Hello students. Today we are going

to deal with the module monitoring

and control of fermentation

parameters and in this module we are

going to study about temperature.

This module covers the basic principles of

temperature measurement and control; effect

of temperature change on fermentation;
and monitoring and control of temperature.

In this module you will be able to

understand the basic principles of

temperature measurement and control.

You will be able to identify the effect of

temperature changes during fermentation.

You will be able to measure

temperature change during fermentation.

And you will develop strategies

for control of temperature.

In any fermentation,

the microorganism requires to be

incubated at an optimum temperature.

So precise temperature and

control profiling is the key

factor for growth of an organism,

be it in the laboratory or be it

at pilot and industrial scale.

During initial stages of fermentation,

heat is required by the microorganism

for biomass growth because

each organism has a particular

temperature at which it will grow,

which is called as the optimum temperature

for growth and metabolite production.

Later, during fermentation

as fermentation progresses,

the organism will breakdown the substrate

and will generate heat during metabolism,

because of the exothermic

reactions of metabolism.

Heat is generated and this heat

energy is normally used for ATP

generation and the excess of heat is

released into the surrounding medium.

Now, besides this,

we need to remember that during fermentation,

mechanical agitation is taking

place inside the fermenter.

Now this agitation will also generate heat.

If this heat is not removed,

the temperature will increase inside

the fermenter and the environment will

become uncomfortable for the organism

to perform at its maximum potential.

Therefore,

it is very very important to

regulate the temperature inside

the fermenter.

Addition or removal of heat from

the fermenter will depend on what

is the capacity of the fermenter.

That means how much of volume of

culture is there in the fermenter,

how dense the organisms are,

because the more the organisms,

the more the heat that will be generated;

The type of organisms, that means, whether

they are thermophilic or psychrophilic;

and the growth rate, that

means, how quickly they grow.

in the fermenter.

What is the effect of temperature

change on fermentation?

We know that if the temperature is

too high it will affect the enzymes

because enzymes are proteins which

get denatured at high temperature.

Similarly, at low temperature

the enzymes will be inactivated,

so temperature is important

because temperature affects the

growth of the microorganism.

If the growth is affected,

it will affect the productivity.

That means the organism may

not be able to give you the

product which you had expected,

and also the quality of the yield

will not be as per our expectations.

So how do we measure

temperature in the fermenter?

We can measure the temperature in

the fermenter by using temperature

sensors or temperature probes.

Here I have encircled a diagram

which is showing you how probes are

inserted in the lab scale fermenter.

Similarly you have production

scale fermenters also have probes

which are inserted from the.

lid of the fermenter.

Now in the laboratory.

the type of thermometers

used are mercury and glass,

bimetallic or pressure bulb thermometers,

whereas for production scale, that

means, in batch and continuous

fermenters we can use thermocouples,

metal resistance thermometers and

resistance temperature detectors.

One of the most common example.

is the thermistor.

How do we control the temperature?

The temperature can be controlled manually.

That means there is a human operator

who is going to check the temperature

by using a thermometer and then

accordingly he will deal with the heat

which is produced or he will cool it,

if it is too hot; and he will heat it up,

if it is too cold.

But you know that humans can

make mistakes so it is prone to.

errors; so the other option is

automatic temperature control.

In the automatic temperature control we use

different types of heat transfer systems.

So if you are doing temperature control

in the laboratory,i.e. laboratory scale,

you take your fermenter and

immerse it in the water bath.

If it is a medium size fermenter,

you have jackets as I've shown you here.

These jackets are similar to what

we use to keep ourselves warm.

So it will enclose the outer surface

of the reactor and you heat up this

jacket and the jacket will transfer

the heat in and out of the fermenter.

If the jacket is too small then

you may need to use internal coils.

Now these coils are present inside

the shell of the jacket and the coil

can be heated up to increase the

temperature or you can circulate

cold water to cool the fermenter.

In large fermenters you can circulate

refrigerated water in pipes within

the fermenter,

or you can sparge cold water on

the fermenter from the outside.

These mechanisms of jacket and coil are

not only used for temperature control,

but this very same mechanism is also

used for sterilization of the fermenter.

before you start the fermentation.

This shows you the different

types of jackets.

It can be either a single external

cooling jacket or a batch reactor

with half coil jacket and here

you have a constant flux jacket.

If you need to add heat,

you can do either a direct

heating using a mantle,

or you can circulate hot water or

steam in the jacket or another method

is you can use a heat exchanger.

This diagram shows you the thermal jacket,

how steam is injected inside the fermenter,

how cooling water is supplied,

and there is a discharge of

cooling water here , this steam is

there and this part shows you

those sensors which are

present on the reactor.

To summarize,

temperature increases due to metabolic

activity of microorganisms and due to

agitation. Temperature changes can be

monitored with the help of a sensor.

Temperature control depends on the

scale of fermentation as shown.

If you need to heat up in lab

scale you will use electric heating.

For production scale you use steam;

and cooling for laboratory scale.

It is done by cold water bath and for

production scale by cold water

or refrigerants. Thank you.