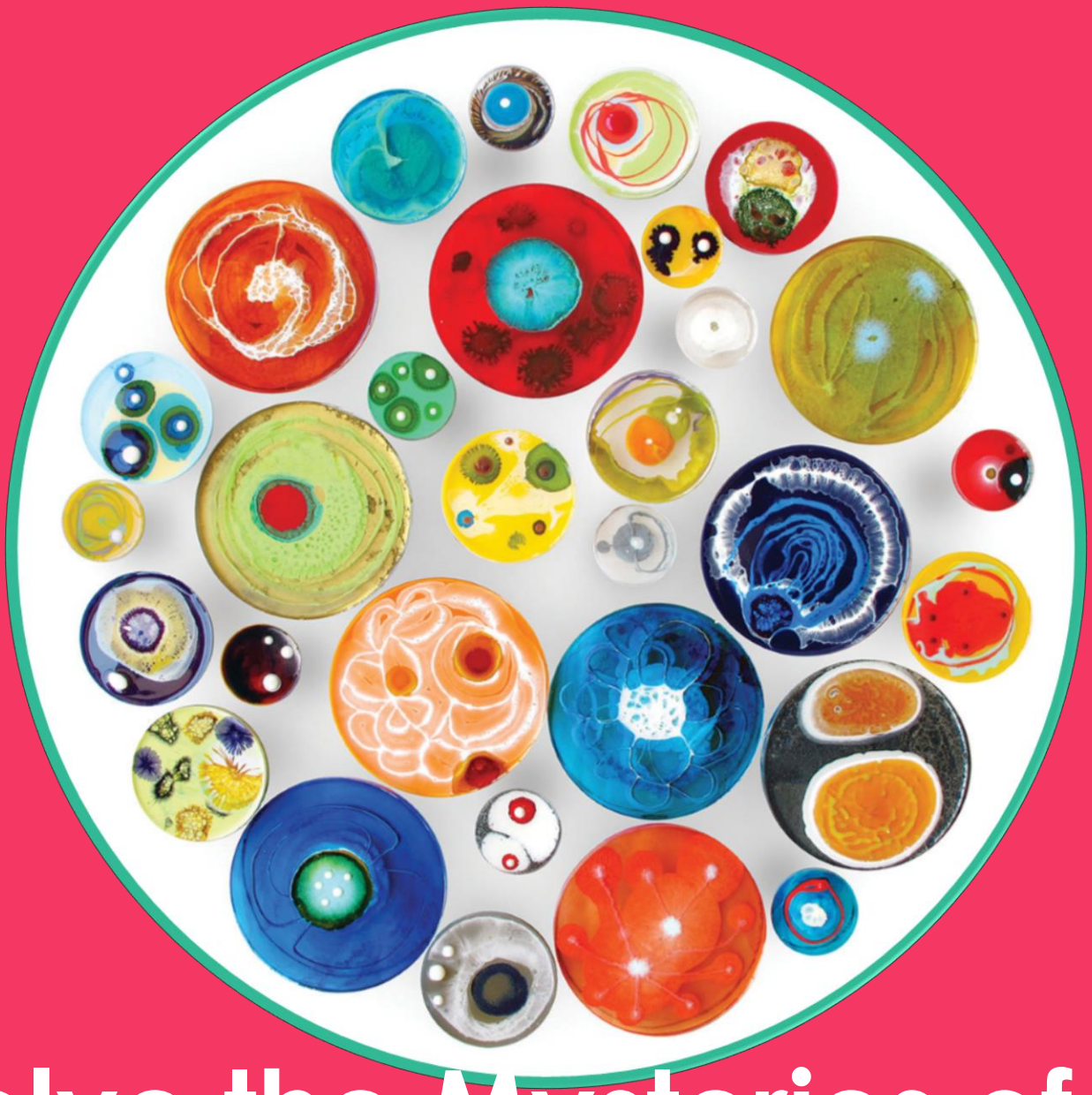
The Scholars Programme



Solve the Mysteries of Microbiology

Key Stage 4 Programme

Pupil Name

Tutorial Group

Coursebook Designed by Clair Preece

Course Rationale

Have you heard of diseases such as pneumonia, bronchitis, meningitis, or sepsis? Have you ever been poorly or had an infection? Maybe strep throat (tonsilitis) or gastroenteritis (a stomach bug)? Did it leave you wondering; how did I get this, why did I get this, how does the doctor know what it is and how do they know how to treat it? You may have had to give a sample of urine or blood to your doctor when you've been ill. Have you ever wondered what happens to this next?

Countless infections are caused by bacteria. These are pathogens (infectious agents) commonly known as germs or bugs and can be caught in a variety of ways.

Some bacteria are also known as 'superbugs'. An example you may have heard of is MRSA.

MRSA is not the name of the disease as many people think but is actually the name of the bacteria that causes the disease – Methicillin Resistant *Staphylococcus aureus*: Methicillin resistant, as it is very difficult to treat and resistant to numerous antibiotics and *Staphylococcus aureus*, the species of bacteria.

If you have ever had a stay in hospital, you may remember having a simple screening test to check for MRSA. A nurse will run a cotton bud (swab) over your skin so it can be checked for MRSA. Swabs may be taken from several places, such as your nose, throat, armpits, groin or any damaged skin. This is painless and only takes a few seconds, but it is vitally important to know if you are a carrier of MRSA to prevent transmission to others who may be vulnerable (children or elderly) or have a weak immune system (having chemotherapy or have cystic fibrosis) and may struggle to fight off this infection.

Staphylococcus aureus is both a commensal bacterium (meaning they live on or in the body without causing disease) and a human pathogen. About 30% of the population are colonised (which means that the bacterium is present on or in the body) with *Staphylococcus aureus* and two in every 100 people carry the MRSA strain in their nose without developing infections.

Within the UK, MRSA is a significant burden to the NHS so there are many different strategies to prevent this. For example, the swabs taken in hospital, thorough cleaning and disinfection of hospitals and care homes, good hand washing education, and the use of PPE (gowns and face masks).

Throughout this course you will be learning all about the different types of bacteria, how they get into the body and cause diseases and how Doctors and scientists diagnose these diseases. You will learn about some of the diagnostic tests that a microbiologist will do once they receive your specimen (sample of blood, urine, skin swab etc…). You will also find out how they grow the bacteria in the laboratory and identify it.

At the end of the course, you will bring together everything you have learnt and complete a final assignment. You will be acting as Marvellous Microbiologists and writing a report established on laboratory results you have gained from your patient's sample. Based upon evidence you have from investigations you will discuss the various tests and finally determine the type of bacteria the patient has.

During this course you will be developing a substantial range of transferable skills including how to conduct independent research, critical analysis, essay planning and writing, comprehension, how to reference accurately and by the end you will have significantly expanded your scientific knowledge. It will hopefully additionally uncover some budding microbiologists.

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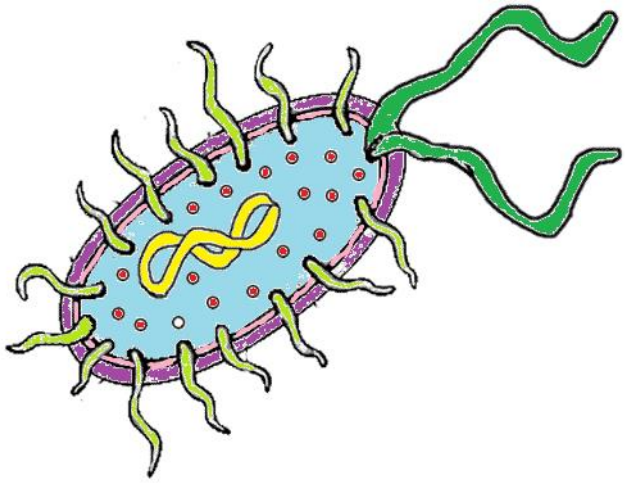
Sample Tutorial Activity



Learning Outcome: Discuss bacterial morphology

Read the following sections from two academic journals. Can you **interpret** what is meant by **bacterial morphology** from these articles?

Kysela DT, Randich AM, Caccamo PD, Brun YV (2016) ***Diversity Takes Shape: Understanding the Mechanistic and Adaptive Basis of Bacterial Morphology***. PLoS Biol 14(10): e1002565

Perusing the once-definitive guide to bacterial identification, *Bergey's Manual of Determinative Bacteriology*, one easily finds shapes much more interesting than rods and cocci. Even the language used to describe the morphologies of various species in the text quickly illustrates the veritable bacterial zoo found on earth: In addition to the familiar coccoid, rod-shaped, or spirilla types, there are also dendroid, coryneform, cylindrical, bulbiform, fusiform, and vibrioid types. There are uniseriate or multiseriate filaments of cells that are flexible or rigid, flat or round, unbound or bound in hyaline or slime sheaths. Single cells are described as star-shaped, disk-shaped, hourglass-shaped, lemon-shaped, pear-shaped, crescent-shaped, or flask-shaped. Rods can be pleomorphic, straight, curved, or bent, with blunt, pointed, rounded, or tapered ends. Some cells grow appendages such as prosthecae, stalks, or spikes. The representative schematics offer a glimpse of some of this diversity but hardly do justice to the variation of size and shape across the bacterial domain. *Bergey's* served as a guide for identifying species phenotypically for a century, underscoring how reliably each species reproduces its signature morphology.

van Teeseling MCF, de Pedro MAand Cava F (2017) ***Determinants of Bacterial Morphology: From Fundamentals to Possibilities for Antimicrobial Targeting***. Front. Microbiol. 8:1264

Bacterial morphology is extremely diverse. Specific shapes are the consequence of adaptive pressures optimizing bacterial fitness. Shape affects critical biological functions, including nutrient acquisition, motility, dispersion, stress resistance and interactions with other organisms. Although the characteristic shape of a bacterial species remains unchanged for vast numbers of generations, periodical variations occur throughout the cell (division) and life cycles, and these variations can be influenced by environmental conditions. Bacterial morphology is ultimately dictated by the net-like peptidoglycan (PG) sacculus. The species-specific shape of the PG sacculus at any time in the cell cycle is the product of multiple determinants.

Make your notes here:

The **shapes and arrangement** of bacteria is known as **Bacterial Morphology**. This is used for bacterial classification. Bacteria come in a variety of forms and have distinctive characteristic shapes. Under appropriate conditions, the shape and size of bacteria are relatively constant. It is important to know the morphological structure of bacteria, as it provides a better understanding of microbial physiology, pathogenicity, antigenic features, and allows us to identify them by species. This can be helpful in diagnosing disease and preventing microbial infections.

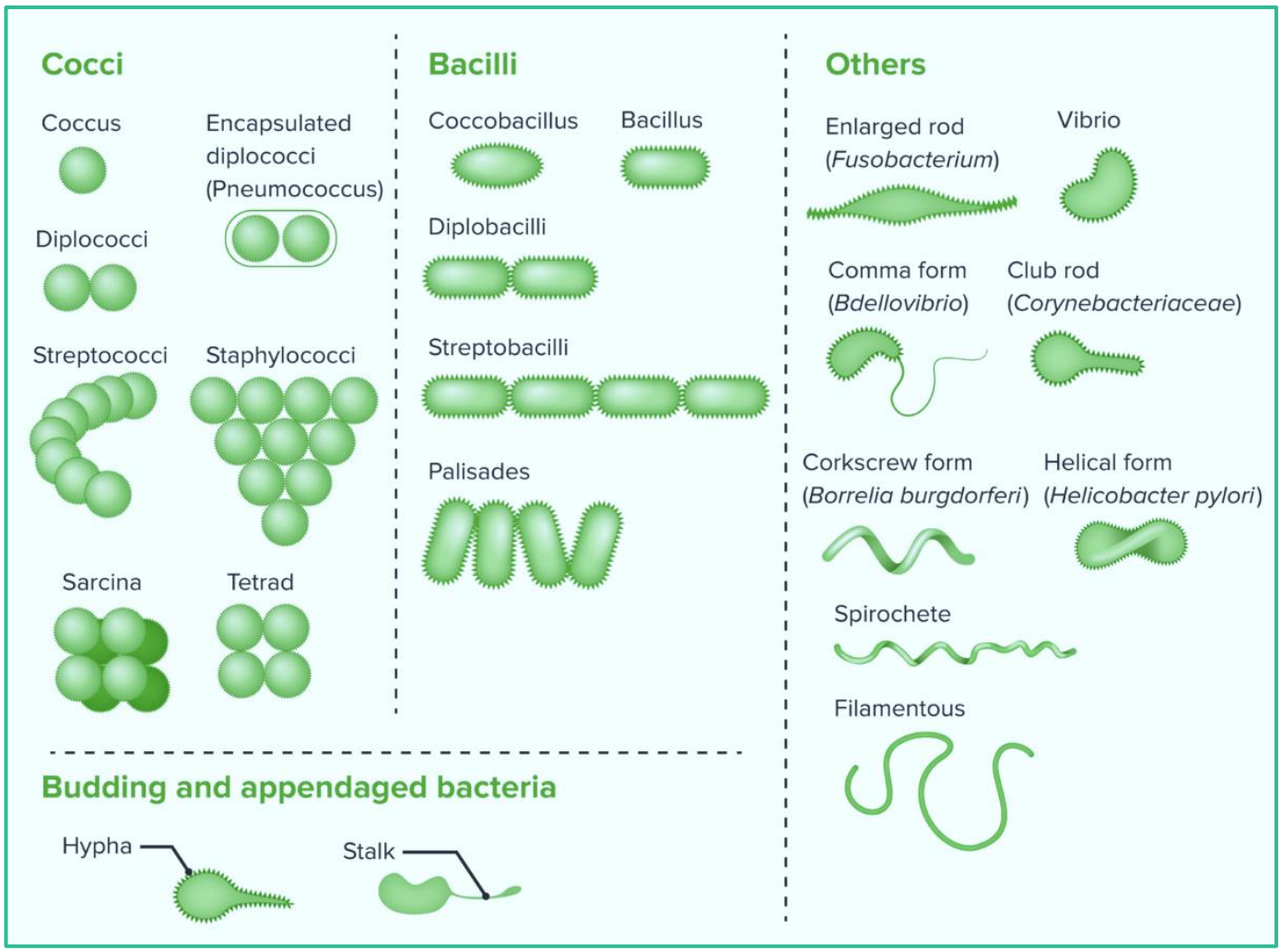


Image: Lecturio. Available at: https://app.lecturio.com/#/article/514

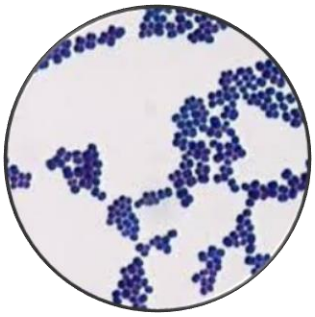
Morphology	Arrangements	Example
Cocci	Spherical, single or paired (diplococci), chains (Streptococci), Clusters (Staphylococci)	*Staphylococcus aureus*
Bacilli	Round ended cylinders, rods, pairs (diplobacilli), chains (Streptobacilli), palisades (fence like structure)	*Escherichia coli*
Coccobacillus	Short and stumpy, combination of cocci and bacilli	*Haemophilus influenzae*
Spirilla	Wavy, spiral, flexible	*Heliobacter pylori*
Spirochetes	Tight, corkscrew, rigid	*Treponema pallidum*
Vibrions	Comma shaped	*Vibrio cholerae*

The most common morphologies are cocci and bacilli.

Name that bacteria

Have a look at the information below. See if you can link the bacteria and Gram stain with its description. You can work in pairs or as a group to confer and share ideas.

Stapylococcus aureus

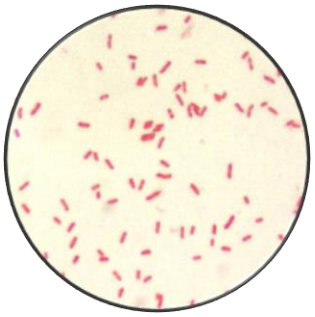


Gram negative bacillus. I live harmlessly in the intestines of humans, but certain strains of me can give you pain, diarrhoea and vomiting.

Escherichia coli

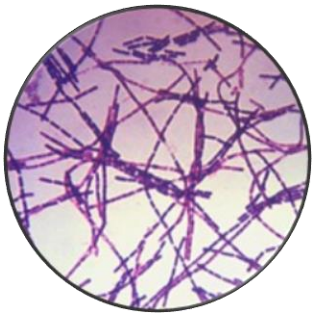
Gram positive bacillus in chains. I can give you a very serious infection called anthrax, causing sepsis and multiple organ failure

Yersinia pestis



Gram positive coccus in clumps. I can cause nasty skin infections and if I am resistant to most antibiotics, I am known as MRSA

Bacillus anthracis



Gram negative coccobacillus. I am famous for causing the plague (black death) in 1346. You catch me from bites off rats I have infected