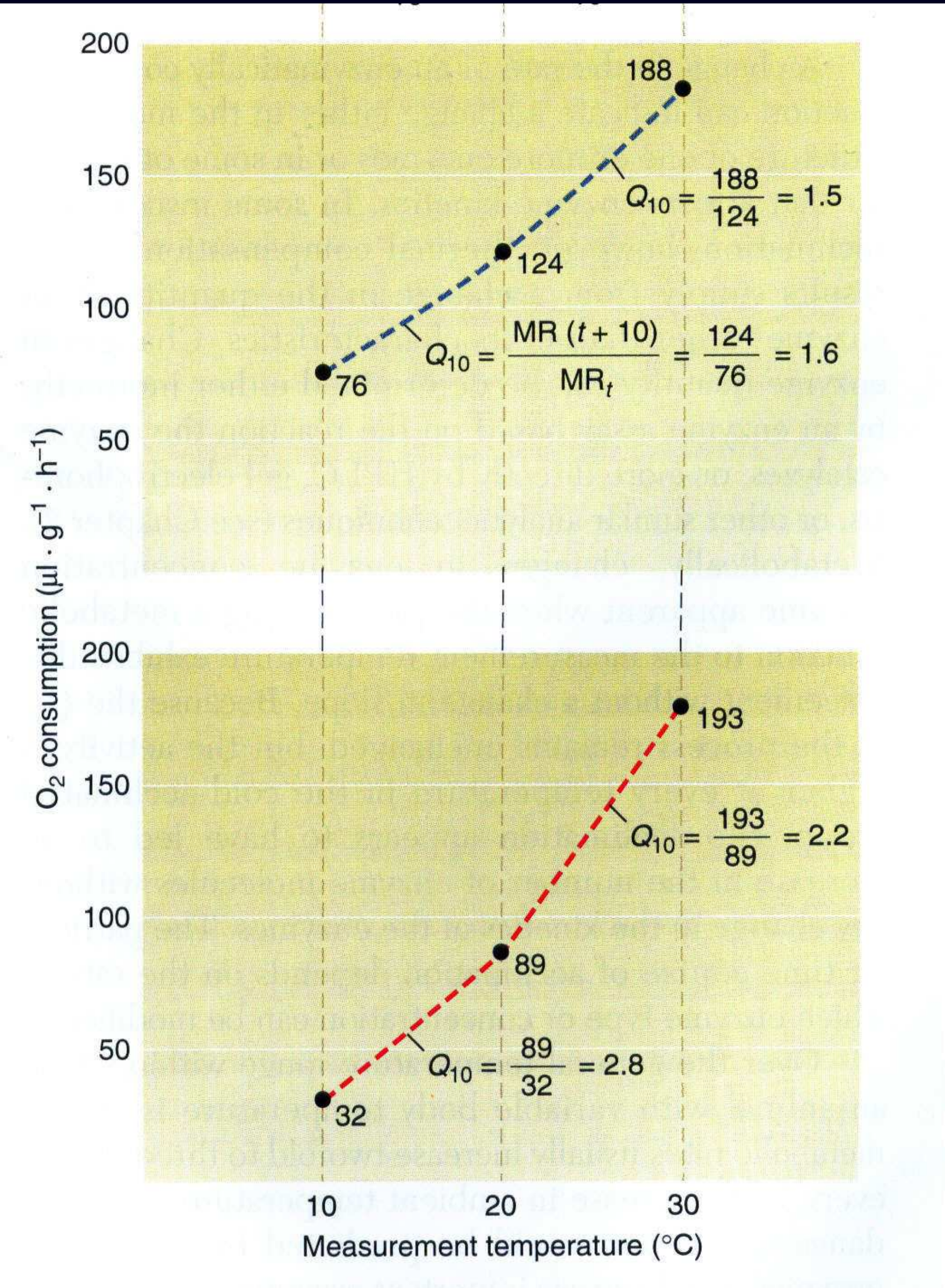
Can calculate Q_{10} for any temperature interval:

$$Q_{10} = \left(\frac{R_2}{R_1}\right)^{10/(t_2 - t_1)}$$



$$Q_{10} = \frac{R_{T+10}}{R_T}$$

O_2 Consumption in a Frog



Compensation changes at enzyme level:

Two basic choices:

- increase quantity of a given enzyme
- production of different isozymes

- **Changes in Amounts of Enzymes**

If rate of reaction inc. with inc. in T -
can slow reaction by dec. in amt. of enyzme:

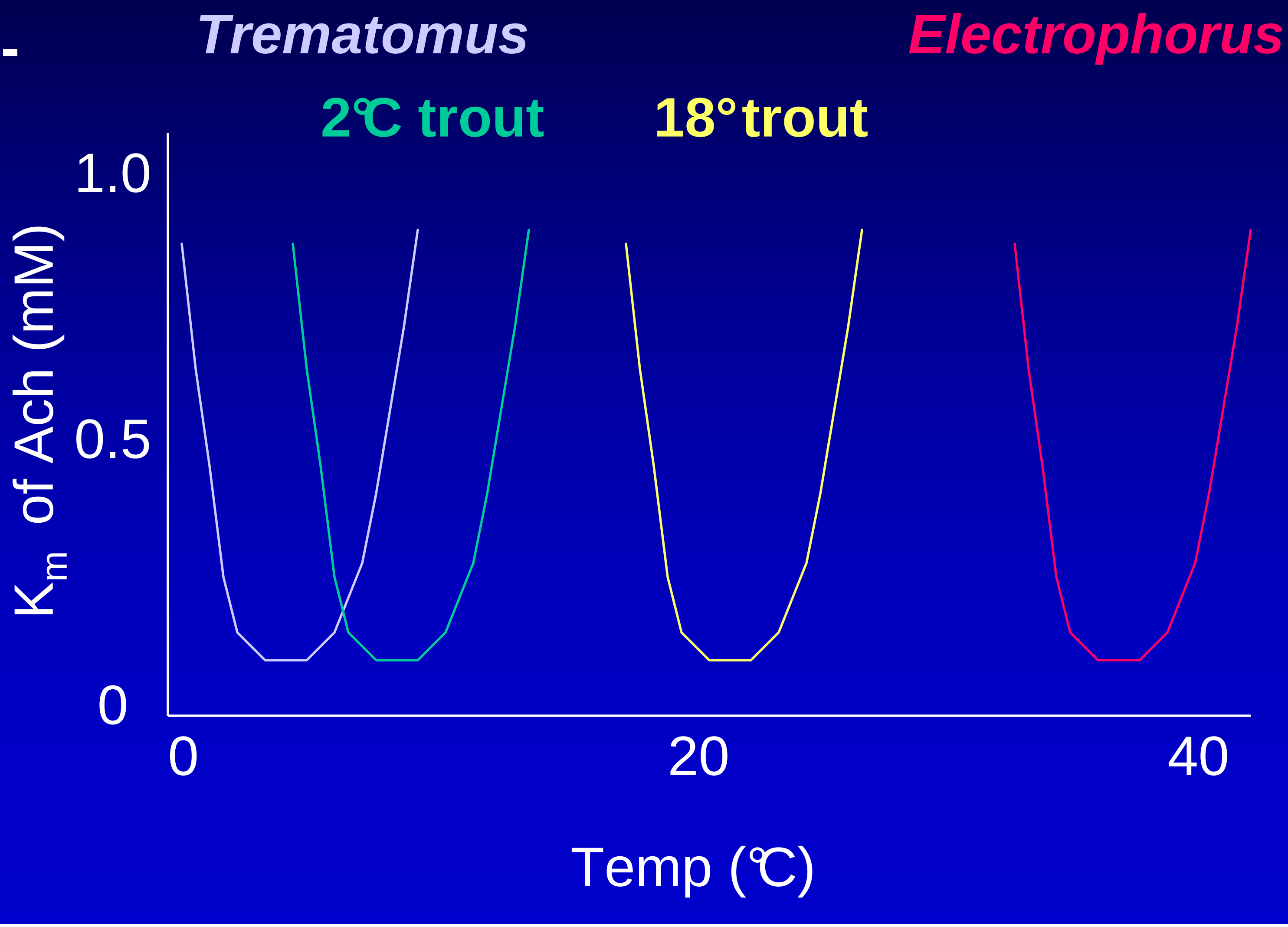
Callinectes hepatopancreas -
glucose-6-phosphate dehydrogenase

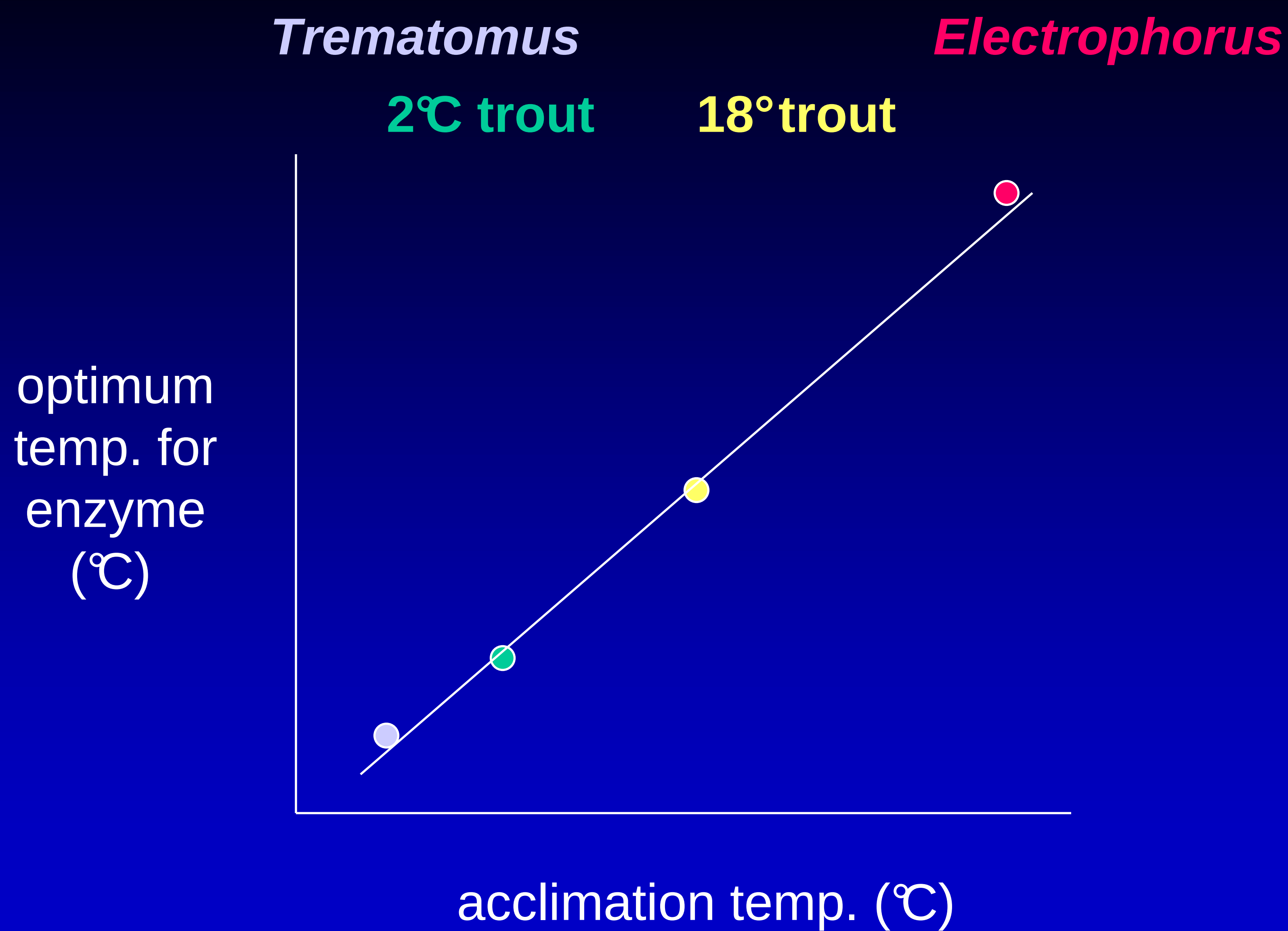
1.4 X amt. of enzyme present at 10℃ compared to 20℃

Do you see any problem with this strategy?

- **Isozymes -** different forms of an enzyme representing variation in the multiple copies of the genetic code for the enzyme (e.g. LDH).

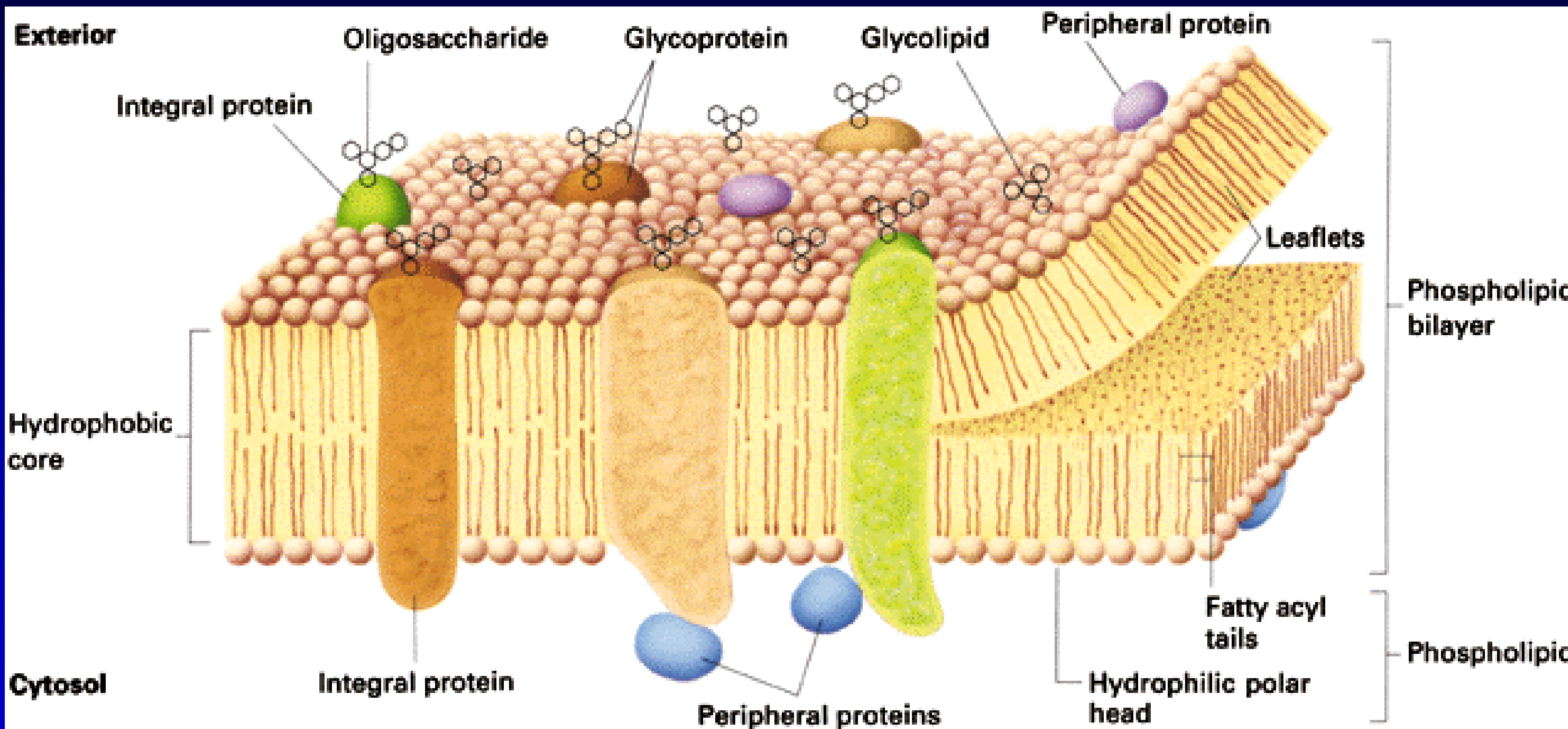
Acetylcholinesterase

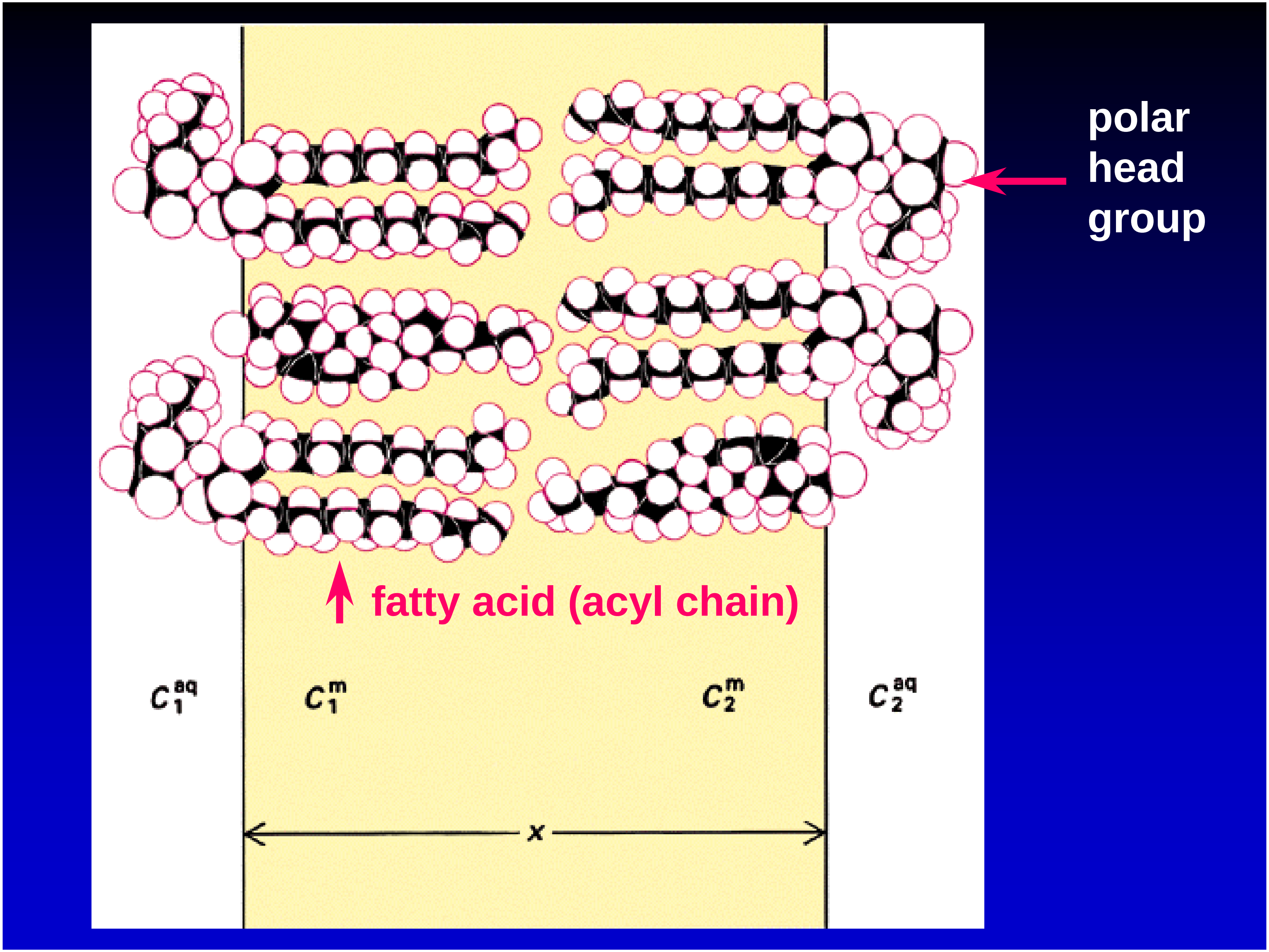




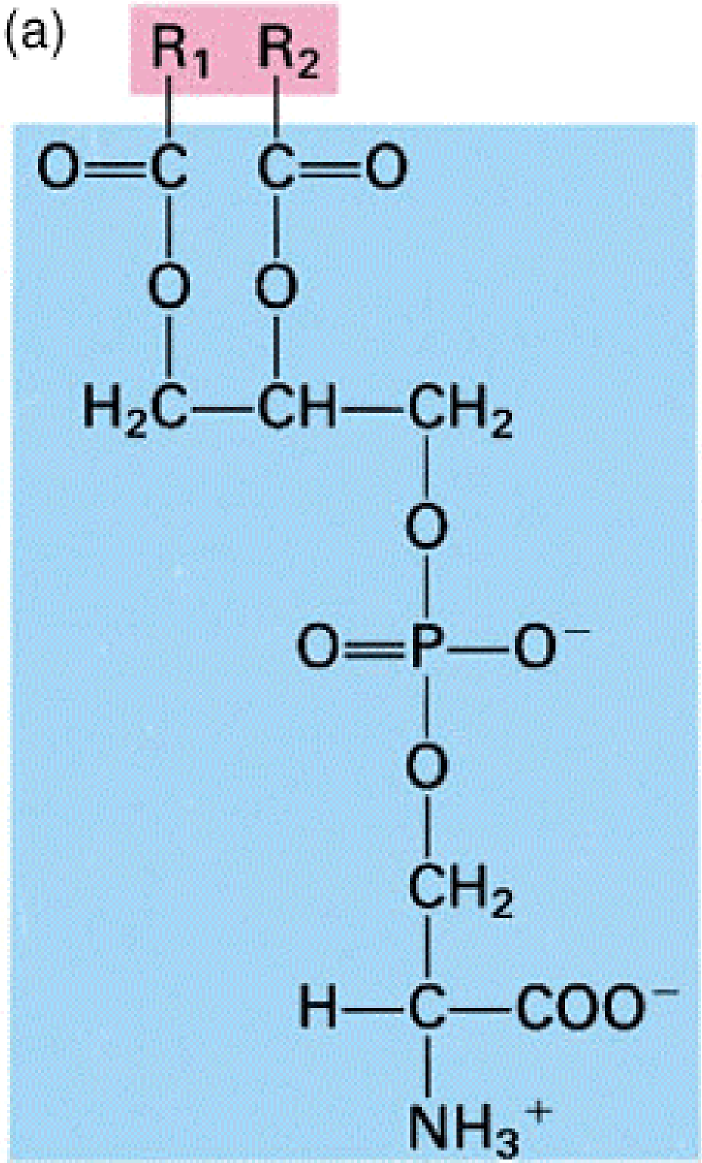
Trematomus
Electrophorus
2℃ trout
18° trout
optimum temp. for enzyme (℃)
acclimation temp. (℃)

• Effect of temperature on membranes

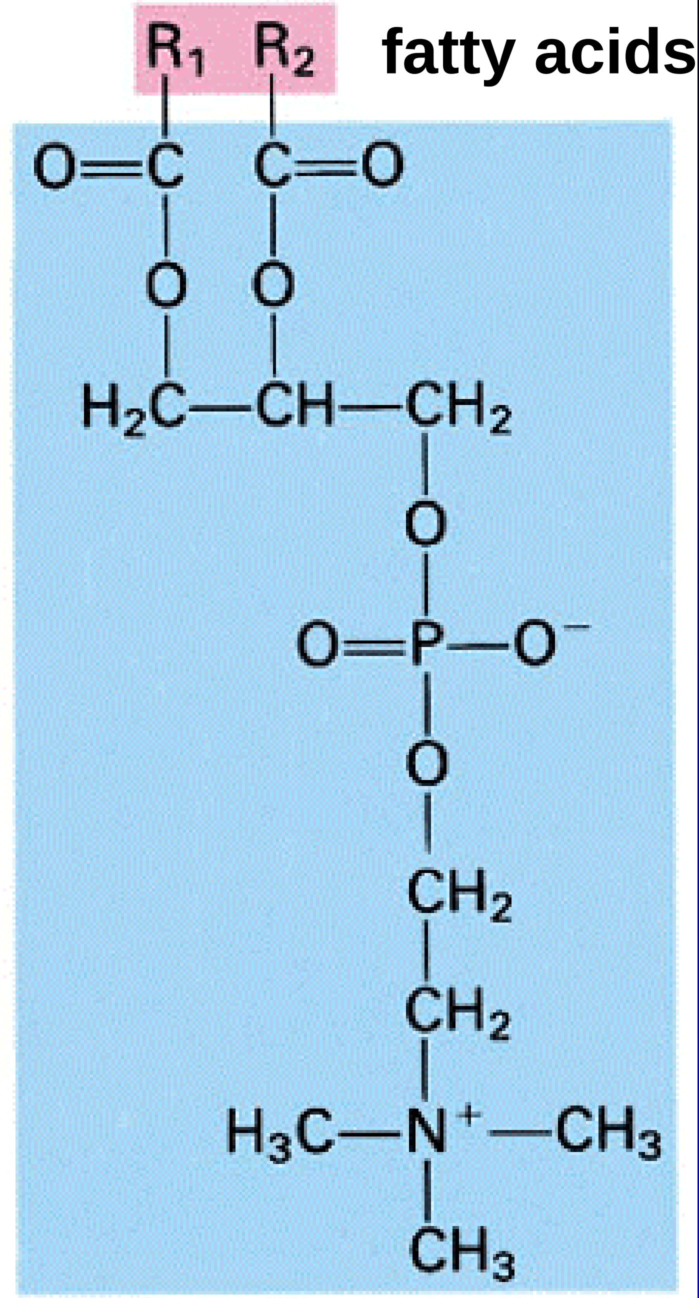



polar
head
group
fatty acid (acyl chain)
C_1^{aq}
C_1^m
C_2^m
C_2^{aq}
x

(a)



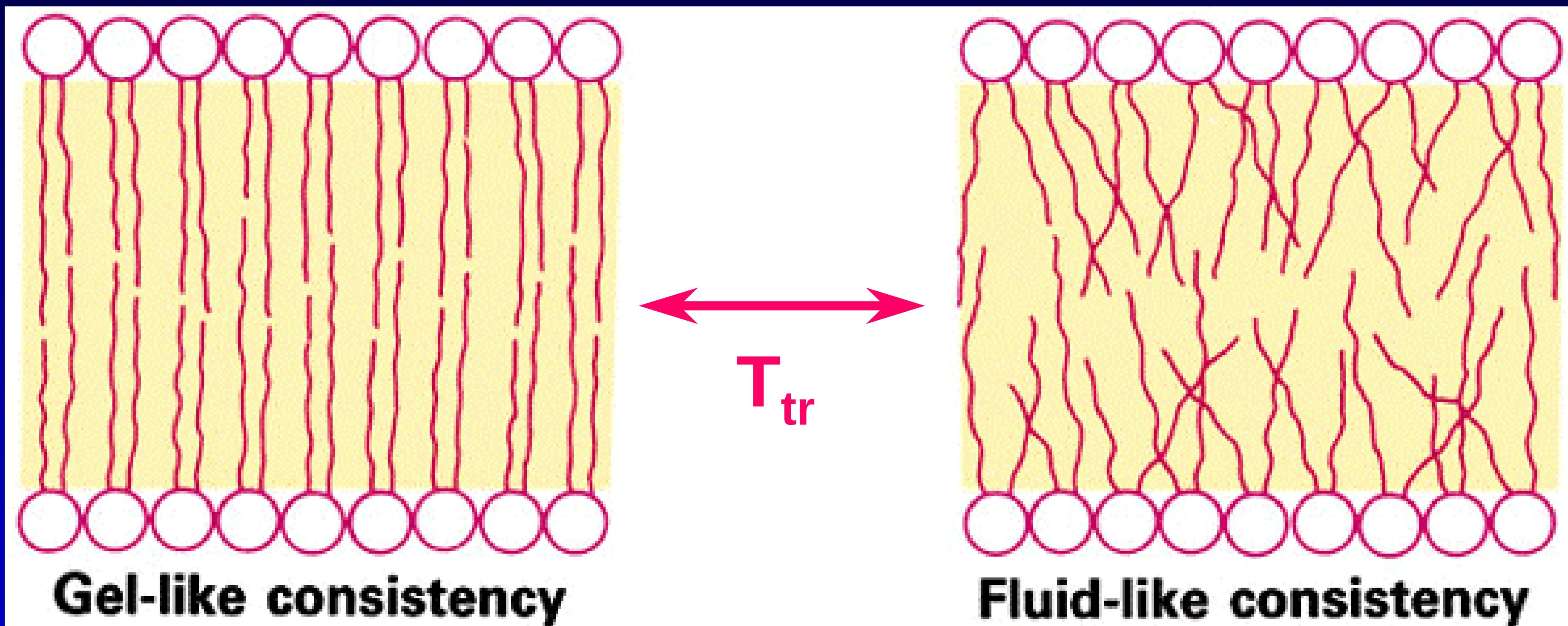
Phosphatidylserine



Phosphatidylcholine

Phospholipid bilayers undergo a **phase transition** (just like water which undergoes a phase transition from liquid to solid at 0℃)

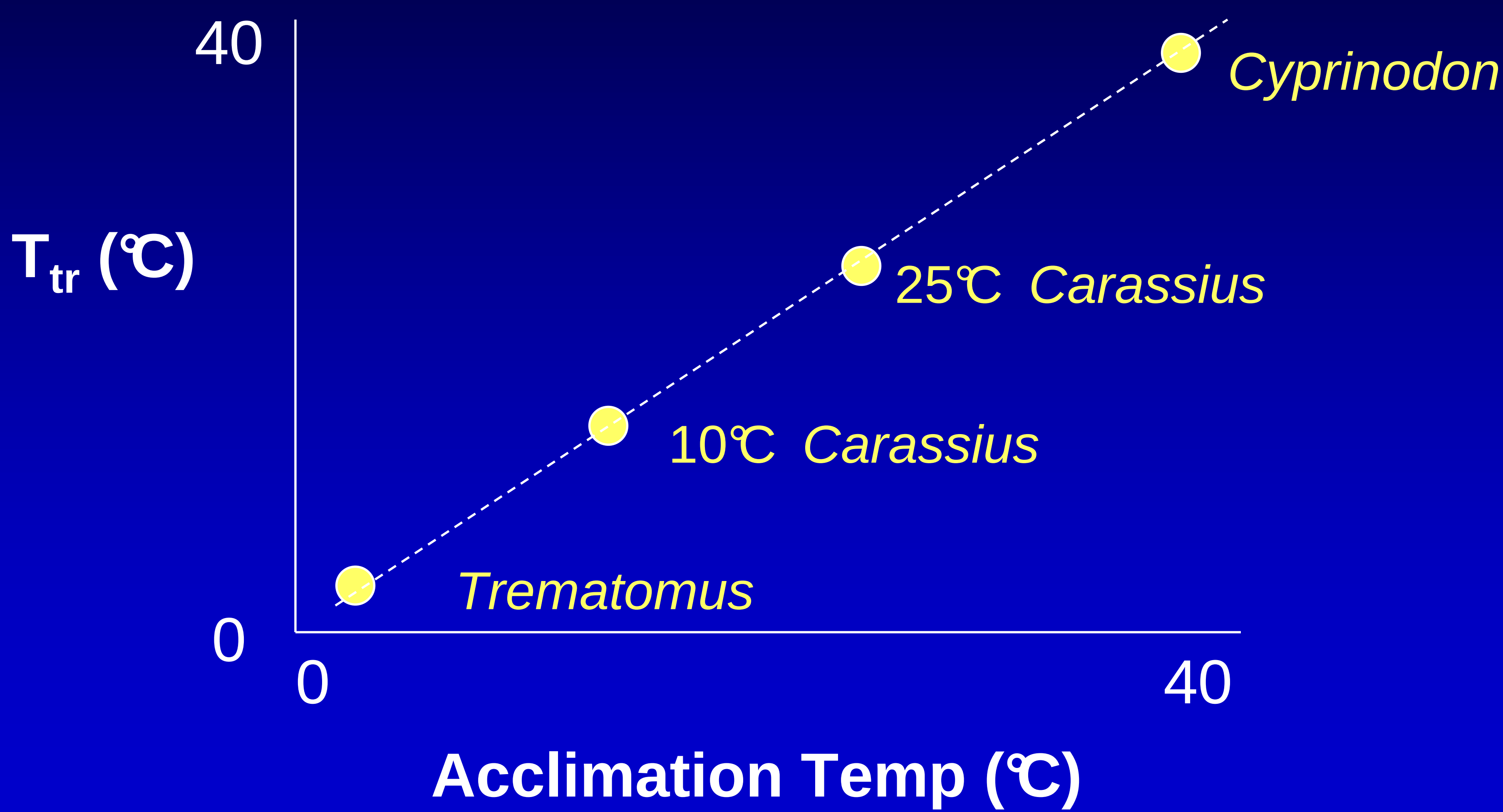
gel **liquid crystal**



inc. in temp.

T_{tr} = phase transition temperature

Membranes appear to function best at a temperature close to T_{tr}



Phase transition temperature (T_{tr}) of membrane phospholipids is strongly influenced by:

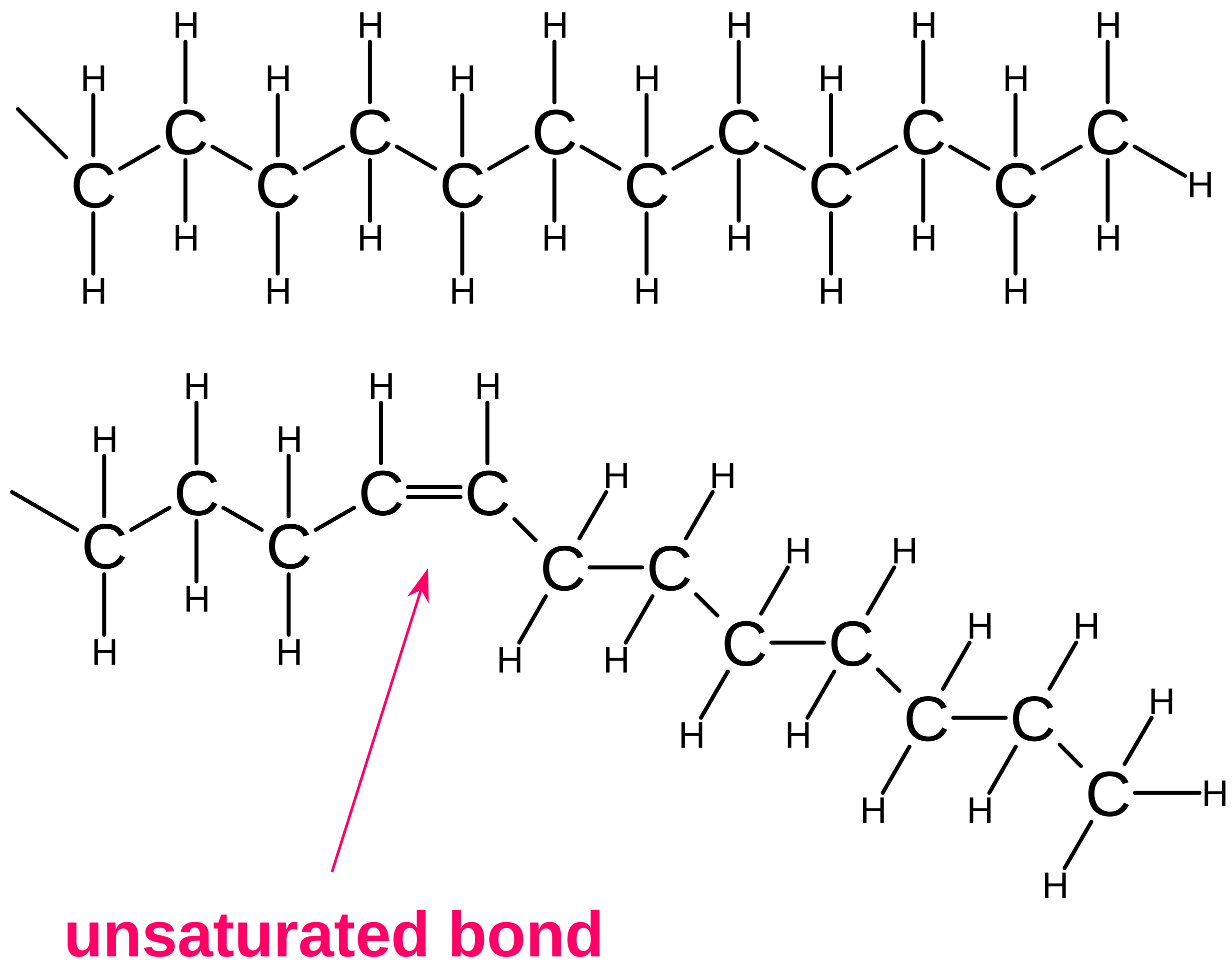
- polar head group
- length and saturation of fatty acid acyl chain

- polar head groups

With dec. temp. find:

inc. in PA and PE relative to PC

- saturation of fatty acids



With dec. in temp. get increase in degree of unsaturation of fatty acids:

Species	**(temp.)**	**Sat/Unsat in PC**
Myoxocephalus	(0℃)	0.59
Carassius	(5℃)	0.66
	(25℃)	0.82
Cyprinodon	(34℃)	0.99
Rattus	(37℃)	1.22