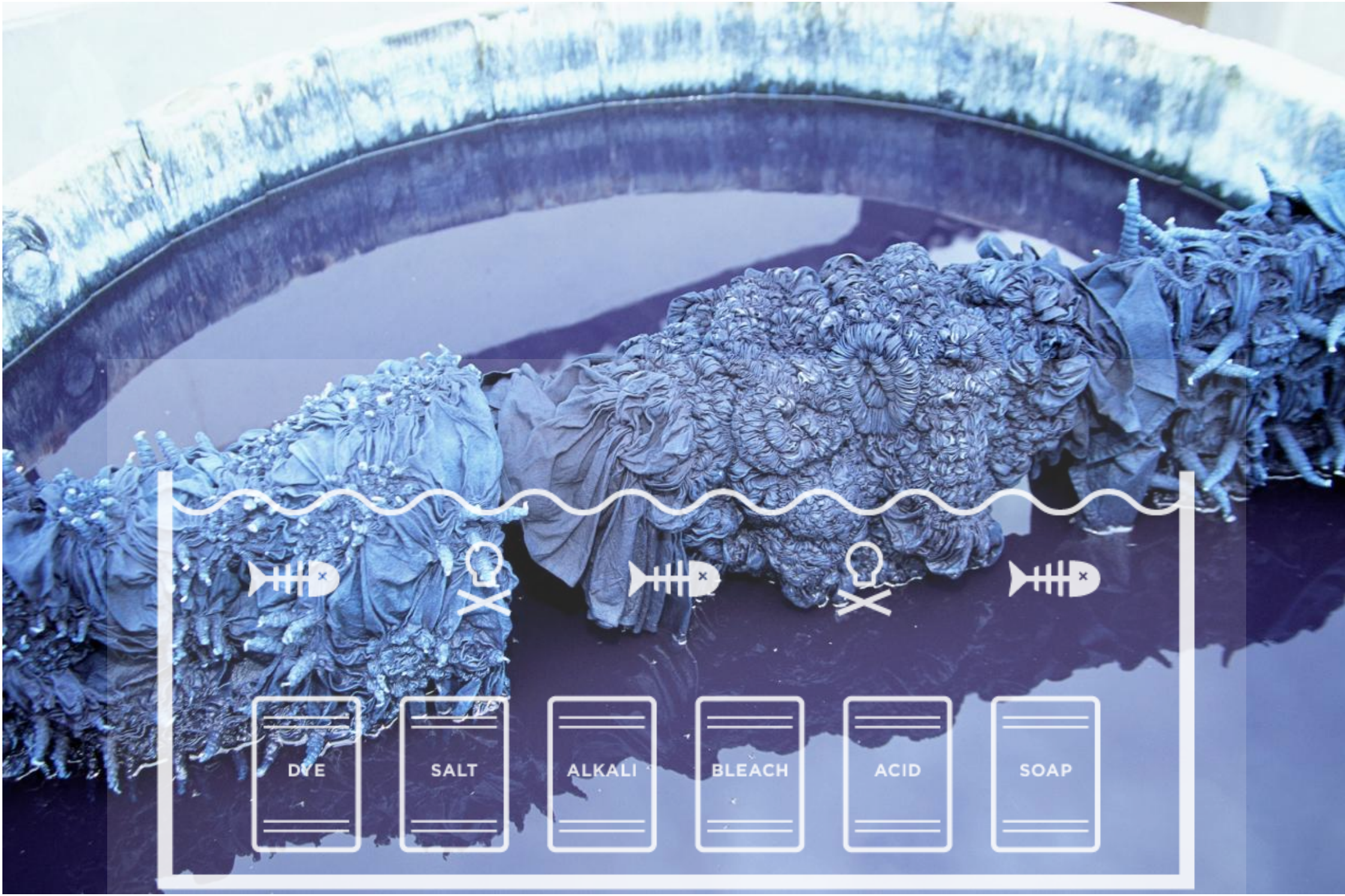
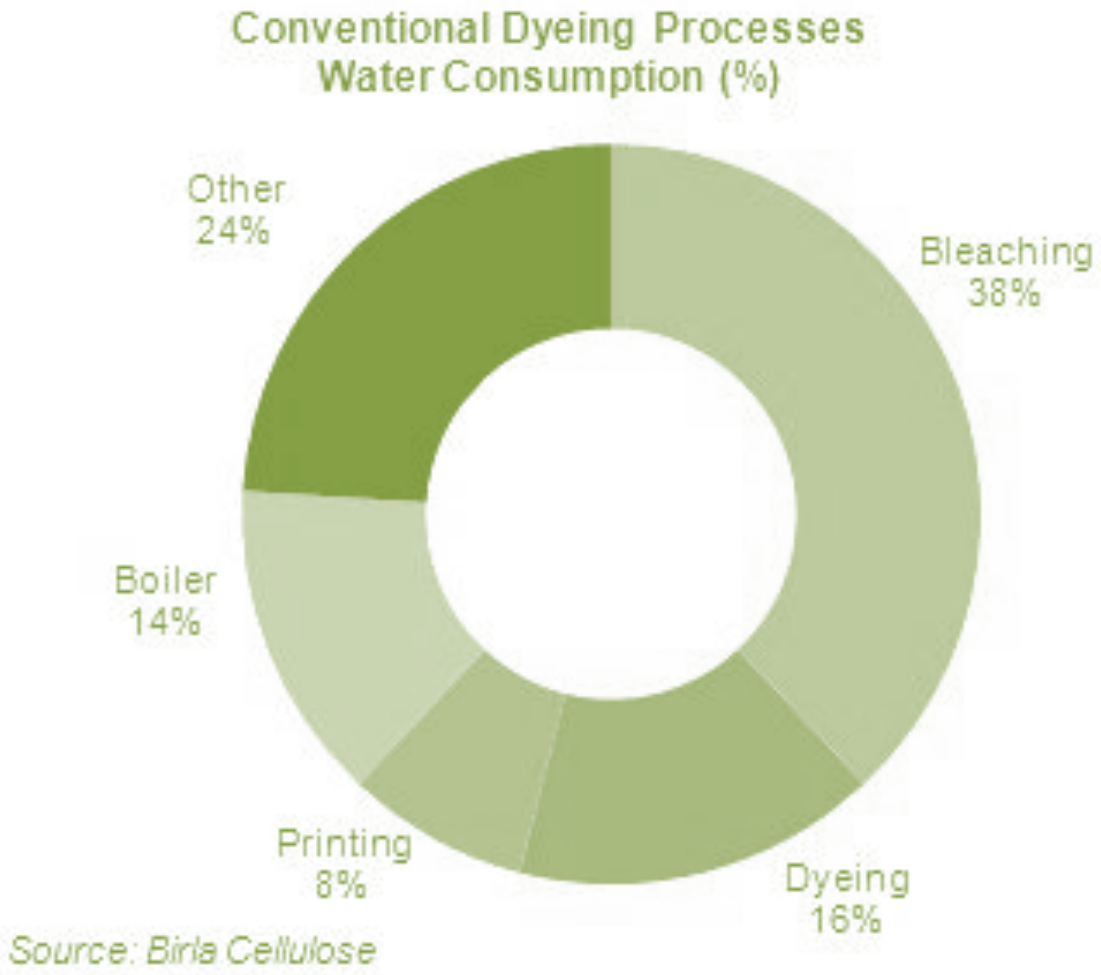

BIOFABRICATING
DYES

dyeing

BEFORE	TODAY	TOMORROW
Natural dyeing	Chemical dyeing	Bacterial dyeing?

Which color are you wearing?


DYE
SALT
ALKALI
BLEACH
ACID
SOAP



Source: Birla Cellulose

GREENPEACE

TOGETHER WE CAN BUILD A

TOXIC-FREE FUTURE

where dangerous chemicals are no longer produced, used and released into our environment

http://www.greenpeace.org/international/en/campaigns/detox/

Alkylphenols

Azo dyes

Brominated and chlorinated flame retardants

Cadmium, lead, mercury and chromium

Chlorinated solvents

Chlorobenzenes

Chlorophenols

Organotin compounds

Perfluorinated chemicals

Phthalates

Short-chain chlorinated paraffins

dyeing

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NATURAL
DYES

HOW TO

- Start by weighting your dry fibers
- Wash and scour your fibers
- Mordant your fibers with one of the mordants
- Prepare the dye bath based on the WOF: make enough dye to submerge completely the fibers
- Measure the PH or your dye
- Rinse with luke warm water
- Choose between: mordanting again, color change by mordanting or by modifying the PH of your rinse water.

TOOLS & INGREDIENTS

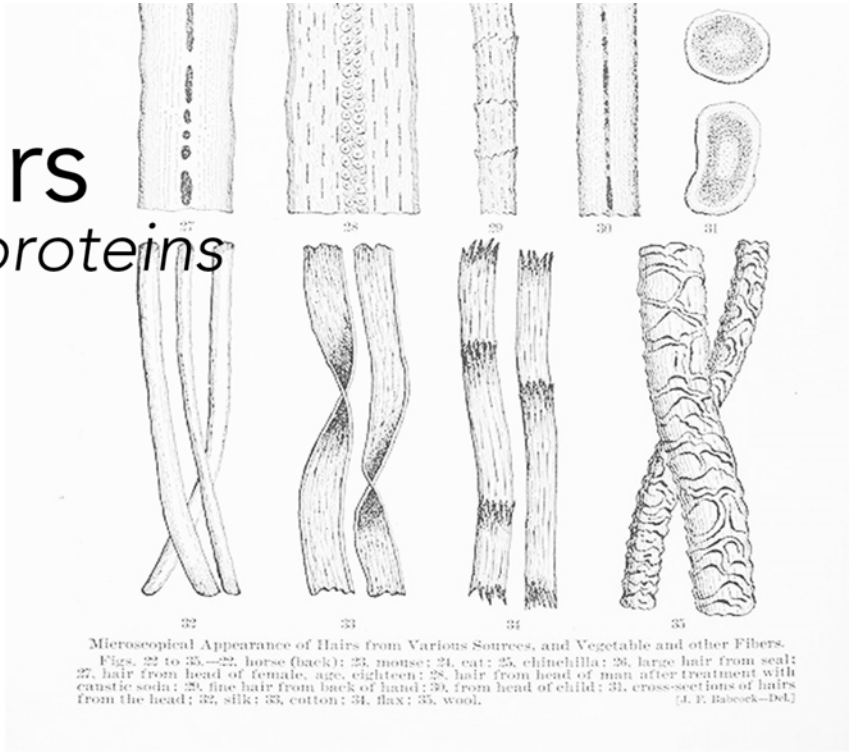
Stove
Pots
Scale
Mixing spoons
Water
Dye
Alum
Copper & iron liquor
Washing powder
Vinegar
Soda
Sodium carbonate
Silk, Cotton, Linen et c.

SAFETY

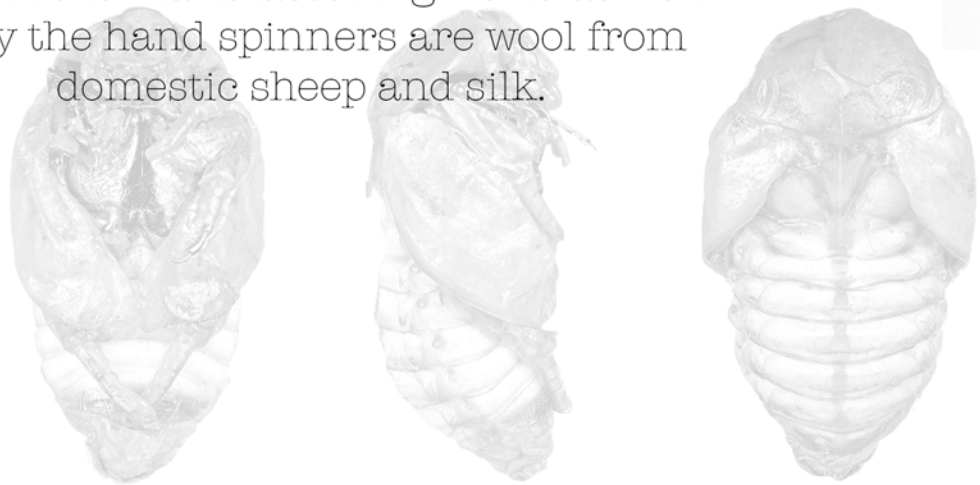
Always be careful when handling alum, copper or iron liquor and other mordanting or scouring material.
Wearing gloves and a lab coat is safer if you are not used to work with natural dyes.
NO FOOD OR DRINKS AROUND!

Animal fibers

proteins



Animal fibers are natural fibers that consist largely of particular proteins. Instances are silk, hair and fur (including wool) and feathers.
The animal fibers used most commonly both in the manufacturing world as well as by the hand spinners are wool from domestic sheep and silk.



Wool

Silk

Mohair

Alpaca

Camel

Vegetable fibers

cellulose

Plant-derived vegetable fibers are classified according to their source in plants as bast, leaf, or seed-hair. The fibers in bast and leaf plants are integral to the plant structure, providing strength and support. The principal chemical component of vegetable fibers is cellulose, with varying amounts of lignin and hemicelluloses also usually present; thus the fibers are also referred to as cellulosic or lignocellulosic.

Cotton
Linen
Ramie
Hemp
Raffia
Jute

FIBERS PREPARATION

HOW TO PREPARE YOUR ANIMAL FIBERS

Wash the fibers gently with luke warm water and a little bit of soap.

Keep in mind that to much friction and heat will felt the wool, while it will damage the silk fibers making them dull and brittle.

Also sudden temperature changes are not recommended with animal fibers.

HOW TO PREPARE YOUR VEGETABLE FIBERS

Boil the fibers for an hour in water and sodium carbonate (soda ash)
±2 spoons for 4 liter water.

This process will remove the oil and waxes that are naturally presentin the fibers.

It's good to repeat this process twice or to start by washing the fibers at a high temperature in the washing machine.

Mordants

Alum

A mordant is a substance, typically an inorganic oxide, which is combined with a dye bath to enhance the fastening proces of the dye onto organic fibers. They enhance the light- and wash-fastness of the dye on the fibers, both the protein based and the cellulose based ones. Mordants also have an impact on the final colour.

Copper liquor

Iron liquor

mordants

Alum

Alum can be used to mordant on all kinds of fibers. It helps brightening the colours and assures a good light and wash fastness

Animal fibers

for a 100 gr of textile/yarn

Enough warm water to cover completely the textiles
Use 10-20% of weight of fibers of Alum
Add 8% of weight of fibers of tartaric acid (the tartaric acid works better when first dissolved in a little bit of boiling water)

Vegetable fibers

for a 100 gr of textile/yarn

Enough warm water to cover completely the textiles

Use 10-15% of weight of fibers of Alum

mordants

Copper

Copper can be used to mordant on all kinds of fibers, it has a greater effect on vegetable fibers than animal ones. It helps darkening and saddening the colors, providing shades which are otherwise very difficult to obtain. While saddening the colors, it brings out greens and blues. It is a good additive for any dyeing bath of those colors, but also for any dyeing bath which aim is to add a subtle blue hue to any other specific color.
Wear rubber gloves when handling the fibers in this bath.

Animal fibers

for a 100 gr of textile/yarn

Enough warm water to cover completely the textiles
Use 3%-6% of weight of fibers (powder)

or

Use copper liquor

Vegetable fibers

for a 100 gr of textile/yarn

Enough warm water to cover completely the textiles
Use 3%-6% of weight of fibers (powder)

or

Use copper liquor

mordants

Iron

Iron can be used to mordant on all kinds of fibers, it's often used as a modifier instead as of a mordant. It helps darkening and saddening the colors, it increases the color wash and light fastness a lot. Wear rubber gloves when handling the fibers in this bath.

Animal fibers

for a 100 gr of textile/yarn

Enough warm water to cover completely the textiles
Use 3%-5% of weight of fibers (powder)

or

Use iron liquor

Vegetable fibers

for a 100 gr of textile/yarn

Enough warm water to cover completely the textiles
Use 3%-5% of weight of fibers (powder)

or

Use iron liquor

MODIFIERS

These are substances applied after the dye bath to extend the number of shades possible with one dye bath.
The same modifier in combination with different mordants will produce different colours as well.
With some dyes the colour change is drammatic, with other is subtle and soft.
Some modifiers change the Ph of the water, other act as a stronger mordant while imporving the .
Usually they can be divided into 4 typologies of modifiers:

Acidic modifiers:

Simmer in vinegar for 5 – 10 min

Tends to make the shades lighter or yellower in tone

From red to orange
From purple to pink
From rust to yellow
From blue to purple

Alkaline modifiers:

Pour hot water on the crystals until they dissolve, then **simmer 5-10 min**

Tends to make the shades pinker in tone or strong changes.

From purple to blue or green
From yellow to orange or red
From brown/red to red/pink

Copper modifiers:

Simmer in the copper liquor for 10 - 20 min

Tends to make the shades greener in tone

From yellow to green
From red to purple/ blue
From ocher to brown

Iron modifiers:

Simmer in the iron liquor for 5 min

Tends to make the shades darker in tone

From yellow to olive green/brown
From orange/red to brown
From purple to dark purble/dark grey

Turmeric

Onion skins

Berberis

Black Beans


black bins
no boil
black bins
+soda
boiled
black bins
+vinegar
+lime

Cabbage

Tea

Lichens

Coffea

Bloodroot

DYE RECIPES

HOW TO DYE WITH TURMERIC

To use turmeric powder mix it to a paste with a little warm water, stirring well to incorporate all the particles. Add more water continuing to stir well before pouring it into the dye bath. This dye solution can be applied to all fibers, with or without heat.

If you are dyeing skeins of yarn, it can be difficult to rinse turmeric powder particles out of the fibers. To avoid this problem, simmer the dye solution for one hour and then strain it through a coffee filter before adding the fibers. Rinse the fibers well after dyeing but teen always use a pH-neutral washing solution to prevent an unwanted color change.

DYEING INSTRUCTIONS

½ WOF Turmeic powder for intense yellow shades

¼ WOF Turmeric powder for light shades

MORDANTS

No mordants are truly needed with Turmeric.
Copper or Iron pre mordants will affect the final colour results.
Modifiers will produce tones from yellow – orange – red – greens.

DYE RECIPES

HOW TO DYE WITH ONIONS

Onion skins can be added to dye baths prepared from tree bark to make the dye yellower and brighter or introduced to madder dye baths to produce colors that are more orange in tone.

Used on their own with an alum mordant, onion skins give orange, rust, and brown shades, depending on the quantity used.

The skins from red onions can also be used, although they do not always produce the same colors as white onions. Materials dyed with onion skins produce green shades when overdyed in an indigo vat.

Onion skins can also be used to supplement a yellow dye bath made from other plant material, the addition of the onion skins brightens the final result.

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DYEING INSTRUCTIONS

¼ WOF Onion skins

Don't mix golden onions and red onions!

MORDANTS

Mordanting helps keep the colours intact.
Copper or Iron pre mordants will affect the final colour results.
Modifiers will affect lightly.

DYE RECIPES

HOW TO DYE WITH MADDER

To process the fresh or dried plant tops for dyeing, cut them up into small pieces and simmer gently for about one hour. Let the solution cool, then add the fibers and either leave them to steep or apply gentle heat until you achieve a suitable depth of colour.

Madder root can also be simmered gently to extract the dye color but once the fibers have been added, the temperature should be kept well below a simmer to achieve clear reds. Simmering or boiling the dye bath will turn red colors browner and duller.

The best color results are often achieved if the pieces of madder root are left in the dye pot during the dyeing process.

When planning a madder dyeing session,have plenty of fibers ready to be dyed, and aim for a range of red to orange shades from one dye bath.

Then, take the largest dye pot, put in the chopped madder root, and fill up the pot with warm water. Add the first batch of fibers to be dyed and leave them in for at least a day or two. But keep checking the color and when it seems deep enough, remove half of the fibers and leave the rest to soak for another day for deeper shades.

When the bath seems to hold no more color, add vinegar or acid to modify the color into bright oranges and yellows.

DYEING INSTRUCTIONS

1 WOF Madder powder for intense reds and rusty shades

1/2 WOF Madder powder for soft orange and peach.

MORDANTS

Both mordants and modifiers work a great deal with Madder roots. Producing up to 25 distinct shades.

Alum mordanting and alkaline water will give you true reds.

DYE RECIPES

HOW TO DYE WITH HIBISCUS

To extract the dye color: pour boiling water over the flowers, then simmer them for half an hour. Strain off the dye liquid or leave the flowers in the dye bath.

Simmer the fibers in the dye liquid for about 45 minutes then leave them to soak in the dye bath overnight and longer for really deep shades.

DYEING INSTRUCTIONS

¼ WOF Hibiscus dried flowers for bright fuchsias

1/8 WOF Hibiscus dried flowers for pinks and lilacs

MORDANTS

Both mordants and modifiers work a great deal with Hibiscus dried flowers. Producing more than 25 distinct shades, ranging from pinks, to purples to blue and soft greens!

DYE RECIPES

HOW TO DYE WITH CAMPECHE

To make a dye bath from logwood chips, first pour boiling water over the chips and leave them to soak for at least 4 hours.

Then add enough water to make the dye bath and simmer the wood chips for 15 to 20 minutes.

Strain off the dye liquid and use this for the first dye bath. Add the fibers, simmer them for 45 minutes, then leave them to cool in the dye bath.

Then remove the fibers, squeeze out any excess dye, and rinse well several times.

Take particular care with this rinsing process, as logwood dye tends to "bleed" out if the fibers have not been thoroughly rinsed.

The logwood chips can be simmered again for 45 minutes to 1 hour to extract more color.

The dye liquid can then be strained off and used to make a second dye bath for a further batch of fibers.

DYEING INSTRUCTIONS

1/2 WOF Campeche logwood dried flakes

MORDANTS

Lovely purple shades result with an alum mordant. Copper or iron mordants will increase colorfastness on all fibers. Iron mordant or modifier gives dark purples and black, while copper gives bluer hues.

DYE RECIPES

HOW TO DYE WITH ANNATTO

To extract the dye, gently simmer the annatto seeds in water for about one hour The seeds can either be removed from the dye bath or left in the dye bath during the dyeing process.

Stronger colors will result if the seeds are left in the dye bath when the fibers are added.

Simmer the fibers in the dye bath for one hour, then leave the fibers to cool overnight in the dye liquid. Annatto can also be successfully applied without heat.

To get the maximum color from the seeds, add one or two teaspoons of washing soda to the water in which the seeds are simmered to extract the dye.Then strain off the dye liquid and allow it to cool before adding the fibers.

Soak the fibers in the cool solution until the depth of color required is achieved.

DYEING INSTRUCTIONS

1/2 WOF	Annatto seeds

MORDANTS

Pre mordants won't affect strongly the color changes, only after mordanting done with iron and copper liquors will affect the colours.

dyeing

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BACTERIAL
DYES

What are bacteria?

A single-celled organism.
These dwell nearly everywhere on Earth, from the bottom of the sea to inside animals.

Janthinobacterium lividum is an aerobic, gram-negative, soil-dwelling bacterium that has a distinctive dark-violet (almost black) color. This color is due to a compound called violacein, which is produced when glycerol is metabolized as a carbon source. Violacein has anti-bacterial, anti-viral, and anti-fungal properties.

Bacterial dyes – Natsai Audrey

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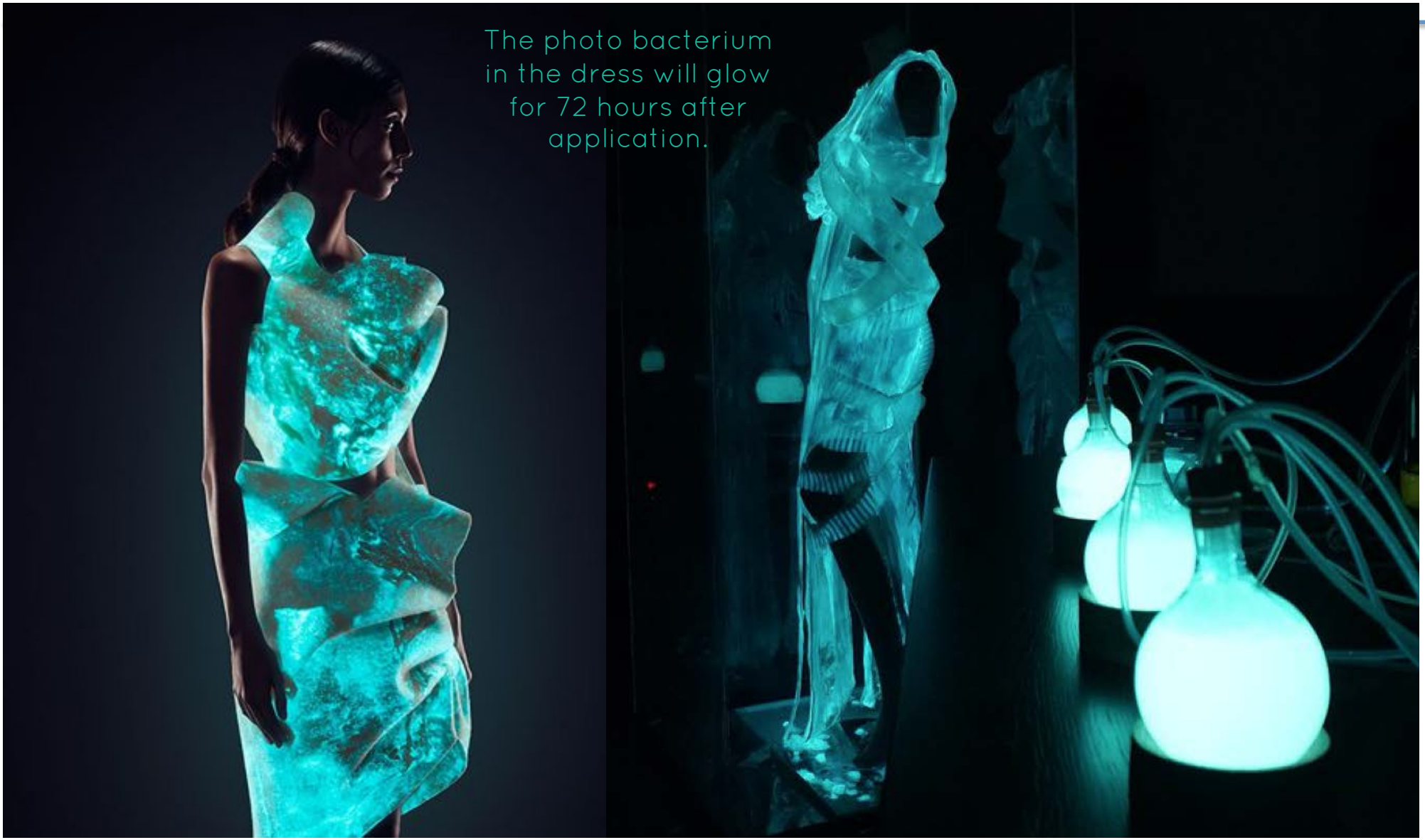
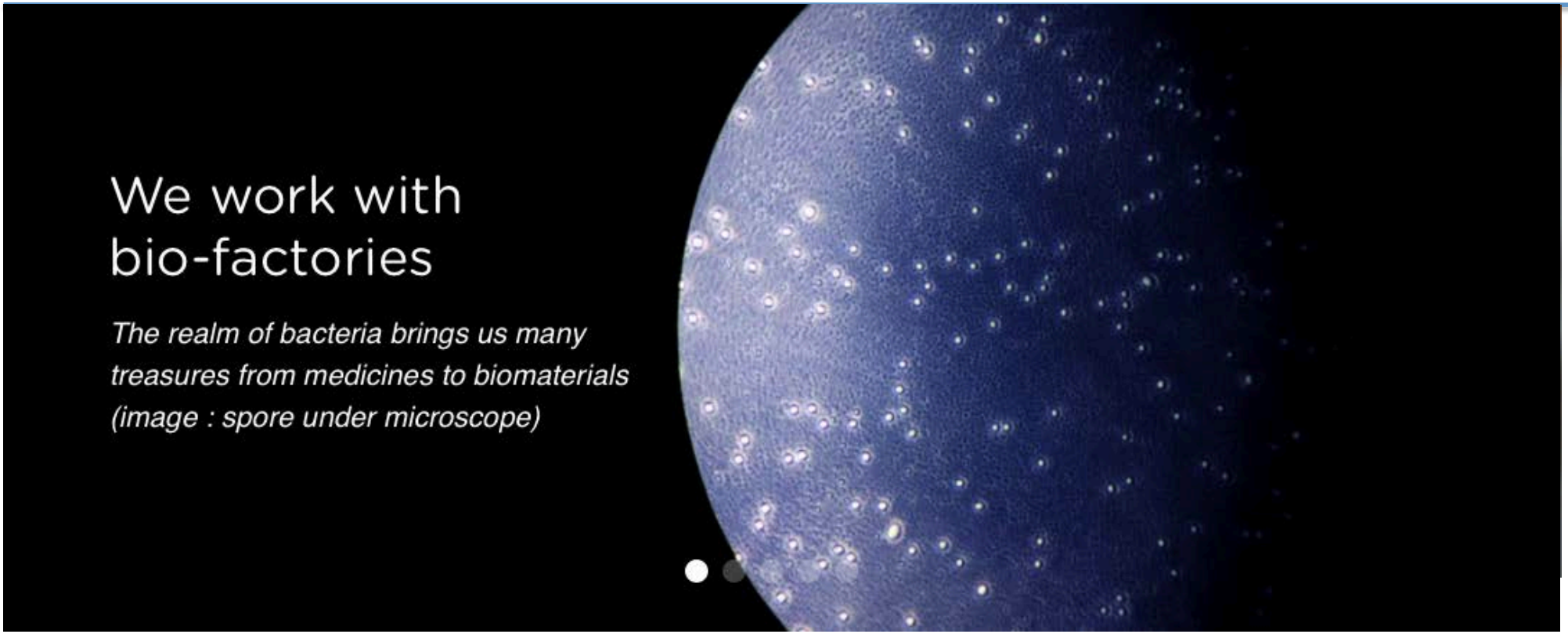


Bacterial dyes – Victoria Geaney



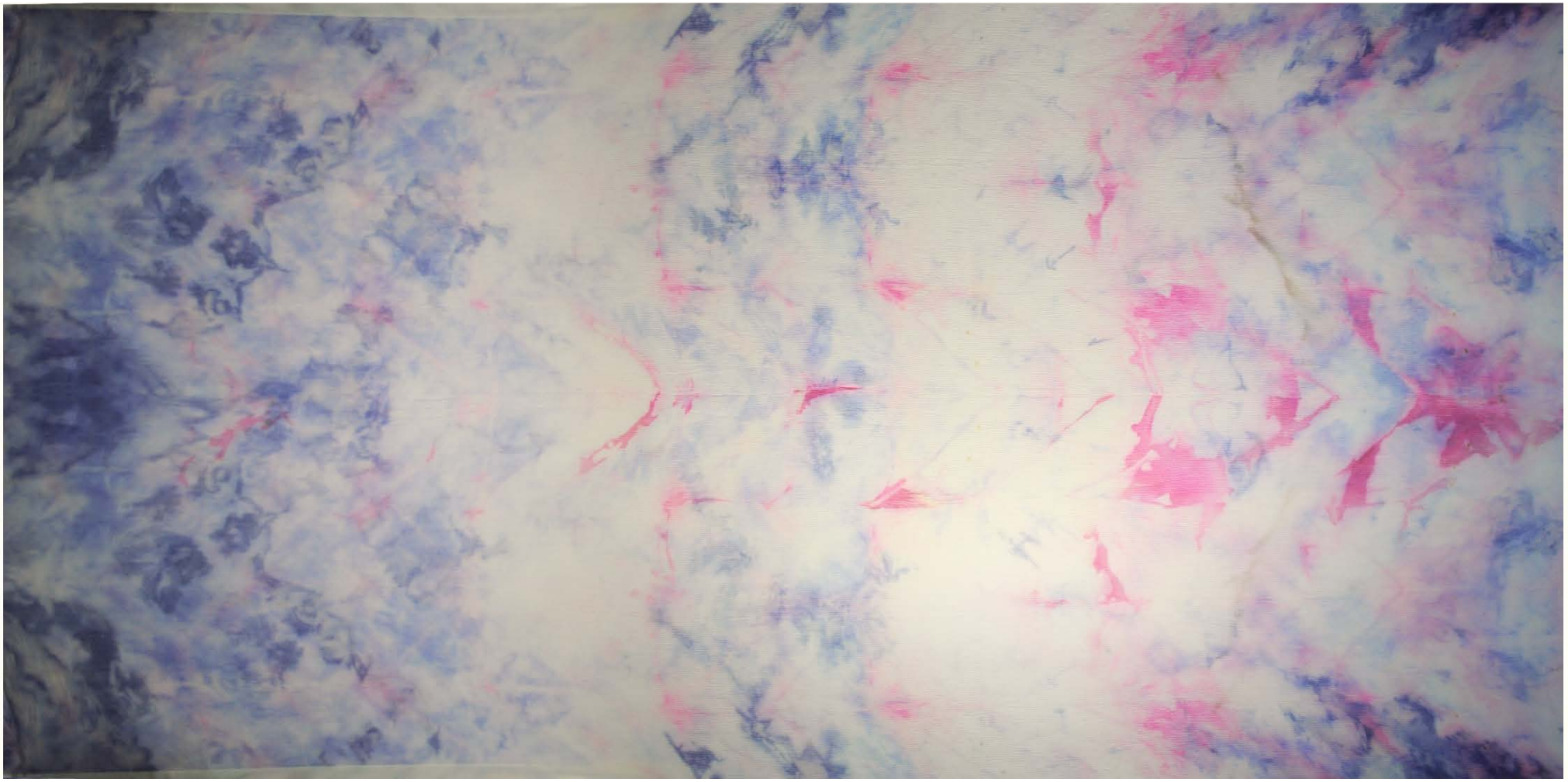
Bacterial dyes – Pili

Colorifix

Life isn't black and white

Bacterial dyes – Colorfix

Bacterial dyes – TextileLab Amsterdan



Bacterial dyes – TextileLab Amsterdan

Janthinobacterium lividum

violacein

Nutrient agar or Nutrient broth

Serratia Marcescens

monascins

Nutrient agar or Nutrient broth

Athrobacter citreus

Nutrient agar or Nutrient broth

Corynebacterium Insidiosum

indigodine

Nutrient agar

Monascus purpureus

monascins

Nutrient agar or Nutrient broth

Micrococcus lutea

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nutrient agar and trypticase soy agar

Pantoea Agglomerans

indigodine

5gr/l glucose, 10g/l tryptic soy broth, 40g/l glycerol

Stemphylium Lycopersici

monascins

Nutrient agar

Erwinia Chrysanthemy

indigodine

23 g of nutrient agar, 10 ml glycerol (1% v/v), and 0.4 g $MnCl2{:}4H2O$ (2 mM) to 1.0 liter of water.

Micrococcus Roseus

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nutrient agar and trypticase soy aga

Bacterial dyes – different patents

Bioplastics + JL Bacteria – Maria Viftrup @ TextileLab Amsterdam

Dagmar Grote &
Caroline Bronkers

Laura Luchtman
& Ilfa Siebenhaar

Karlijne Opmeer

Bacterial dyes – students that took it a step further

HOW TO

- Place the textiles in an autoclave bag for 121 degrees
- Mix growing medium
- Sterilize the textiles, petri dishes and growing medium in the pressure cooker
- Sterilize working area with ethanol and the camping gas
- Tag your petri dishes and pour growing medium
- Place sterilized textile in the dish
- Inoculate the dish with bacteria

TOOLS & INGREDIENTS

500 ml glass bottle with cap that fits into the pressure cooker
Nutrient broth NR1 (sigma aldrich)
Nutrient Agar
Pipette
Glycerine
Water
Pressure cooker
Electric stove
Petri dishes
Inoculation loop
Camping gas + lighter
Parafilm tape
Silk, Cotton, Linen et c.

SAFETY

Always be careful when handling bacteria and other biological material.
Wearing gloves and a lab coat is safer if you are not used to work in a biolab.
Clean your hands after with ethanol and soap.
NO FOOD OR DRINKS AROUND!

Bacterial dyes – Instruction video – Nina @ TextileLab Amsterdam

procedure

step # 1

Start by preparing the fabric.
Using an iron, fold the fabric according to the desired pattern.
If you want to create freeform patterns use small rubber bands instead, similar to the japanese shibori dyeing tecnique.

step # 2

Try to fold the textile piece in a size tha fits easily on the petri dish and to minimize its volume as much as possible.

Stich your fabric to minimize its' volume even more and to fix its shape.
Skip this step if you use rubber bands to create the shibori effect.

step # 3

Make sure that your folded piece can fit in the petri dish once you complete the stiching.

step # 4

step # 5

Place the fabric in a glass petri dish, a glass bottle or in the special autoclave plastic bag to sterilize it

step # 6

The petri dih is now ready to be autoclaved before inoculating it with bacteria

Collect all the ingridients that you need to prepare the cultivation medium for your bacteria.
You will need water and a glass bottle and a spoon

step # 7

Measure the amount of your medium using a scale.
Precision of 0.1 gr is desirable.

step # 8

Place the medium in a glass bottle and add the approriate amount of water for the solution.

Mix slightly the medium by shaking the bottle.

Make sure that the amount that you you prepeare is up to half of the volume of your glass container. so that the medium does not fall out of it while being sterilized. (eg for 250ml of medium use a 500 ml bottle and not smaller)
Add 1-2% of glycerine at this stage if you work with Janthinobacterium Lividum.

Slacken a bit the cap of the glass bottle so that air can pass through while autoclaving.

Place the bottle and the glass petri dish with the fabric (in a plastic autoclave bag) in the pressure cooker.

Seal the pressure cooker by pulling the blue button of the handle towards you and allign the blue bar of the lid with the handle (middle position).
Cook at maximum power until the red valve pops up and then lower it to minimum and continue cooking for 15' minutes.
Switch off the power.

When the red valve drops you can open the lid.
Let the fabric and the medium to cool to room temperature until you continue with the process.

Sterilize your working space by using ethanol (70%)
Gather around your workspace a gas burner, a lighter , the bacteria, an inoculation loop the fabric and the medium.

Fire the gas burner and let the flame burn while you work.
In this way you will create a sterile environment around your working space, so that you keep everything as clean as possible.

Pass the edge of the bottle quickly back and forth through the flame and puur the medium into the petri dish, opening it as less as possible, towards the side of the gass burner.

Wet the folded fabric piece in the petri dish by gentling dripping the medium.
Repeat the last two steps until your fabric is completely soaked in the medium.

Place the inoculation loop tip into the flame and burn it until it becomes red.
Hold it for a few seconds close to the fire, to keep it sterile.

Dip gently the loop to an unoccupied area of the plate to cool it down and then touch the culture to inoculate in a new petri dish.
You will hear a sound of the loop cooling down if you have burn it enough.

Open the lid of the new petri dish as little as possible and quickly drag the loop in a zigzag manner over a section of the fabric soaked in the cultivation medium.
Drag it with a single stroke over the surface of the fabric.

Repeat these two steps 3 to 4 times, rotating every time your petri dish so that you inoculate almost the whole surface of your fabric.
Remember to keep it disinfected, by burning the loop everytime you use it.

Incubate your textile piece at the optimum temperature and in a stable environment.
Find out about all the specific needs of your becteria in the OpenWetLab github page here: http://biohackacademy.github.io/biofactory/annex/culture-collection/