Open Learning Materials

SEAFISH

The Chilled Fish Chain

The Chilled Fish Chain

The Chilled Fish Chain
An Open Learning Module for the Seafish Open Tech Project.

This work was produced under an Open Tech contract with the Manpower Services Commission. The views expressed are those of the author and do not necessarily reflect those of the MSC or any Government Department

ISBN 1 85280 008 9

Contents

Page

SEGMENT FOUR – HANDLING OF FISH IN THE DISTRIBUTION CHAIN

The Author

Peter Warren is a Principal Lecturer in Food Technology in the School of Food Studies at the Humberside College of Higher Education. He has a special interest in food processing technology, in particular, the low temperature preservation of food.

Prior to his present position Peter worked for 8 years as a production and factory manager in the food processing industry.

A Guide for Open Learners

This will help to explain what open learning is all about. It will help you to make the best use of your open learning module.

WHAT'S SO GOOD ABOUT OPEN LEARNING?

Open learning gives you freedom to choose.
You study:–

- What you like
- Where you like
- When you like
- At a pace to suit you.

You can pick the subjects you want. You don't have to be in a certain classroom at a certain time. You won't be bored because the teaching is too slow, or lost because it's too fast.

You seldom need any qualifications before you are allowed to study.

All this freedom lets you fit your studying into your daily routine.

The best thing about it for most people is that they can study without taking valuable time off work.

Modules are written in a way that allows you to study without help. However, it is expected that you will need assistance from time to time, this can normally be provided.

THINGS YOU SHOULD KNOW ABOUT YOUR MODULES

What is a module?

A module is the name we have given to a study package. It will have a printed text. In a few of them there will be audio or video tapes as well.

Each module will be divided into segments. You could think of each segment as a lesson.

Before you begin
Each module will have a short introduction. You will be given a list of things you will need. For some modules, special equipment will be needed. We can supply most of this. This section will also tell you if you need any knowledge or experience before you begin. Check that you have everything you need.

Objectives
Modules are based on objectives which tell you what you will be able to do when you have finished. These are clearly stated. You should check that the module objectives match your own reasons for studying. You will be told when you have achieved each one of the objectives. In this way you can easily keep track of your own progress.

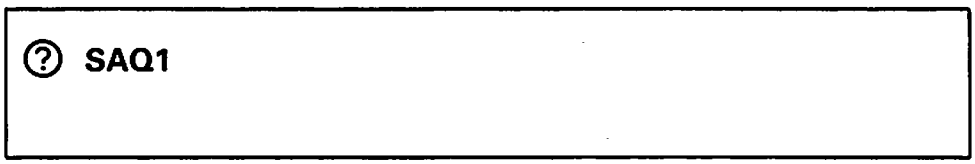
S.A.Q.'s
This is short for **self assessment questions**. These questions are carefully designed to help you. They let you know how you are getting on. They help you to find out any problems that you may be having with the material and help you to put them right.

Don't be tempted to skip these questions. Don't look at the answers before you try them! You will only be cheating yourself.

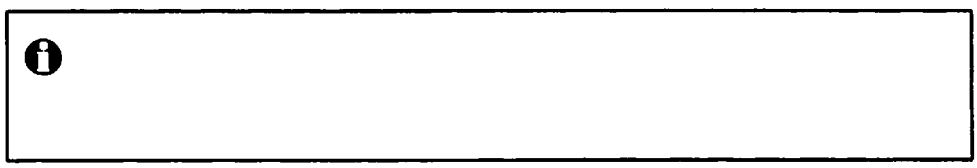
Where you are expected to write an answer, a space will be left in the text. Remember the module is your learning tool, not a textbook, so go ahead and write on it. **Don't** try to keep an answer in your head until you have checked it. **Always write down your answer first**. Writing the full answer down is very important, it makes you really think about what you are doing. The wide margins are also there for you to make notes in.

You will notice that the numbers given to the S.A.Q.'s are out of order. We did this on purpose. This is to stop you from accidentally seeing the answer to the second S.A.Q. when you are looking at the response to the first. The responses to the S.A.Q.'s are at the back printed on yellow paper. They are in the correct number order. I have called them responses because they are usually more than just answers. It is a good idea to read the whole response every time. It usually helps to know about common mistakes even though you got the right answer.

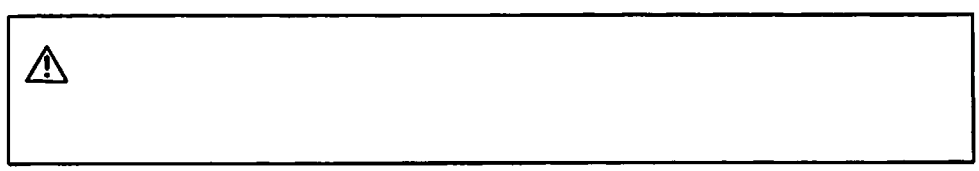
S.A.Q.'s are shown by a box with a question mark and the number of the question.



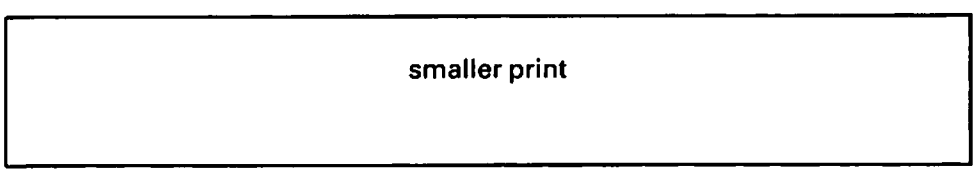
Important information
Other boxes are used to show different types of information. This box with the ℹ in the top left corner contains important information.



Warnings
This box with the warning sign gives information about possible dangers, health hazards, etc.



Definitions
A box with smaller print is used for definitions and extracts from documents.



Other emphasis
Shading like this is used to pick out important sentences and paragraphs.

Bold type is used to make **important words** or **numbers** stand out.

HELP IF YOU GET STUCK

At the time of obtaining your module you will be told of any support which can be arranged.

This might be through one of the following:

- Telephone
- Face to face meeting
- Letter
- Tutor marked assignment

Questionnaire
Some modules will be accompanied by questionnaires. The questionnaire is your chance to help us. Your answers are our way of finding out if any changes are needed. If there is one, please remember to fill it in and return it.

HINTS ON STUDYING

When?
Try to get into a regular study routine. Set aside times for study but be ready to give and take a bit. Miss one of your planned sessions if you must, but try to make it up later.

Set yourself realistic targets such as 'I will finish segments one and two by this weekend' and **stick to them!**

Grab the chance to study at odd moments. You'll be amazed how much you can learn in fifteen minutes. It's difficult for the average person to really concentrate for more than 20 minutes at a time anyway. A word of warning – don't think you can learn anywhere. You need to be able to concentrate, there are often distractions which prevent this.

- Time spent just **reading** a module is not the same as time spent **learning**.

- You must become involved, the best learning happens when you're active, e.g. answering questions and making notes.

- Don't study too long without a break.

This module will remind you of suitable places to stop for a while, but if you need a break earlier, take one. It's entirely up to you.

Where?
Try to find somewhere where you will not be distracted. Almost anywhere will do. It all depends on how you are placed at home and at work. Don't forget your local library. Fishermen might find their local mission is able to help, especially with video equipment.

The secret is, **be flexible**. If the kids are having a party, go to Auntie's. If she's not in, go to the library. All you need is somewhere where you can get on with it and not be disturbed.

Carry your module with you when you can. Try to find gaps in your normal routine when you could do some useful work.

Now that you've decided to have a go, **stick with it!** Don't give up. Most people find studying hard at times, this is quite natural. It is also quite natural to need help with parts that you find especially difficult. I'm sure you'll find it worthwhile.

Introduction

Welcome to this study module which describes the reasons for and the methods of chilling fish. The importance of correct handling of fish throughout the distribution chain is dealt with in the final segment.

The module should be useful to persons employed, not only in the chilling process and ice making, but also in the transportation and retailing of fish.

PRE-ENTRY REQUIREMENTS

There are no special entry requirements but an involvement in some area of the chilled fish chain is assumed.

EQUIPMENT REQUIRED

All that you will require is a pen or pencil in order to answer the self assessment questions.

Objectives

When you have completed this module you should be able to:

1. State the most usual causes of spoilage of fish and describe some of the processes and hygiene procedures which reduce spoilage.

2. Describe and compare some methods of cooling fish.

3. Describe methods of producing and storing different types of ice suitable for chilling fish.

4. Describe the main factors affecting the quality of fish during handling in the distribution chain.

Segment One

Why do Fish Spoil?

Segment One – Why do Fish Spoil?

INTRODUCTION

One of the most important points to be aware of when handling fish, is that fish is a very perishable material. As soon as the fish dies, the process of spoilage begins. Although this process is very complex, this segment will explain, in simple terms, some of these changes to you.

AIMS OF THE SEGMENT

The main aim of this segment is to help you to achieve Objective 1 given on page xiii. When you have finished this segment you should be able to:

- Explain why fish spoil;
- State the importance of gutting fish, in relation to fish spoilage;
- State the need to maintain good hygiene standards when handling fish;
- Explain the effects of temperature reduction on the rate of fish spoilage.

SPOILAGE

Spoilage occurs as a result of a series of changes in the tissues of the fish. Many of these changes are so slight, especially in the early stages after death, that only an experienced eye can detect them. These changes are **irreversible** and add together so that, over a period of time (from a few hours to a few days), changes in flavour, texture and appearance of the fish become much easier to see.

At some point in this chain of events, the customer will see the fish as being of 'lower quality' or even as 'unfit to eat'. Lower quality fish has to be sold at a lower price, and this is, of course, bad for business.

Spoilage changes in the dead fish are caused mainly by **enzymic and bacterial changes.**

WHAT ARE ENZYMIC AND BACTERIAL CHANGES?

Whilst the fish is alive, any food taken into its body is digested in the gut. Here the food is broken up into smaller units which pass through the walls of the gut into the bloodstream.

The bloodstream carries the broken down food units to different sites around the body, such as the muscles. Here they are built up into larger units or broken down to release energy to fuel movements of the fish. These complex changes or reactions proceed faster in the presence of small amounts of special **proteins** called **enzymes**. Enzymes occur naturally in the fish tissue, especially the gut, and are not destroyed immediately the fish dies.

Bacteria (bugs) are very small, living organisms which cannot be seen by the naked eye. In fact they are so small that over one million would fit onto a pinhead. Bugs are found practically everywhere in nature, including the skin, the gills and in the gut of the fish.

Whilst the fish is alive, its natural defence mechanisms prevent the invasion of these bugs into the fish tissues. So the bugs feed, grow and multiply on the surface of the fish without causing any damage. In fact many of these bugs are useful to the fish. For example, bugs in the gut help the fish to breakdown its food.

It is when the surface of the fish is damaged that the problems begin. Bugs invade the flesh, and start the process of decay. Similar problems occur when the fish dies.

Before we move on to a closer look at fish spoilage let's see how much you have understood about enzymes and bacteria. Try the following two SAQ's.

? SAQ8

Tick which of the following statements best describes the nature and function of **enzymes**?

a) They are living organisms which cause spoilage in fish.

b) They occur only in living tissues and cause spoilage of the fish.

c) They are proteins which accelerate chemical changes in the fish tissues.

d) They are found in the gut and help to produce energy.

? SAQ12

Mark the following sentences as **true** or **false.**

a) Bacteria are not found in the tissues of live fish.
true/false

b) Bacteria are so small that they cannot usually be seen without the aid of a microscope.
true/false

c) Bacteria found in fish cause it no harm.
true/false

d) If the surface of the fish is cut, bacteria can enter the tissues and cause decay.
true/false

HOW DO FISH SPOIL?

When the fish dies a whole series of irreversible changes begin. These changes result from a complicated series of breakdowns in the tissues.

Autolysis

Major changes are caused by the action of enzymes in the tissues, especially the digestive juices of the fish. The process is a form of **'self-digestion'** and is known as **autolysis.**

The end products of autolysis produce changes in flavour, texture and appearance of the flesh. The **flavour** of the fresh fish changes rapidly from a sweet, meaty flavour to a rather bitter, unpleasant flavour, and the fish spoils.

The **texture** of the fish changes dramatically within a few hours of death. The muscles harden and the fish becomes quite stiff. This stiffening is known as **rigor mortis** and is caused by **autolytic changes** in the muscles. The fish may remain rigid for periods of several hours to several days. Then the muscles begin to soften again, as further **enzymic changes** take place. In rigor, the fish may distort and begin to bend.

⚠
Rough handling at this stage, such as forcible straightening of the fish, must be avoided.

Bad treatment can lead to texture damage when the fish is filleted.

⚠
Filleting of fish pre-rigor or in rigor should also be avoided.

Once the fillet is removed from the bone, the fillet will shrink without a skeleton to support it.

The **appearance** of fish changes dramatically as the fish spoils. Changes can be observed in the appearance of the eyes, gills and skin. These changes may be used to estimate the quality of a sample of fish (see Segment Four).

Bacterial Spoilage

Many of these changes in flavour, texture and appearance may also be due to **bacterial spoilage**.

As we saw earlier, bacteria from the surface, gills and guts of the fish invade the tissues after death. These bugs 'feed' on the tissues breaking them down with enzymes from the bugs themselves. The bugs grow and multiply during storage of the fish.

- As they increase in numbers they produce a thick **slime** on the skin and gills of the fish.
- **Unpleasant odours** are also produced, often with a strong smell of **ammonia.**
- The flesh becomes softened and in ungutted fish, the gut wall eventually bursts.

This process of breakdown of dead tissues by bacteria, is known as **putrefaction.**

Chemical Changes

One final series of changes that can occur during spoilage is due to **chemical changes not involving enzymes.**

These chemical changes involve oxygen from the air and fat in the fish. In fatty fish such as herring or mackerel, these chemical changes produce **rancid odours and flavours.** Oxidation (rancidity) of fat is a major problem when fish is stored for long periods, even under frozen conditions.

SAQ16
In what ways does gutting help and improve the quality of many types of fish?

.....
.....
.....
.....

? SAQ20

Standards for fish working premises recommend that 'all working surfaces should be made from materials which do not soak up water and which can easily be cleaned.' What problems with fish quality might you expect to occur, if this simple rule is not carried out?

.....

.....

.....

HOW CAN FISH BE KEPT FRESH?

Spoilage begins as soon as the fish is caught. Freshness is soon lost. However, both bacterial and autolytic spoilage occur most at certain temperatures. For example, the bacteria and enzymes in fish from cold waters, are adapted to sea temperatures of between 5°C – 10°C. A reduction in fish temperature below this will reduce the rate of spoilage. The control of spoilage by reduction of temperature offers the most common and practical way of keeping fish fresh.

The lower the temperature the longer the fish will take to spoil.

Two methods of lowering temperature that are used by fish processors are:

- **Chilling** – the fish are held at a temperature as close to 0°C as possible **(but not below)**. Chilling should be regarded as a short term storage method. However, it can increase the storage life of some fish by between 14 – 21 days.

- **Freezing** – the temperature of the fish is reduced so that the water in the fish freezes. Usually temperatures of between –30°C to –18°C are used to store frozen fish. This enables the fish to be kept in good condition for much longer periods than chilling. (Freezing of fish is the subject of a separate module in this series).

? SAQ1

Which of the temperature histories, shown below, will result in the best quality fish reaching the consumer?

	(a)	(b)	(c)	(d)
Landing	0°C	0°C	0°C	0°C
Sale	5°C	0°C	1°C	0°C
Transport to processors	0°C	0°C	3°C	0°C
Filleting	10°C	0°C	4°C	0°C
Storage	0°C	0°C	5°C	5°C
			CONSUMER	

SUMMARY

- Changes in the fish due to spoilage are additive.
- Quality, once lost, cannot be regained.
- Temperature rises should be avoided as much as possible when handling fish.
- Chilling and freezing maintains quality if carried out correctly.

Well that brings us to the end of this segment. I hope that you have found it interesting and informative.

You have now achieved Objective 1 given on page xiii.

If you have found any of the sections difficult, read them again, before starting the next segment.

Segment Two

Methods of Chilling Fish

Segment Two – Methods of Chilling Fish

INTRODUCTION

In segment one you learnt that chilling is used to slow down fish spoilage and extend shelf life. I hope you remember that, for the best results, chilling must be carried out as quickly as possible and in a way that does not damage the fish.

In this segment we are going to look at different methods of cooling fish and why some methods are used more often than others.

AIMS OF THE SEGMENT

The main aim of this segment is to help you to achieve Objective 2 given on page xiii.

When you have finished this segment you should be able to:

- Recognise why ice is so widely used as a means of cooling fish;
- Identify how much ice is needed to cool a given weight of fish;
- Explain the disadvantages of chilling fish in cold air;
- State the differences between chilled seawater and refrigerated seawater and their application to chilling fish;
- Explain super chilling and its application to chilling of fish;
- Choose the most suitable method of chilling fish for different situations.

ICE

To chill fish we must surround them with materials which are colder than the fish itself. Ice is the most popular cooling material but cold air and cold water can also be used. If we are to use these materials properly, we need to understand how they work.

Let's look firstly at **ice**, which has often been called the **ideal cooling medium.**

Ice is a portable cooling system. It can be moved around from one place to another. It is formed when water freezes, at temperatures of 0°C.

For freezing to occur, large amounts of heat have to be removed from the water. This is removed by a refrigeration system. Before the ice is able to melt, this same amount of heat must be added back to the ice. This is a big advantage when using ice to cool fish.

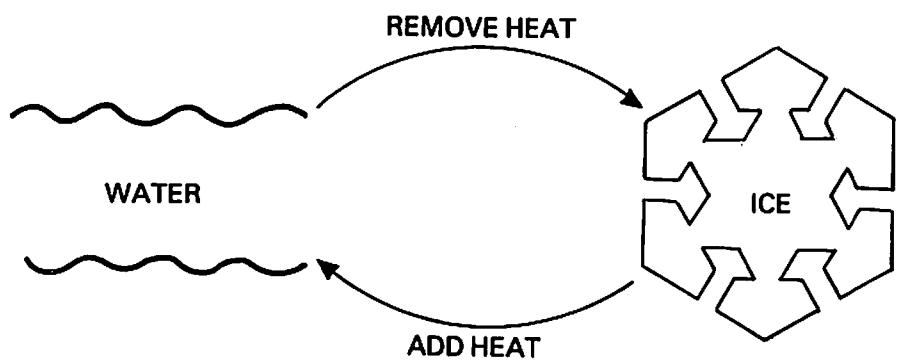


Figure 1.

Since ice will absorb large amounts of heat when it melts, it is said to have a **large cooling capacity** and so it can cool fish rapidly, if used correctly.

Just as water freezes at 0°C, ice will melt at a constant temperature of 0°C when heat is added to it. Thus melting ice, if present in sufficient amounts, will maintain fish at a temperature of 0°C. By the way, fish begin to freeze when the temperature is below 0°C, usually between –1°C to –2°C. **So fish in melting ice will never freeze.** This is important since freezing can affect the quality of the fish, unless it is carried out under very carefully controlled conditions.

Another advantage of ice is that the melt water, formed from the melting ice, flows over the fish and helps to keep the fish looking moist and shiny.

Now let's check if you have understood why ice is such a useful material for cooling fish.

? SAQ5

Which of the following do you think are good reasons for using ice to cool fish? Just tick **yes** or **no** as appropriate.

a) Ice can cool fish quickly when used correctly. yes/no

b) Ice is harmless to the fish. yes/no

c) Ice keeps the fish moist and shiny. yes/no

d) Ice will not freeze the fish. yes/no

e) Ice is a portable chilling system and is easily transported from one place to another. yes/no

f) Ice has a large cooling capacity. yes/no

So how much ice do I need to cool fish properly?

The quantity of heat to be removed from the fish will set how much ice is needed. Both depend on:

- The weight of fish to be cooled;
- The temperature of the fish at the start of chilling;

- The length of time the fish are required to be kept chilled;
- How much the fish and ice are protected from outside heat sources.

It is possible to calculate how much ice is required to chill fish, but in practice a rough guide is to use at least **1 part ice:1 part fish by weight** for the initial chilling. Extra ice can then be added as needed. It is good practice to always have some ice present at all stages of storage and distribution.

Now try this SAQ as a check that you understand how much ice you would need to use in practice.

? SAQ9

You have 250kg of ice available. Using the rough guide given above which of the following alternatives would be possible? Just tick the boxes beside the correct ones for both (i) and (ii).

(i) Which of the following weights of fish could you cool down to 0°C?

a) 100 kg ☐
b) 200 kg ☐
c) 250 kg ☐
d) 500 kg ☐

(ii) Which, if any, of the following weights of fish could you store at 0°C for 7 days?

a) 100 kg ☐
b) 200 kg ☐
c) 250 kg ☐
d) 500 kg ☐

COLD AIR

An alternative cooling agent to ice is chilled (refrigerated) air. Cold air passed over the surface of a fish will rapidly cool it.

In a chill room, heat from the fish will warm the air around it. The warm air rises and is cooled by the refrigeration system. This cold air then falls or is blown by fans, back to the fish surface.

Good circulation of air is necessary to maintain uniform temperatures in the fish in store.

Unfortunately 10,000 times less heat is required to warm a given volume of air from 0 to 0.5°C, than the same volume of crushed ice. Thus, compared with ice, large refrigeration systems and larger volumes of air are needed to cool a given weight of fish. Cooling with cold air is therefore generally more inefficient and more expensive than cooling with ice.

Now try this SAQ.

? SAQ13

Tick which of the phrases below correctly complete the sentence:

"Passing refrigerated air over fish in a chill room is a less efficient method of chilling than using ice because .....

a) A given volume of ice absorbs more heat than the same volume of air.

b) The air has to be circulated around the store.

c) The air only cools the fish containers.

d) Air has to be chilled before use.

Fish that are cooled in cold air soon become dry. This is because the air removes moisture from the fish surface causing loss of weight and loss of eating quality. The water travels with the air to the cooling coils where it is deposited as ice (frost). This can interfere with the cooling of the air, as it acts as an insulating layer. **The evaporator must be regularly defrosted to prevent this.**

Fish stacked high up in the chill room, close to the evaporator, will receive the coldest air. If the average store temperature is set at 1°C, the air temperature at the evaporator will be less than 0°C and the fish here may freeze.

Often chill rooms are used together with ice, which helps to slow down the speed at which the ice melts. It is important to remember that, for ice to cool effectively, it must be allowed to melt and the chill room temperature should not fall below 2°C to 3°C.

SAQ17

Cold air can be used for cooling fish, but which of the following problems might you expect to occur with batches of fish stored in this way? Indicate **yes** or **no** as appropriate.

a)	Loss of weight	yes/no
b)	Loss of eating quality	yes/no
c)	Uneven fish temperatures	yes/no
d)	Prolonged cooling time	yes/no

CHILLED AND REFRIGERATED SEAWATER

The immersion of fish in chilled seawater cooled by the addition of ice (CSW) or by mechanical refrigeration (RSW) can provide an alternative method of icing.

This chilling method is particularly useful for cooling large numbers of small fish at one time. It is sometimes used on board fishing boats fishing for pelagic fish such as herring, mackerel and sardine.

SAQ2

Use words from below to fill in the blank spaces.

..... is produced by chilling seawater by the addition of ice.

..... is produced by chilling seawater by the use of a mechanical refrigeration system.

Chilled seawater
Ice
Cold air
Refrigerated seawater

Ice, of course, can be produced from seawater, but only by freezing, not just chilling.

Icing of large numbers of small fish is slow and difficult to carry out properly. RSW and CSW provide a method which give:

- More rapid cooling;
- Less risk of damage to the fish during storage;
- Easy washing and bleeding of the fish in the seawater tanks.

A major disadvantage of RSW/CSW cooling is the salty flavour that results from absorption of salt from the seawater.

The increase in salt content of the fish also reduces the storage life of the fatty fish types, compared with ice.

SAQ6

Which cooling method is best for rapid, on-board chilling of large catches of pelagic fish?

.....

CHILLING

This is a chilling technique in which the temperature of the fish is reduced so that about **half the water** in the fish is frozen. This occurs between –2°C and –3°C and results in the shelf life of the fish being extended by **over 50%**. This extension of shelf life is mainly due to the lower temperature slowing down of the growth of bacteria on the fish.

Superchilling is sometimes used on board fishing boats to enable longer trips between landings. The chilling is carried out by cooling firstly in ice and then by cooling to below 0°C using cold air in a chill room.

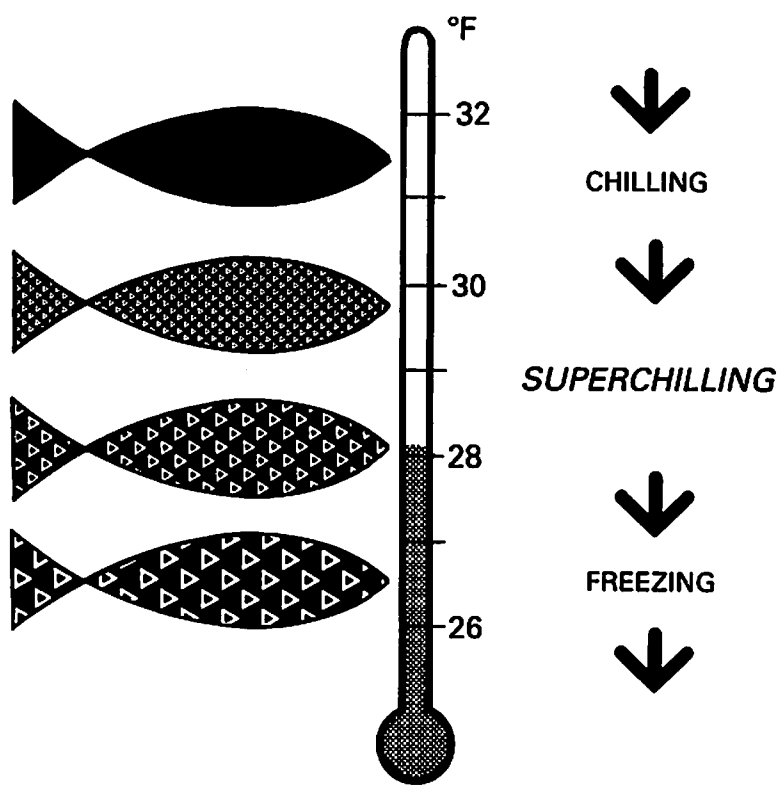


Figure 2: Chilling

Quality problems can occur if the temperature is not carefully controlled. Below –3°C more water will freeze in the fish and the texture will be affected. Because of this problem superchilling is not often used.

? SAQ10

Fill in the space from the alternatives given below.

"Superchilling requires fish to be cooled to ..... °C

a) 0°C
b) –2°C to –3°C
c) 10°C

SUMMARY

This segment has described the following methods of cooling fish:

- Use of ice;
- Use of cold air;
- Chilling and Superchilling. (including the use of seawater.)

I hope that you have found it instructive. You should now have a better understanding of the principles of different methods of cooling fish.

You have now completed Segment Two and achieved Objective 2 given on page xiii. Well done! Time for a break?

Segment Three

The Manufacture and Storage of Ice

Segment Three – The Manufacture and Storage of Ice

INTRODUCTION

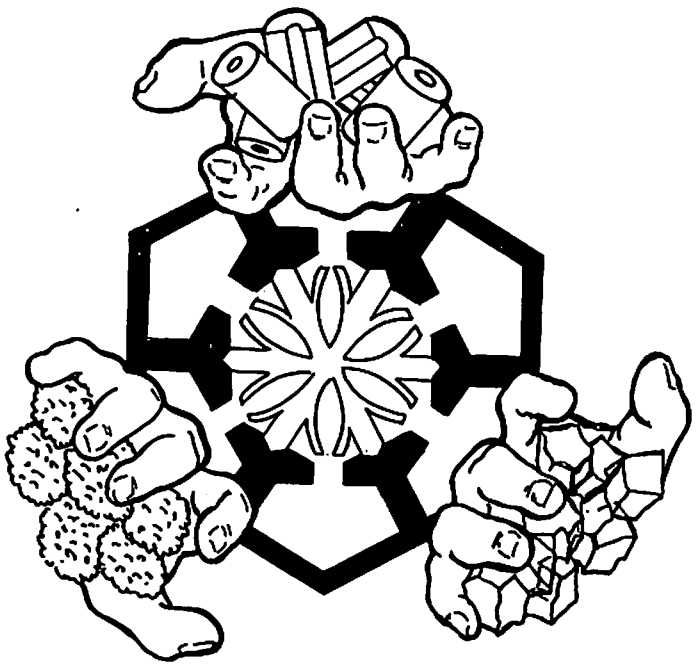


Figure 3.

We have seen, in the previous segment, why ice is popular as a cooling medium. This segment will help you to understand more about the different types of ice available, and how they should be stored correctly.

AIMS OF THE SEGMENT

The main aim of this segment is to help you to achieve Objective 3 given on page xiii.

When you have finished this segment you should be able to:

- State the characteristics of the different ice types;
- Describe the basic methods of ice storage;
- State the problems associated with storing ice.

WHAT TYPES OF ICE ARE AVAILABLE?

Ice is often made in the form of lumps or blocks, of various weights from 10 to 200 kg. Alternatively, ice may be made in the form of smaller pieces (granular ice). Different types of granular ice exist such as, flake ice, tube ice, and plate ice.

WATER FOR ICE-MAKING

Ice should always be made from water which is fit to drink. Water which is unfit to drink will contain bugs which are harmful to our health. These will infect the fish as the ice melts.

When fresh water is scarce or unavailable, **seawater may be used instead.**

However, problems may occur:

- The fish will take up salt from the ice;
- Fish cooled in seawater ice may become partly frozen because the freezing point of seawater is lower than that of pure water.

Fish held for periods in this partly frozen state will show poor quality texture.

HOW IS LUMP ICE MADE?

The water to be frozen is filled into large metal moulds, which are left in a large tank of refrigerated brine for up to 24 hours. (Figure 4). When the ice blocks are completely frozen, they are removed from the freezing tank and dipped into hot water. This melts the surface of the block so that it can be tipped out of its mould.

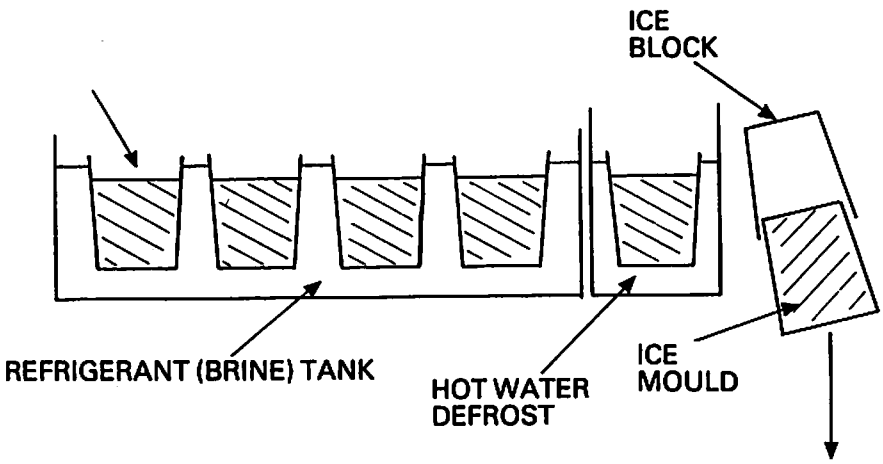


Figure 4: Production of Lump Ice.

The moulds can then be refilled with water, and then returned to the freezing tanks. The large ice blocks may then be broken down into smaller pieces in a crushing machine. (Figure 5.)

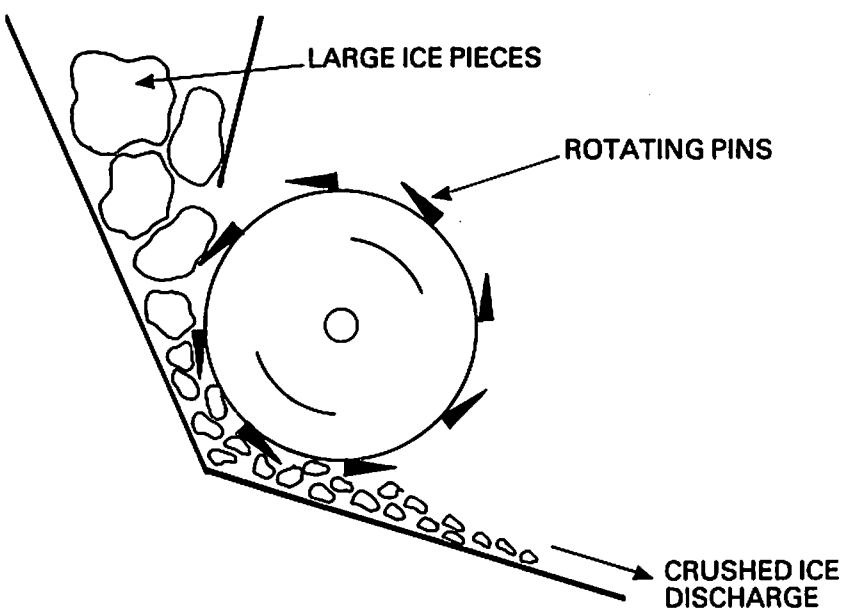


Figure 5: The crushing machine.

The final size of the crushed ice is important.
Large pieces:

- Make poor contact with the fish they are meant to cool;
- Melt less rapidly and cool the fish more slowly than smaller pieces;
- If they are irregular shapes they can also mark and bruise the fish.

Smaller pieces are easier to move around by mechanical, pneumatic or gravity distribution systems.

Now, check to see if you have understood why lump ice needs to be crushed before use by attempting the following SAQ:

? SAQ14
Which of the following do you think are reasons for crushing lump ice? Just tick **yes** or **no** as you think.

a)	So that it melts more slowly	yes/no
b)	To make it easier to handle	yes/no
c)	To prevent damage to the fish	yes/no
d)	To help chill the fish rapidly	yes/no

HOW ARE THE GRANULAR TYPES OF ICE MADE?

The most common type of granular ice is **flake ice.**

This is made by spraying water onto the surface of a rotating, refrigerated drum (Figure 6). The water freezes into a 2-3mm thick layer of ice. This is scraped off the drum as dry flakes of ice.

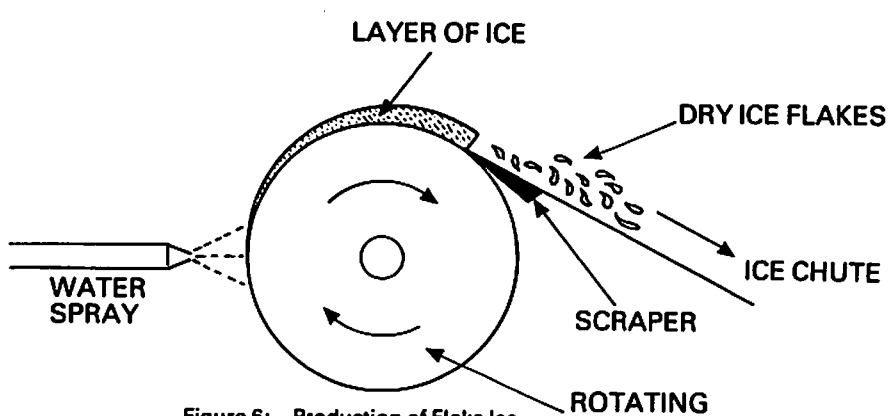
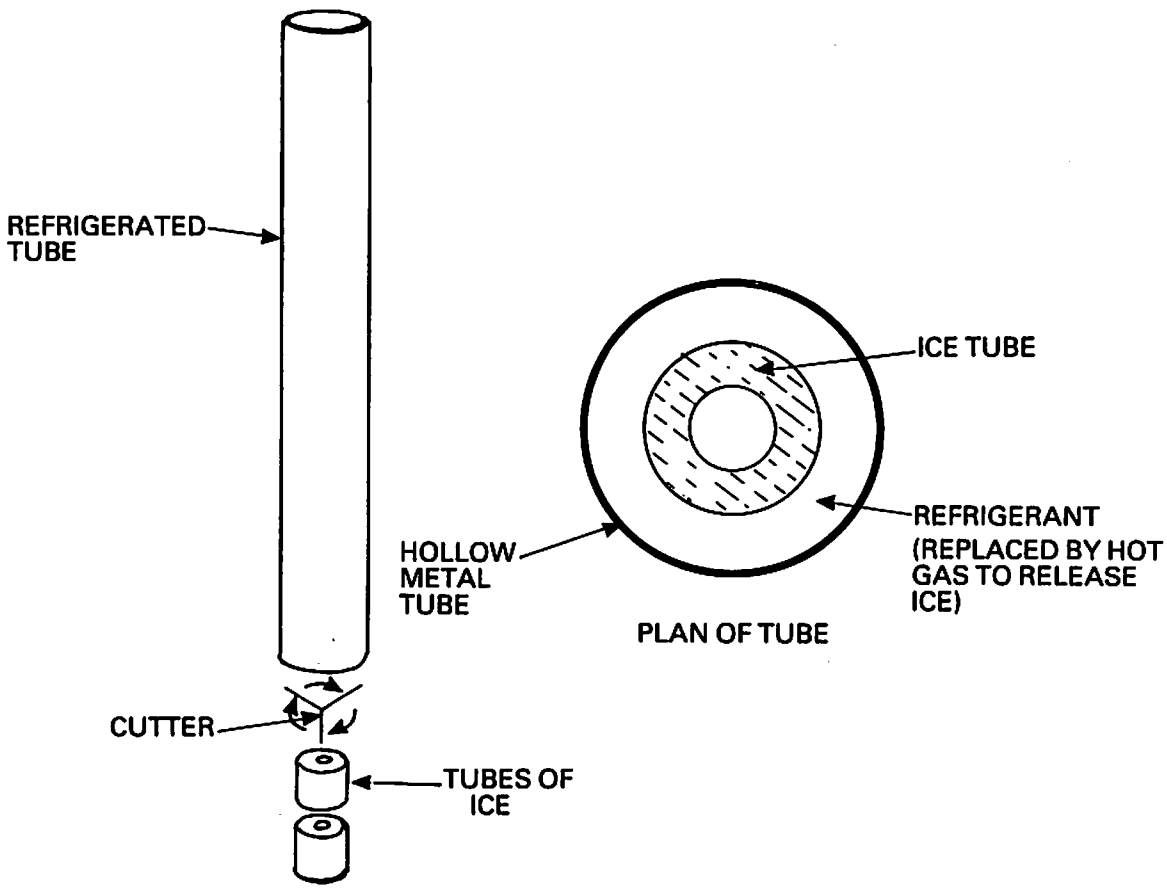


Figure 6: Production of Flake Ice.

Tube ice is made by freezing water onto the inner refrigerated surface of long metal tubes. (Figure 7). The hollow cylinders of ice are then released by passing a hot gas into the tubes, in place of the refrigerant. The tubes of ice are broken into smaller pieces as they fall through a cutter beneath the tubes.



STORAGE SPACE FOR DIFFERENT TYPES OF ICE

Apart from differences in shape, large variations in size can be seen. Granular ice is usually no larger than 1½" long by ½" diameter (tube ice). Often, it is much smaller, for example flaked ice (1" x 1" x ¼"). Crushed lump ice is more irregular in shape and size, varying from ¼" to 3" in diameter. You will remember from the previous section that large, irregular pieces of ice can cause damage to the fish.

Density

Differences in partical size and shape account for differences in the space required to store different types of ice. Equal weights of different ices do not occupy the same volume. The weight of a given volume of ice is expressed by the **density**. It is usual to record density of ice in tonne per cubic metre, but other units of weight or volume may be used.

To see if you have understood this term density, try this SAQ.

? SAQ18

The density of crushed block ice is given by:

a) Weight divided by volume;
b) Volume divided by weight;
c) Volume added to weight.

Tick the correct answer.

Stowage rate

Now that you understand what density is, you need to understand the meaning of **Stowage Rate.**

This is given by the relationship 'cubic metre per tonne' which means that Stowage Rate is volume divided by weight.

If you compare this to the expression for density you will see that:

$$\text{The volume occupied by 1 tonne of ice} = \frac{1}{\text{Density}}$$

and therefore $\frac{1}{\text{Density}}$ is called the **stowage rate**

The following table shows the different **stowage rates** (and densities) of the various types of ice.

Type of ice	Density (tonne/m^3)	Stowage rate (m^3/tonne)
Flake ice	0.45 – 0.43	2.2 – 2.3
Tube ice	0.66 – 0.5	1.5 – 2.0
Block ice	0.71	1.4
Crushed block ice	0.67	1.5

? SAQ3
You have a box of fish with a limited space for ice in the box. Which type of ice would you use to give the greatest cooling capacity?

.....

STORED ICE

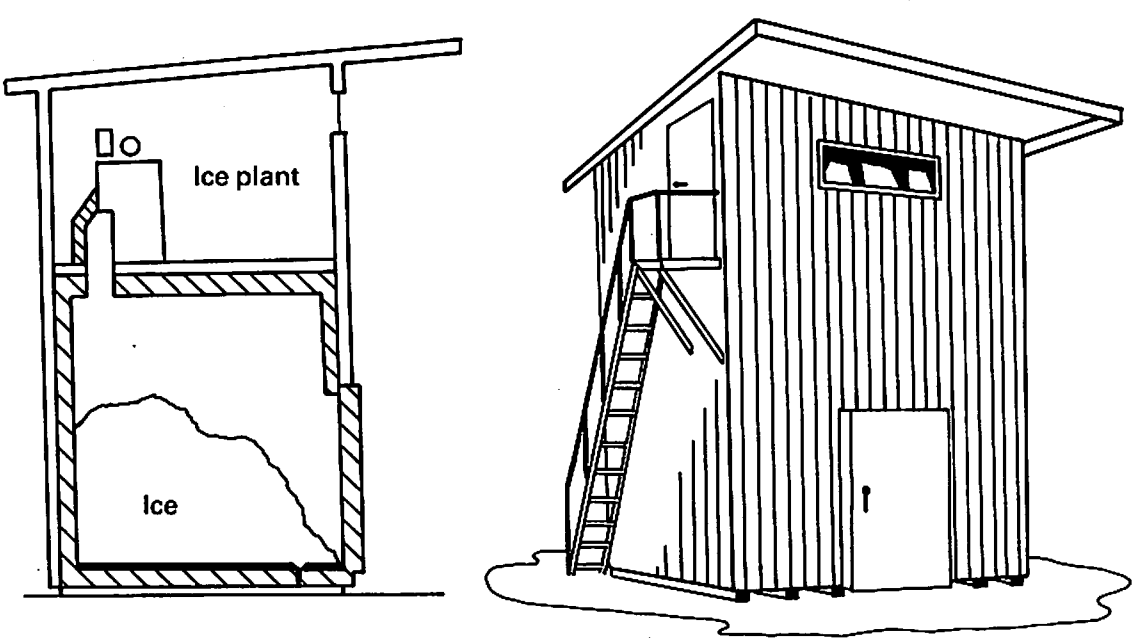


Figure 8: Simple Bin Store.

Flake ice, which is removed mechanically from the refrigerated surface is dry. This type of ice has a temperature below 0°C and is said to be **sub-cooled.** Dry ice should be stored below 0°C to keep its free flowing properties.

But why store ice?

A stock of ice needs to be held available during each 24 hour period to:

- Meet the varying demands of customers;
- Ensure that the ice plant is as fully used as possible during the period;
- Provide a safeguard against breakdown of the ice making plant.

Up to 2 days production capacity will be held in store. Of course the size of different ice stores will depend on the:

- Operating pattern of the company;
- Type of ice being produced.

So how are the different types of ice stored?

Lump ice is generally stored in blocks in a chill room at below 0°C. The blocks must not be stored touching to prevent them freezing together.

Granular ice may be stored in:

- Insulated containers of between ½ to 1000 tonnes capacity.

This type of storage is useful for crushed block or tube ice, i.e. 'wet' ice released by defrost from its mould.

- Insulated and refrigerated containers. The refrigeration permits dry ice to keep its free flowing properties. This is an expensive method of storage. It is generally used for large amounts of ice, between 40–100 tonnes.

SAQ7

What problems would you expect if granular ice is stored in a poorly insulated container?

.....

.....

.....

What other problems are likely during ice storage?

Most problems in ice storage arise from **compacting and fusion** of the ice particles. This produces clumps which are difficult to handle. Apart from the effects of wet ice mentioned above, fusion can occur due to pressure.

To avoid these problems it is useful to remember to:

- Clear storage containers completely at regular intervals.
- Avoid filling containers with a greater depth than 5m of ice.

SUMMARY

You will see, from the previous sections, that different types of ice have much to commend them.

Flake ice causes less physical damage to the fish and melts more rapidly than other types of ice. However for the large scale production of ice, it is probably difficult to find a cheaper method than the lump ice system. For small to moderate quantities the granular ice systems become much more competitive.

In the end, it is usually cost, rather than the ice properties, which determines a particular ice making system.

However, whatever ice you use, remember **you can never use too much to keep fish cool and fresh.**

You have now completed Segment Three and achieved Objective 3 given on page xiii.

Well done! A good time for a break.

Segment Four

Handling of Fish in the Distribution Chain

Segment Four – Handling of Fish in the Distribution Chain

INTRODUCTION

Welcome to this final segment of the chilling module. In earlier segments we have looked at why it is important to keep fish cool and the different chilling methods available. In the previous segment we examined the manufacture and storage of different types of ice. In this segment, we will look at ways of improving the handling of chilled fish at all points in the distribution chain.

AIMS OF THE SEGMENT

The main aim of this segment is to help you to achieve Objective 4 given on page xiii.

When you have finished this segment you should be able to:

- State the factors influencing the quality of fish in the distribution chain;
- Describe the application of good hygiene methods to handling fish.
- State the importance of applying the principles of correct handling and icing of fish to your own work situation.

WHAT IS 'THE DISTRIBUTION CHAIN'?

This is the name given to the series of steps, through which the fish is passed, from landing at the port to the final point of sale.

The distribution chain can be long, and involve many stages as shown in Figure 9.

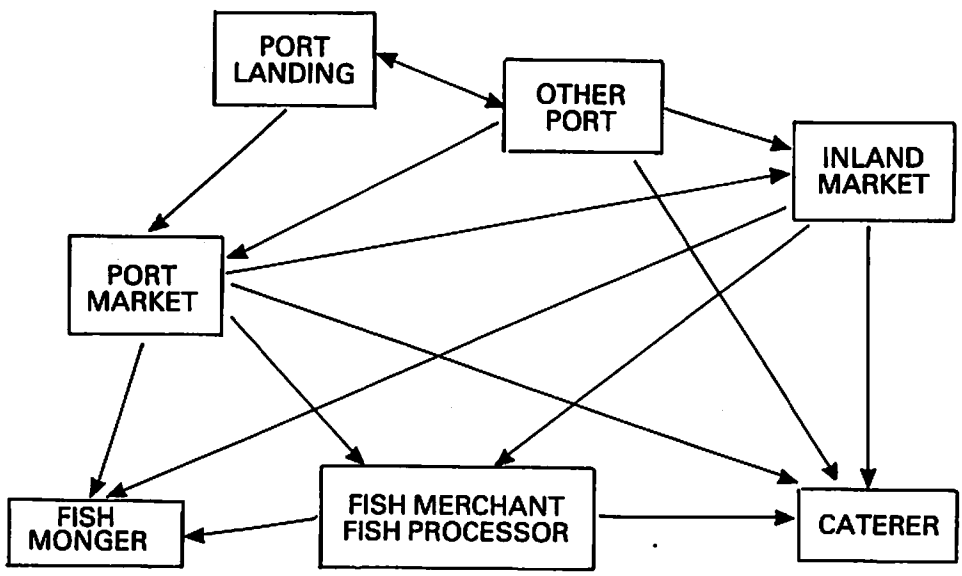


Figure 9: The Distribution Chain for Chilled Fish.

Distribution nowadays in the UK is mainly by road, since this is the quickest method. This has largely replaced distribution by rail in the last 15 years. However, whatever distribution method is used, if the fish is to be kept fresh it must always be taken by the **most direct route** and with the **minimum of delay.**

MAINTAINING 'FRESHNESS' IN THE DISTRIBUTION CHAIN

Now, I hope you remember that the 'freshness' of fish depends on the **temperature** at which it has been kept, as well as the **time** since it was caught. Fish can rapidly become stale during distribution if conditions are not carefully controlled.

Unfortunately distribution conditions may vary considerably so it must be expected that the freshness of fish may vary.

Therefore it is very important to check the freshness at every stage of distribution. This is particularly important at points in the distribution chain where the fish is bought and sold.

HOW IS 'FRESHNESS' JUDGED

The 'freshness' of whole fish may be assessed by appearance and smell. Some of the characteristics of 'fresh' fish are shown in Table 1 below.

Characteristic	Description
Eyes	Bright and bulging, not sunken or cloudy.
Gills	Bright red or pink.
Skin	Bright
Slime	May be present on skin or gills. Should be clear or colourless.
Odour	Gill odour should be sharp and seaweedy.

Table 1

The appearance deteriorates as the freshness of the fish is lost. Some fatty fish, such as herring, begin to show signs of deterioration by bursting of their bellies. The odour also changes from 'seaweedy' through 'neutral' to a characteristic 'stale' or 'fishy' smell.
Some fish, such as dogfish or skate, begin to smell very strongly of ammonia as they deteriorate. Skin and gills become dark, and any slime present becomes discoloured.

During distribution fish may be processed into fillets or steaks. The quality of fish in this form may also be assessed by appearance. Naturally, this is more difficult than with whole fish, as there are fewer characteristics to judge but Table 2 will give you a few pointers to look for.

Characteristic	Description
Flesh	White, clear, with discolouration especially around the bone in a steak.
Texture	Firm and Springy.
Odour	Clean and sharp.
Skin (if present)	Smooth. Any slime should be clear and not discoloured.

Table 2.

The changes in appearance of the skin during spoilage are similar to those in whole fish. The texture is also a particularly good indicator of 'freshness'. Flesh which is limp and soft, and holds the marks of fingertips, when gently pressed, can be assumed to be stale.

CLEANLINESS AND HYGIENE

I hope that you also remember, from Segment One, that **hygiene in fish working premises is very important.** Fish that are heavily contaminated with bacteria will spoil more rapidly than less contaminated ones, at the same temperature.

So, all equipment which comes into contact with fish must be kept thoroughly clean. The cleaning process can be divided up into **five** easy steps, see Table 3.

Characteristic	Purpose
1. Rinse with cold water.	Remove much of the loose 'dirt', such as blood, slime and fish waste, from the surface of the equipment. Makes Stage 2 easier.
2. Wash with 'hot' detergent solution with vigorous brushing.	The detergent helps to break up stubborn fish deposits on equipment. Detergent suppliers will advise on a suitable detergent. It is preferable that the detergent solution is as hot as possible, and so the use of gloves is desirable. Brushing is important as it helps to remove difficult deposits as well.
3. Rinse with hot water.	Ensure that the water is as hot as possible. Rinsing washes away the detergent and the remaining fish waste. The equipment should now **look clean.**
4. Disinfection or sterilisation.	Sterilisation must be carried out to kill any remaining bugs. The surface may look clean, but it will still be contaminated with bugs. Sterilisation may be carried out using hot water or steam but this may be difficult to control. For small scale operations it is easier to use chemical sterilants. Detergent suppliers will advise on a sterilant which is suitable for your application and equipment. They also advise on the method of use. This method of sterilisation depends on concentration and contact time. **Do ensure that you control both carefully.**
5. Rinse with cold water.	Wash away all traces of sterilant to prevent corrosion of equipment and contamination of fish.

Table 3.

Each step must be carried out thoroughly to prevent contamination of the fish by spoilage and disease producing bugs. Cleaning is best carried out **immediately** after the equipment has been used. Fish deposits soon dry onto surfaces and become very difficult to remove.

Equipment surfaces should be easy to clean. Smooth surfaces are best. Stainless Steel provides a very suitable surface, but such equipment is expensive. Corrosion of surfaces, which can occur under special circumstances, must be avoided. Smooth surfaces will become rough and pitted, and more difficult to clean.

⚠
Wood, although this is commonly used for fish filleting boards, should be avoided.

The open surfaces is very difficult to clean effectively. Plastic is a preferred alternative for filleting boards. However these should be renewed if they become deeply scored.

SAQ11

Have a look at the picture below. Can you spot any problem areas where cross-contamination between uncooked and cooked fish may occur?

.....

.....

.....

Personal hygiene is every bit as important as keeping equipment clean. The rules are simple and should be followed by all.

- Keep hands clean.
- Wash hands after every visit to the toilet.
- Keep hair covered and wear clean protective clothing.
- Have protective clothing cleaned regularly.

WHAT IS THE BEST WAY TO HANDLE FISH DURING DISTRIBUTION?

Everyone who handles chilled fish, has a responsibility to treat it with care. It may only be a 'dead fish' to you, but it is 'food' to someone else.

We all have a personal responsibility. We can no longer say that 'quality' is somebody else's problem! You must ensure that **you** handle fish correctly. Job satisfaction is important to everyone. If, at the end of the day, you can honestly say to yourself, 'all the fish I have handled today have been given the best possible treatment', then that is a job well done.

It does not matter what stage of the distribution system you work in, the general rules for handling fish are the same. Only the situations are different.

The point of having a general set of rules is that they can be used by everyone, wherever they work. They are also easier to remember.

Now try this next SAQ.

? SAQ15

You want to make sure that you are handling your fish correctly. Draw up a list of **five** rules which will help to keep fish as fresh as possible in the distribution chain.

.....

.....

.....

.....

.....

KEEPING COOL DURING DISTRIBUTION

Icing

Icing is probably the most satisfactory way of cooling fish. Although any convenient method may be used, the fish must be cooled **quickly**. Remember chill rooms or vehicles are **not** designed to cool fish, only to hold them at the temperature at which they are put into the store.

What is the correct way to use ice?

Fish are iced for two reasons:

- To remove heat from the fish and cool it down to 0°C;
- To remove heat entering the fish container from the surroundings.

However, time must be allowed for the fish to lose heat. Furthermore, the greater the distance of the fish from the ice, the longer it will take to cool. A layer of fish 1 inch thick, iced on either side will take about 2 hours to cool from 10°C to 5°C. Whilst a fish layer 2 inches thick will take about 8 hours to cool to the same temperature.

? SAQ19

Which of the following statements is correct?

1. The thicker the layer of fish the faster it cools.
2. Doubling the thickness of the fish layer, doubles the cooling time.
3. If the thickness of the fish layer is doubled, it will take four times as long for the centre to cool.
4. The rate of cooling at the surface of the fish layer is the same as at the centre of the fish layer.

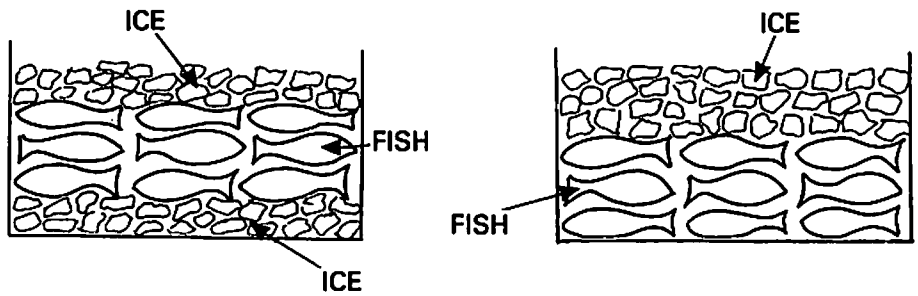
.....

.....

So packing fish in ice must be carried out correctly. Ideally, the fish and ice should be well mixed. Small pieces of ice are best. Sufficient ice should be used so that some ice is present when the fish reaches its destination. Finally, if the ice is not melting, it is not absorbing heat, and so is not cooling the fish.

? SAQ4

Which of the following will cool the fish most rapidly?



(a) (b)

Can you explain why?

How could you improve this icing method further?

.....

.....

.....

.....

.....

.....

AVOIDING CONTAMINATION IN THE DISTRIBUTION CHAIN

Remember fish spoil quickly. Contamination with bugs or enzymes from guts or other spoiling fish, will make the fish spoil even faster.

Contamination can occur in many different ways. The secret of avoiding or reducing contamination is to recognise situations where it is likely to occur. The general rules are:

- Separate 'good' from 'bad';
- Clean all work surfaces and equipment thoroughly after use.

Now let's look at some typical situations.

All of the following practices will help to reduce contamination.

- Separate fish caught at different times.
  Fish caught at different times will be at a different state of spoilage. The older fish would therefore contaminate the freshest, if they were not separate.
- Separate small fish from large fish.
  Small fish spoil faster than large fish.
- Separate fish with 'soft bellies'.
  'Soft belly' is a sign of spoilage. So these fish will be spoiled more than the others. Also there is a risk of contamination with guts, if the belly were to burst.
- Separate guts and fish.
  Of course guts contain large quantities of the bacteria and enzymes which cause spoilage. So they must be kept separate from the fish.

Now, we can look at some more examples of 'good' practices.

- Use clean, plastic boxes for distributing fish.
  All too often fish boxes are dirty. The older wood type are difficult to clean and harbour many bugs. Re-usable fish boxes should be cleaned regularly to remove contamination.
  By the way, the single use cartons, made of waxed paper board in which fish is often distributed from the fish merchants, must not be re-used. This type of container is not designed to be cleaned.
- Do not re-use surplus ice, left in fish boxes after distribution.
  Surplus ice will of course have become contaminated during distribution. As this melts it would contaminate the fish with bacteria and enzymes.

- Do not put fish directly on the ground.
  Would you eat any food if it had been lying around on the ground? Bacteria from the ground can also be dangerous to health, as well as causing fish spoilage.
- Do not mix different species of fish during distribution or storage.
  Flavours, odours and skin pigments are easily transferred from one species to another. Skate and dogfish, for example, produce ammonia when they spoil, which easily taints other fish.

I hope by now the explanations are becoming fairly obvious. That means you have really understood the principles involved.

FROM PRINCIPLES TO PRACTICE!

Everyone can make some contribution to improving the way in which they handle fish. To put into practice those principles I have discussed in this module involves:

- Understanding those principles;
- Being familiar with individual working practices.

It is important that you should try and put these principles of handling fish correctly into practice in your own area of work. If you are just starting a business involving handling fresh fish, it will help you to adopt good practices into your method of working rather than developing bad ones.

GOOD HANDLING GUIDE

Here is a list of some do's and don'ts that apply in some different areas of the distribution chain.

Fish merchants and processors

Do buy the best quality fish.

Don't leave boxes of fish lying around on the market or on your premises. Remove them quickly and keep them cool.

Do ensure all surfaces and equipment are kept clean and hygienic.

Don't throw or tread on fish. Handle them gently.

Do separate different types of fish to avoid tainting.

Don't use chill stores to cool down fish. They are not designed for this and ice does it better anyway.

Do rotate stock properly, operating first in first out policy to ensure fish is moved quickly to the next distribution stage.

Don't store waste and offal near fish working areas. This will encourage flies which can carry disease and introduce bugs onto the fish.

Do ensure fish is adequately iced before despatch.

Don't fill boxes so full that fish get crushed.

Depot Handlers

Do ensure fish are kept at 0°C. Use plenty of ice.

Don't leave fish lying around in the reception area. Move them quickly and keep them cool.

Do keep the reception and storage areas clean and tidy.

Don't walk on boxes or throw fish around. Handle them gently.

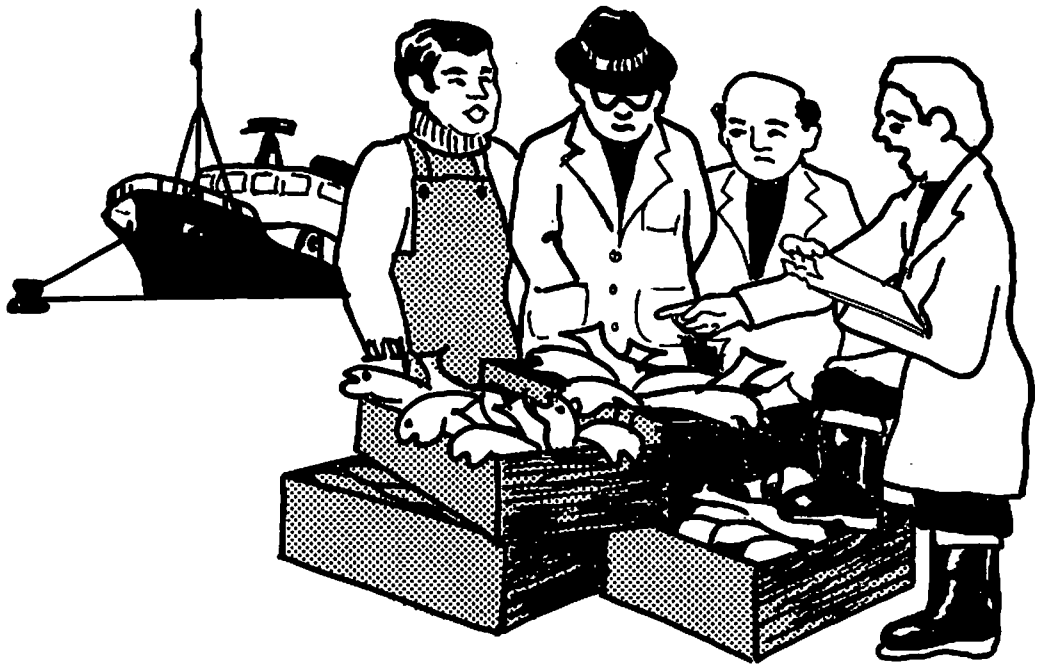


Figure 10.

Do rotate your stock properly. Operate first in, first out policy.

Don't leave fish uncovered and unattended.

Do avoid contamination of the fish from cats, dogs, birds, etc. Keep fish covered.

Don't accept deliveries outside normal working hours without making special and specific arrangements with the hauliers.

Do stack fish boxes carefully to avoid damage to the fish.

Don't accept delivery of uniced fish.

Don't mix types of fish and product. This can result in cross-contamination.

Don't let wet fish drip onto smoked or cooked fish.

Road Transportation

Do ensure that the fish is transported as close to 0°C as possible. Use plenty of ice.

Don't allow fish to become contaminated during transport, e.g. cats, dogs, birds, etc. Take particular care with uncovered vehicles.

Do use refrigeration as instructed.

Don't climb over boxes for access. Handle the fish gently.

Do take care in stacking and loading of boxes onto the vehicle.

Don't leave deliveries uncovered and unattended in the open. This is particularly difficult with early morning deliveries. If necessary make special arrangements with the customer to keep the products cool and uncontaminated.

Do keep your vehicle clean.

Don't carry offal at the same time as fresh fish.

Do avoid direct sunlight on the load.

Don't delay. Delays mean deterioration in quality.

Don't mix types of fish and product. This can result in cross-contamination.

Don't let wet fish drip onto smoked fish or cooked fish.

Fish Retailers

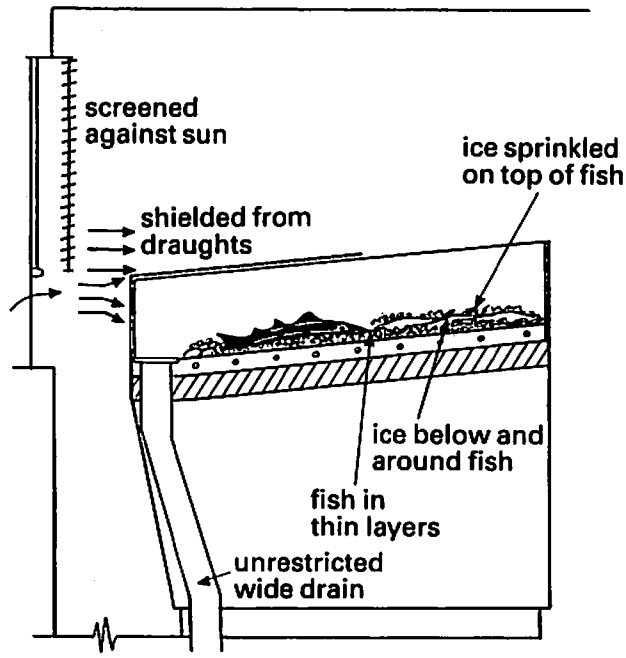


Figure 11: Fresh fish, ideally displayed on ice.

Do keep wet fish on display cool and moist by using plenty of ice.

Don't buy poor quality fish. Reject any fish not up to standard.

Do re-ice fish on receipt from fish merchants.

Don't use refrigerated slabs without ice. Problems with using refrigerated slabs without ice include drying of fish surface and partial freezing of fish.

Do avoid the effects of direct heating from lights and wall heaters on your fish display.

Don't put warm fish onto refrigerated slab. It is not designed to cool the fish. Cool the fish first with plenty of ice.

Do keep the slab and utensils clean. Follow correct cleaning procedures and clean regularly.

Don't re-use empty fish boxes. They are not designed for re-use and cannot be cleaned properly.

Do serve fish from display first to ensure good rotation of stock and rapid movement of fish onwards in the distribution chain.

Fish Caterers

Do only buy the best quality fish. Reject any fish not up to standard/specification.

Don't accept any fish not properly iced.

Do order regularly. Daily turnover of fish is essential if quality is to be maintained.

Don't store fish in refrigerator or chill store without covering with ice.

Do ensure that the ordered species of fish is not substituted for another by the supplier.

Don't allow melt water from the ice to build up around the fish during storage. Fish lying in this water and blood will spoil rapidly.

Do insist on delivery of fish in clean, new boxes.

Don't mix different species together, (avoid contamination problems with odour and colour).

Do clean all equipment and surfaces immediately after use, using a properly designed cleaning procedure.

Don't allow fish to lie around the premises without proper icing.

SUMMARY

This segment has dealt with the following points:

- A typical distribution chain has been described;
- The usage of freshness of both fish and fish fillets have been listed;
- The cleanliness of equipment has been stressed together with details of a cleaning programme;
- The importance of personal hygiene has been stressed;
- Correct handling procedure in parts of the distribution chain has been described.

You have now completed the module and achieved all the objectives set out on page xiii.

I hope that what you have learnt has been interesting and useful. Perhaps you are saying to yourself – 'most of that is commonsense'. If you are, then the unit has been successful. After all, you can only apply commonsense, when the principles of the subject have been clearly understood.

Good luck with your job and I hope that you feel you can really ensure that the fish you handle will be of the best quality all the time it is in your work area.

Responses To the Self Assessment Questions

Responses to the Self Assessment Questions

SAQ 1

I hope you decided that (b) showed the temperature history that would best maintain the quality of the fish for the consumer.

The wide variation in temperature seen in (a) would result in rapid spoilage.
A steady rise in temperature as shown in (c), through processing and distribution, will result in a steadily increasing rate of spoilage.
Up to the final storage stage the temperature in (d) would be low enough to maintain the quality of the fish. At 5°C spoilage is faster than at 0°C.

SAQ 2

I hope that you managed to complete the sentence as follows:

> Chilled seawater is produced by chilling seawater by the addition of ice. Refrigerated seawater is produced by chilling seawater by the use of a mechanical refrigeration system.

SAQ 3

I expect that you have indicated that you would use **crushed block ice** or **tube ice.** If not look again at Table 1.

Remember that cooling capacity is related to **weight** and **not volume** of ice. So, to give the greatest cooling capacity in a limited space, **you must use a high density ice.**
Uncrushed ice and tube ice would damage the fish, so this would not be satisfactory. Crushed ice and tube ice would be used in preference to flake ice, because their density is higher.

SAQ 4

(b) is the best of the two methods. It reduces the thickness of the fish layer being cooled, and therefore, cools the fish faster.

Improving this icing technique is to make cooling take place even faster. This can only be achieved by mixing the fish and ice more thoroughly. That is, by reducing the distance between the fish and ice as much as possible.

SAQ 5

I hope that you felt that all of the statements were very good reasons for using ice to cool fish. However, remember that (d) is true only when the ice is melting.

Ice can be supercooled after freezing to below 0°C and, at this temperature, can cause localised freezing of the fish.

SAQ 6

I expect that you have written something to the effect, that CSW or RSW are the best methods for cooling this type of catch.

Icing of this type of catch is laborious and is likely to damage the fish by crushing.

SAQ 7

Now let's see what problems you have thought of. The series of changes would be as follows. At first, the heat entering through the insulation will melt the ice surface. The pieces of wet ice will clump together, (at the sides or floor of the containers). This will lead to problems in removing the ice from the container.

After a while, much of the ice will have turned to water. The speed of this change depends on how poor the insulation is. Much of the cooling value of the ice will also have been lost. Remember, a slushy moisture of ice and water should not be compared with an equal weight or volume of ice alone.

SAQ 7 contd.

Well, I hope you managed to think that problem through. If you were successful, well done. If you didn't get all the answers, read my answer carefully and think of the effects of heat on ice.

SAQ 8

(a) This statement is not really correct, since enzymes are not living organisms. They are found in the tissue of living organisms, and assist in many of the chemical changes occurring there. They are also responsible for some of the spoilage changes, that occur in fish after death.

(b) This statement is not quite true. Although enzymes are found in living tissues, they are also found in the dead fish. Whilst the fish is alive, the enzymes help changes such as the digestion of food and production of energy. When the fish dies, the enzymes in the tissues cause the fish to spoil.

(c) Yes, well done. Enzymes are proteins, which accelerate chemical changes in the fish tissues.

(d) This is not the best answer, as it only partly describes the nature and function of enzymes.
Enzymes are found in all living tissues, not just the gut. It is true that some enzymes help to produce energy, but generally they have a wider range of function that this.

SAQ 9

(i) If you have ticked a, b and c then you have probably guessed correcty. There will be sufficient ice for (d) to cool the fish properly, assuming a fish:ice ratio of 1:1.

(ii) The answer is **No** to all the questions as the heat from the surroundings over a 7 day period would quickly melt all the ice and then cause the fish temperature to rise. Extra ice must always be added after the initial cooling to keep the fish at 0°C during storage.

SAQ 10

I hope you gave (b) as your answer. If you chose (a) this would be the same as chilling using ice.

If you chose (c) you would freeze the fish to an extent that the eating quality would be reduced.

SAQ 11

Our fishmonger has some extremely bad habits – don't you agree?

Cooked and uncooked fish should always be completely separated.

Separate tools e.g. knives, scales etc. should be available and used for the two types of product.

Ideally separate staff should be used for handling each type of product. Cross-contamination can easily occur by touching, and be transferred to protective clothing, e.g. apron.

SAQ 12

(a) **True.** Unless the tissues are damaged, bugs cannot get into the tissues of the fish. Even bugs in the gut, are not found in the gut tissues. They form part of the gut contents.

(b) **True.** Bacteria are so small that they cannot be seen with the naked eye. A microscope must be used to magnify the size of these very small creatures so that they can be seen.

(c) **False.** The natural defences of the fish usually prevent any bugs causing harm to the fish. However, problems do arise if the fish is damaged. The bugs can then get into the tissues where they cause disease and decay.

(d) **True.** Any damage, such as a cut or other break to the skin, will allow bacteria to get into the tissues and cause decay.

SAQ 13

a) **Yes.** A given volume of crushed ice absorbs 10,000 times more heat than the same volume of air. This is why ice is much more useful for chilling fish than cold air.

b) **Yes** to this part as well. To be effective in removing heat rapidly from the fish, the air needs to be blown over the fish surface. This requires extra energy, which tends to make the use of cold air less efficient than ice.

c) **No.** The extra heat to be removed from the fish containers will have to be removed whatever cooling system is used.

d) **No.** Any cooling medium needs to be chilled before use, but air has less cooling capacity than ice.

SAQ 14

(a) **No.**
Crushing block ice into smaller pieces will actually **increase** the rate at which it will melt.

(b) **Yes.**
Crushed block ice may be handled more easily in small quantities, for example, by shovelling. In larger quantities it may be more easily moved around using conveyors.

(c) **Yes.**
We can all imagine the damage caused to any fish placed beneath a 10 kg block.

(d) **Yes.**
Smaller ice particles give better contact with the fish. This leads to better transfer of heat from the fish to the ice. This results in faster chilling.

SAQ 15

I hope that you thought back through the module. What are the basic things which can affect the quality of the fish?

SAQ 15 cont.

I am sure that you remembered that the speed at which fish spoils depends on temperature.

So, Rule No. 1 – **keep fish cool at all times.**

However, the 'freshness' of the fish is constantly changing. Keeping the fish cool will not improve the existing quality. At best it will slow down the spoilage rate. The fish you use must be as fresh as possible.

So, Rule No. 2 – **only handle good quality fish.**

It is also important to regularly check the quality of the fish you receive. If you are not satisfied with the quality, consult your manager.

Fish kept at 0°C will still spoil given time.

So, Rule No. 3 – **distribute fish quickly and avoid delays.**

Fish must be moved rapidly through the distribution system, by the most direct route. Delays in processing may be kept to a minimum by proper organisation of the flow of fish through the process.

Spoilage is also accelerated if the fish are damaged in any way. For example, crushing, bruising or cutting of the flesh make it easier for bugs to invade the flesh below the skin.

So, Rule No. 4 – **avoid physical damage.**

Physical damage to fish is caused by carelessness.

There can be no excuse if this rule is not followed by everyone.

Finally, fish heavily contaminated with bacteria will spoil more quickly than fresh fish. It's rather like saying that 10 men can usually get a job done faster than 1 man.

So, Rule No. 5 – **Maintain high standards of hygiene and cleanliness at all times.**

Now you know the 5 basic rules, make sure you apply them to your own area of work.

SAQ 16

You could have thought of two reasons why gutting might improve the quality of fish.
First of all, the gut contains one of the major concentrations of bacteria in the fish. By removing the guts, the processor reduces the risk of contamination of the flesh by gut bacteria. The loss of quality caused by bacterial spoilage depends on what extent the bugs have contaminated the flesh.
Secondly, the gut also contains digestive enzymes which continue working after the fish dies. By preventing contamination of the flesh by these enzymes, the rate of autolytic spoilage may be reduced.
Thus, gutted fish are generally of a better quality than ungutted ones, stored under the same conditions, for the same length of time.

SAQ 17

a) **Yes.** Some loss of weight must be expected over several days storage, due to moisture loss from the fish to the air.

b) **Yes.** Eating quailty will be affected by any loss of moisture from the fish, and by freezing, which can occur when the fish is stored close to the evaporator.

c) The answer here depends on how good air circulation is in the store chill room. Good circulation to all parts of the store should maintain even fish temperatures. Poor air circulation will cause quite large temperature differences between fish batches.

d) **No.** Although cold air has a smaller cooling capacity than ice, it can cool fish quite quickly if the cold air is blown quite rapidly over the fish surface.

SAQ 18

The correct answer is (a). Well done. Density is indeed weight divided by volume.

SAQ 19

1. No this statement is incorrect. Heat must find its way from the centre of the fish to the surface before it is removed by the ice. Therefore, the thicker the fish layer, the longer it will take to cool.

2. Rather surprisingly this is also not strictly true, certainly it takes longer to cool a thicker layer of fish. However if you look again at the figures in the previous paragraph you will see that the cooling time increases by 4 times not 2 times.

3. Well done. This is the correct statement. Now think of the importance of this when icing your fish.

4. No I'm afraid you need to think again about how heat is removed from the fish. The heat at the surface is quickly removed and the surface quickly reaches 0°C. However, because it takes time for heat to travel through the fish layer to the surface, the centre takes much longer to cool.

SAQ 20

The problems arising from working under unclean conditions are to do with the increased risk of contamination of the fish with more bugs. As we saw in SAQ 16, the more contaminated the fish becomes, the more rapidly the fish will spoil.

There is also the risk that the fish may become contaminated with bugs which can cause serious illness or even death amongst consumers. These bugs, **must be eliminated from fish by good hygiene practice.**

Other Training Programmes

There are a number of other modules which are intended to help you get a better understanding of different parts of the trade. These include:-

Hygiene and Cleaning in the Seafood Industry – Printed Text, Taught Course. Covering food poisoning, maintenance and standards, premises, materials, routines, pests and laws. Leads to Foundation Food Hygiene and Elementary Food Hygiene Certificates via examination. Available in English, Lithuanian, Polish and Portuguese.

Health and Safety in the Seafood Industry – Printed Text, Taught Course. Leads to Foundation H&S and Elementary H&S Certificates via examination.

Maintenance of Fish Quality – Printed Text
The module is about good handling practice at all stages from quayside to retailer. Advice is given on how spoiling can be minimised. It covers different quality levels, changes in fish after death, icing, effects of handling, parasites, pollution and contamination.

Fish Identification – Digital file
This will teach you how to identify a wide range of fish and shellfish used in the industry.

The Frozen Fish Chain – Printed Text
Covers common freezing processes, benefits, handling, temperature control, premises, good practice during thawing and retailing.

Chilled Fish Chain – Printed Text
This module explains the reason for keeping fish chilled. It covers the different ways of doing so and the correct methods to use. It will help you understand some of the handling problems in the distribution system, putting you in a better position to discuss supplies and quality with your supplier.

Introduction to Fish Frying Skills – Printed Text
This module explains how to prepare and cook fish and chips. Topics included are preparing and frying fish, batter preparation, potato preparation and frying skills.

Included with this module is the *Introduction to Food Hygiene and Health & Safety in Fish Frying* module. This focuses on food

hygiene principles, temperature control and health & safety. Following a practical/theory assessment, these two modules can lead to a Seafish/NFFF Fish Frying Skills certificate.

Introduction to Customer Service in Fish Frying – Printed Text.
This module covers the importance of customer service in a fish frying business. Topics included are workskills, getting ready for opening, dealing with customers and how to deal with customer complaints and incidents.

Included with this module is the *Introduction to Food Hygiene and Health & Safety in Fish Frying* module. This focuses on food hygiene principles, temperature control and health & safety. Following a practical/theory assessment, these two modules can lead to a Seafish/NFFF Customer Service Skills certificate.

Introduction to Fish Monger Practice – Printed Text
This text covers the various duties expected of an assistant in a Fishmongers' premises. It stresses the importance of a correct attitude both to work and to customers.

Primary Processing of White Fish – Printed Text
Deals with hand and mechanical processes together with packaging, quality control and stock control. The need to maintain a high standard of hygiene is dealt with from the point of view of staff, equipment and buildings.

Fish Smoking – Printed Text
This module covers the basic principles of fish smoking. It deals with the choice of raw material, its preparation and packing. There is also a segment on the types of kilns and fire boxes in common use. The module includes two segments dealing with fish spoilage and the preserving properties of smoke.

Scallop Handling and Shucking Practices – Available only with the associated DVD. This incompany training pack provides all the material needed to train and inform your staff through workplace coaching.

Workplace Coaching – Ever wanted to train your own staff in how its done in your company? This easy to follow distance learning pack will help you to coach and train your own staff. Includes a supporting DVD.

Training Films – on DVD

Strikeback II - Developed in 2006 to support Seafish's hygiene and cleaning in the seafood industry open learning module and taught course. Can be used on it's own for staff induction training. A translated script is available for use with staff who speak Latvian, Lithuanian, Polish, Russian, Portuguese and Spanish.

Hand Processing of Seafood - a masterclass. Possibly the most extensive review on DVD of hand processing skills. The hand processing of almost 50 species of fish and shellfish are demonstrated by Duncan Lucas, one of the UK's top fishmongers. Developed in 2006.

Fish Filleting Training Programme – This DVD was developed in 2006 to support the taught fish filleting training programme. Containing six demonstrations of fish filleting techniques.

Identification of Marine Fish and Shellfish – With 45 species shown and described in detail. Developed in 2006.

Health and Safety in the Seafood Industry - Developed in 2006 to support Seafish's H&S in the seafood industry open learning module and taught course. Can be used on it's own for staff induction training. A translated script is available for use with staff who speak Latvian, Lithuanian, Polish, Russian, Portuguese and Spanish.

Scallop Handling and Shucking Practices – Available only with the associated incompany training pack. This DVD provides powerful arguments for the correct handling and shucking of scallops and demonstrates how it should be done. Developed in 2006 with assistance from the Food Standards Agency (Scotland)

Fish Frying Skills - The Movie – This DVD takes the viewer through the process of how to prepare and cook the perfect fish and chips. Topics covered include the preparation of potatoes, batter and fish along with the frying of the fish and chips. Developed in 2005.

Misc DVDs – Various training films that were first produced as VHS videos are now available as DVDs. These older programmes include Upfront - selling skills for fishmongers. For an up to date list contact Seafish.

Training Courses

Seafish have a range of training courses in fish quality assessment, health and safety and food safety.

Our short food hygiene course (*Introductory food hygiene for the seafood industry*) is available in English, Latvian, Lithuanian, Polish, Russian, Portuguese and Spanish.

Other courses are available directly from Seafish or through our network of Group Training Associations. For an up to date list and current information see www.seafish.org or email training@seafish.co.uk