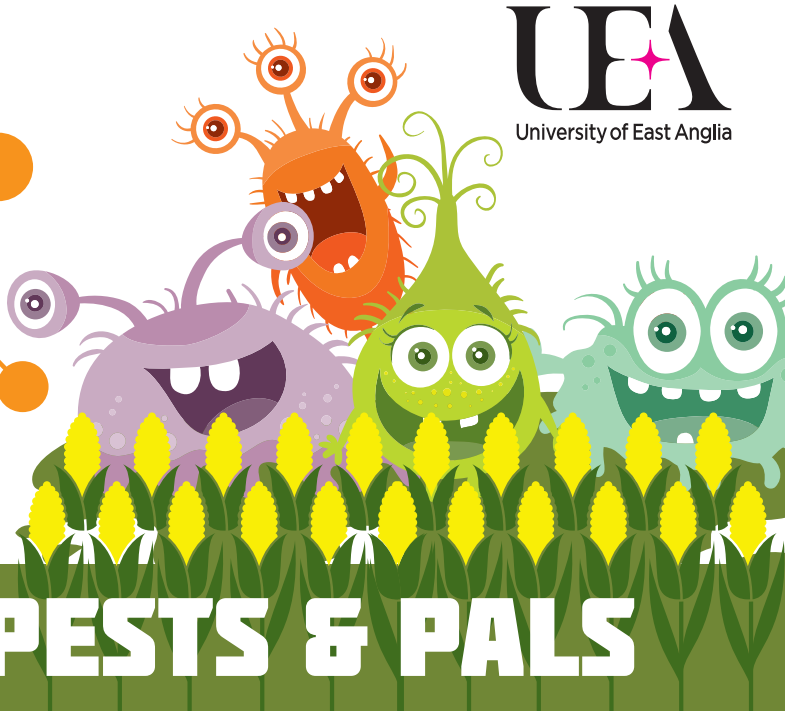
NORWICH SCIENCE FESTIVAL

At home

University of East Anglia



PATHOGENS, PESTS & PALS

You will need:

– Pathogens, Pests and Pals cards

– two or more players

Plants don't live in isolation – they mix with and are affected by pathogens (organisms that cause disease), 'pests' (animals that feed on them) and 'pals' (organisms which help them to thrive). Pathogens, pests and and pals can be insects, bacteria, fungi, viruses and other microbes too.

To play:

First, print and cut out the Pathogens, Pests and Pals cards from the following pages.

To start the game, shuffle and deal all the cards face down. Each player holds their cards so that they can see the top card only.

One player begins by reading out a category from their top card (eg 'genome size 74'). The other players then read out the same category from their card. The one with the highest value wins,.That player puts both cards to the bottom of their pile. It is then that player's turn to choose a category from the next card on their pile.

If two cards share the top value, or data is not available for that particular subject, then the cards are placed in the middle and the same player chooses again from their next card. The winner of the hand takes the cards in the middle as well.

The person with all the cards at the end is the winner.

Categories:

Organism size = The size of a pathogen, pest or pal ranges from tiny bacteria to larger insects. Even tiny microbes can cause huge devastation to plant crops! The winner of this category is the one which is biggest.

Some pathogens, pests or pals are really small and are measured in micrometers (μm). There are 1000 μm in 1 milimeter (mm).

Genome size / Mb = The genome of any living thing is all of the genetic information (DNA) it contains. The genome can help an organism to either attack or make friends with plants.

DNA is made of a very long chain of bases joined in pairs. The size of a genome tells us how many pairs of bases. A human has around 3 billion.

The winner of this category is the one with the largest genome.

How many countries? = For the microbes and insects that cause disease (pathogens and pests) an important way of controlling damage is to identify where they are found and to track movement around the world. New pests and diseases can move quickly round the world as we trade with other countries.

You can help identify some in the UK by joining projects which look for signs of damage or pests.

jic.link/xylella

barbre.co.uk

www.observatree.org.uk/portal/tree-health-citizen-science-projects

While for the microbes that are pals with plants, their distribution around the world allows plants to access more nutrients from the soil. The winner of this category is the one which is found in most countries.

Yield loss = Plant pathogens and pests can cause very large losses to crops. Farmers need to manage the problem whilst taking care of other species living alongside the crops. In this category, you are the winner if you are the nastiest, that is the one that causes largest yield loss.

This activity was created by the team at the John Innes Centre.

The Norwich Science Festival at Home activity sheets were brought to you by the University of East Anglia and the Norwich Research Park. For more information, visit norwichsciencefestival.co.uk.

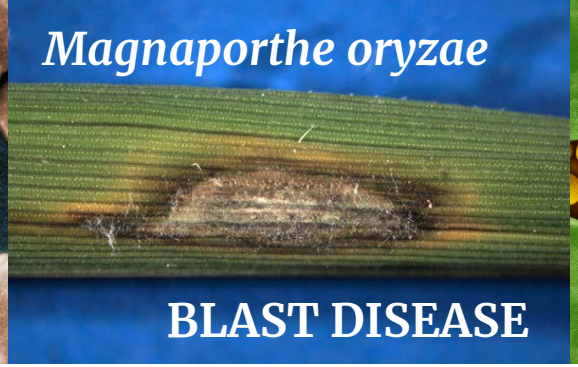
norwich research park

John Innes Centre

INTERNATIONAL YEAR OF PLANT HEALTH 2020

ORGANISM SIZE (µm)	1
GENOME SIZE (Mb)	6.6
HOW MANY COUNTRIES	NA
YIELD LOSS (%)	NA

FACT This pathogen can cause disease in humans as well as plants. For example it can cause infections in people with Cystic Fibrosis.



ORGANISM SIZE (µm)	12
GENOME SIZE (Mb)	41.0
HOW MANY COUNTRIES	80
YIELD LOSS (%)	30

FACT This pathogen affects cereal crops, including rice, wheat, rye and barley.

ORGANISM SIZE (µm)	300
GENOME SIZE (Mb)	74.0
HOW MANY COUNTRIES	98
YIELD LOSS (%)	45

FACT The Romans made sacrifices to the god Robigus to ask for protection of their crops against rusts.

ORGANISM SIZE (µm)	3
GENOME SIZE (Mb)	2.5
HOW MANY COUNTRIES	16
YIELD LOSS (%)	70

FACT Xylella is a bacteria that is transmitted by xylem feeding sap insects. It can infect over 500 species of plants.

ORGANISM SIZE (µm)	140
GENOME SIZE (Mb)	153.0
HOW MANY COUNTRIES	181
YIELD LOSS (%)	29

FACT This is a symbiotic organism that helps plants by making nutrients easier to uptake from the soil.

ORGANISM SIZE (µm)	1950
GENOME SIZE (Mb)	347.0
HOW MANY COUNTRIES	144
YIELD LOSS (%)	46

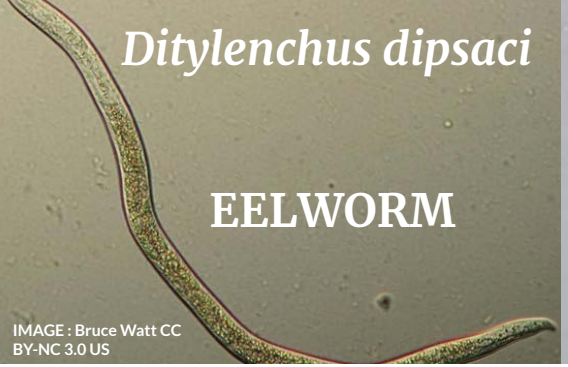
FACT This aphid can transmit at least 78 different plant viruses. It's plant host range is more than 400 species.

ORGANISM SIZE (µm)	8
GENOME SIZE (Mb)	32.0
HOW MANY COUNTRIES	20
YIELD LOSS (%)	70

FACT It was first recorded in 1893 in Italy but didn't establish as an economically damaging disease in barley until 1998.

ORGANISM SIZE (µm)	29
GENOME SIZE (Mb)	240.0
HOW MANY COUNTRIES	132
YIELD LOSS (%)	15

FACT This pathogen looks like a fungus, but is actually another microorganism called an oomycete. It was a causative factor in the Irish Potato Famine.



ORGANISM SIZE (µm)	1500
GENOME SIZE (Mb)	170.0
HOW MANY COUNTRIES	83
YIELD LOSS (%)	70

FACT This nematode causes major damage in plants such as garlic, onion, carrot, fava bean, alfalfa, oats, and strawberry.

ORGANISM SIZE (µm)	10
GENOME SIZE (Mb)	101.3
HOW MANY COUNTRIES	104
YIELD LOSS (%)	75

FACT This pathogen has a specific set of environmental conditions to reproduce and infect. A warm, moist, and humid environment is required.

ORGANISM SIZE (µm)	20
GENOME SIZE (Mb)	39.0
HOW MANY COUNTRIES	7
YIELD LOSS (%)	40

FACT The leaf is the first thing infected by the windborne spores.

ORGANISM SIZE (µm)	10
GENOME SIZE (Mb)	30.0
HOW MANY COUNTRIES	3
YIELD LOSS (%)	7

FACT This fungus is often found on dock leaves

ORGANISM SIZE (µm)	5.4
GENOME SIZE (Mb)	20.0
HOW MANY COUNTRIES	156
YIELD LOSS (%)	32

FACT In Mexico infected ears of corn by a closely related fungus are eaten as a delicacy known as huitlacoche.

ORGANISM SIZE (µm)	36.5
GENOME SIZE (Mb)	30.0
HOW MANY COUNTRIES	13
YIELD LOSS (%)	1

FACT This fungus obtains nutrients from inside grains, leaving behind waste products with a disagreeable odour that makes them too unpalatable for use in flour or pasta.

ORGANISM SIZE (µm)	5.5
GENOME SIZE (Mb)	42.0
HOW MANY COUNTRIES	73
YIELD LOSS (%)	20

FACT Fungi of the genus Fusarium are wide-spread pathogens on maize and small-grain cereals.

ORGANISM SIZE (µm)	65
GENOME SIZE (Mb)	32.0
HOW MANY COUNTRIES	68
YIELD LOSS (%)	8

FACT During the Middle Ages, human poisoning due to the consumption of rye bread made from ergot-infected grain was common in Europe.

Hymenoscyphus fraxineus

ASH DIEBACK

ORGANISM SIZE (µm)	15
GENOME SIZE (Mb)	63.0
HOW MANY COUNTRIES	35
YIELD LOSS (%)	80

FACT One of John Innes Centre's scientists Dr Anne Edwards was the first person to identify this plant pathogen in the UK.

Ophiostoma novo-ulmi

DUTCH ELM DISEASE

IMAGE : Ingwik CC BY-SA 4.0

ORGANISM SIZE (µm)	107.5
GENOME SIZE (Mb)	31.0
HOW MANY COUNTRIES	45
YIELD LOSS (%)	80

FACT The name "Dutch elm disease" refers to its identification in 1921 in the Netherlands by Dutch scientists Bea Schwarz and Christine Buisman

Phyllotreta cruciferae

BRASSICA FLEA BEETLE

IMAGE : James Lindsey CC BY-SA 3.0

ORGANISM SIZE (µm)	3000
GENOME SIZE (Mb)	16.0
HOW MANY COUNTRIES	43
YIELD LOSS (%)	15

FACT All flea beetles exhibit an enlarged hind femur that enables their characteristic flea-like jump

Psila rosae

CARROT FLY

IMAGE : Rasbak CC BY-SA 3.0

ORGANISM SIZE (µm)	9000
GENOME SIZE (Mb)	NA
HOW MANY COUNTRIES	31
YIELD LOSS (%)	50

FACT These flies mainly attack carrots, but can also attack parsnips, parsley and celery.

Sitodiplosis mosellana

ORANGE WHEAT BLOSSOM MIDGE

ORGANISM SIZE (µm)	2000
GENOME SIZE (Mb)	208.0
HOW MANY COUNTRIES	NA
YIELD LOSS (%)	75

FACT This insect overwinters in the soil as a larvae which can survive for more than 10 years!

Psylliodes chrysocephala

CABBAGE STEM FLEA BEETLE

IMAGE : Lucy Thursfield

ORGANISM SIZE (µm)	5000
GENOME SIZE (Mb)	760.0
HOW MANY COUNTRIES	31
YIELD LOSS (%)	20

FACT The changing climate, in particular mild winters, lead to the beetles laying more eggs and more destruction of crops such as oil seed rape.

Fusarium graminearum

FUSARIUM HEAD BLIGHT

IMAGE : CISRO CC BY 3.0

ORGANISM SIZE (µm)	21
GENOME SIZE (Mb)	36.9
HOW MANY COUNTRIES	4
YIELD LOSS (%)	19

FACT This fungus produces mycotoxins which have a toxic affect on animals

Bactericera cockerelli

JUMPING PLANT LICE

ORGANISM SIZE (µm)	2500
GENOME SIZE (Mb)	15.2
HOW MANY COUNTRIES	11
YIELD LOSS (%)	50

FACT This insect can carry a bacteria called *Candidatus Liberibacter solanaceraum* which causes disease in plants such as potatoes and carrots.