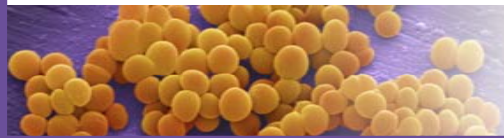


hsdM, hsdS, hsdR: restriction modification system

The proteins encoded by these genes are components that allow the bacteria to protect its DNA and recognise foreign pieces of DNA that enter the cell. This is a key defence mechanism against invasion. The *hsdM* modification enzyme adds chemical markers to the bacteria's own DNA. The *hsdS* specificity enzyme recognises these markers. However, if foreign DNA enters the cell, *hsdS* will recognise it as foreign, unmodified DNA and the *hsdR* enzyme will chop it up.

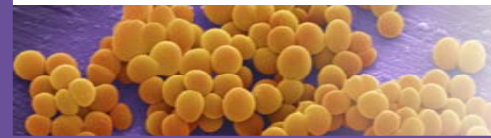
Mobile DNA 'cassettes' or elements tend to carry this suite of enzymes. The theory is that these pieces of DNA might be protecting themselves, but by incorporating them, the bacteria benefits. Specific lineages of *S. aureus* are known to regularly host these types of defence systems; they could be ways of fit strains establishing some barriers to protect against 'free-for-all' horizontal transfer of DNA.



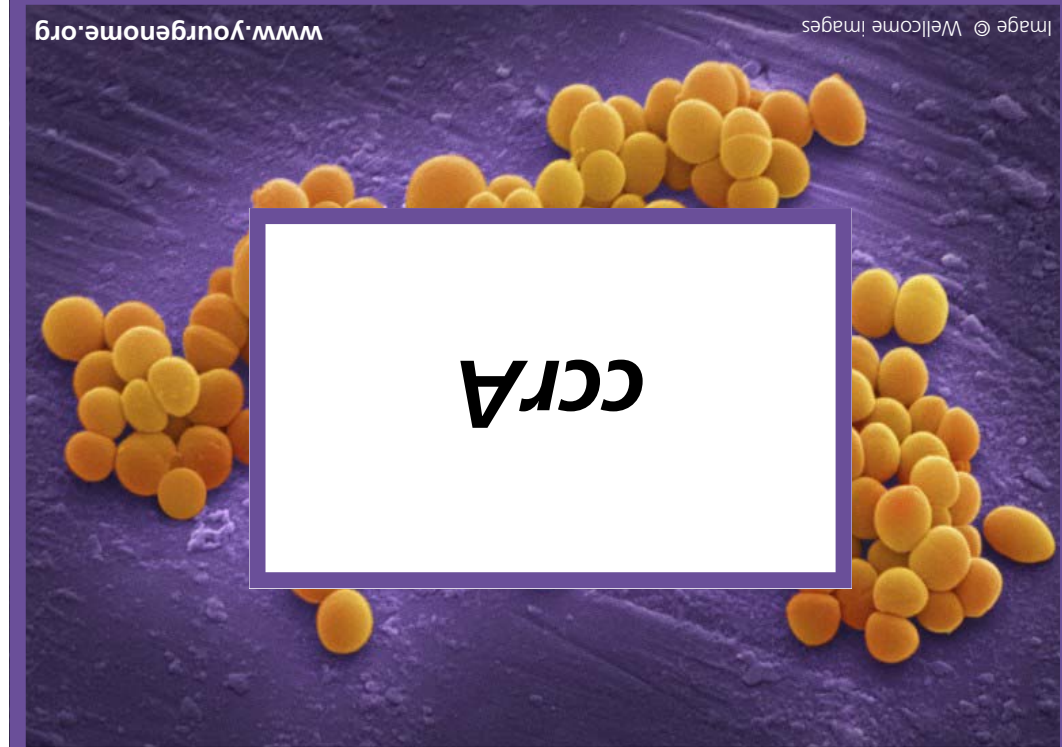
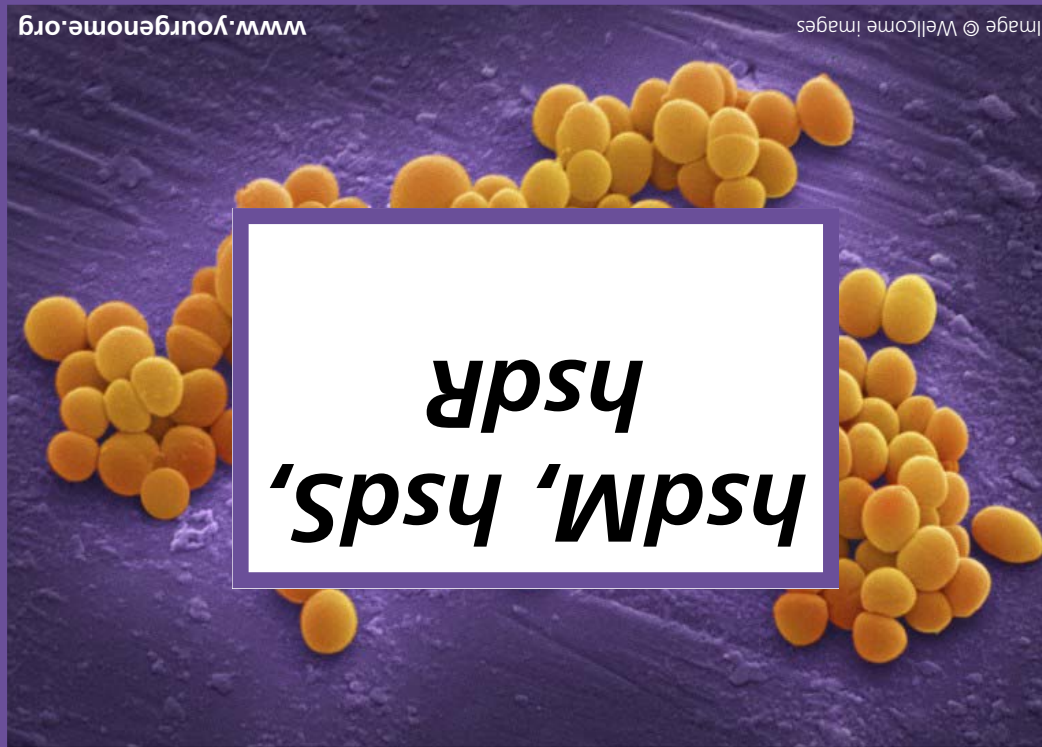
Staphylococcus aureus
MSSA 476

ccrA: Cassette chromosome recombinase A

This gene encodes a protein that allows a genomic 'cassette' of DNA to be inserted into the bacterial chromosome. However, when you compare its sequence to other *ccrA* gene versions, it appears to be more like *ccrA* from other, more-distantly related *Staphylococcus* genomes rather than the *ccrA* gene from MRSA strain MW2.

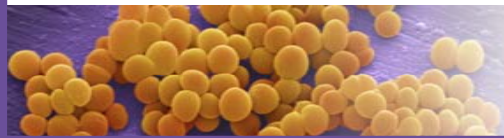


Staphylococcus aureus
MSSA 476



ccrB: Cassette chromosome recombinase B

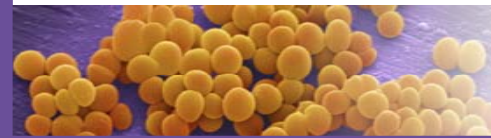
This gene encodes a protein that allows a genomic 'cassette' of DNA to be inserted into the bacterial chromosome. However, when you compare its sequence to other *ccrB* gene versions, it appears to be more like *ccrB* from other, more-distantly related *Staphylococcus* genomes rather than the *ccrB* gene from MRSA strain MW2.



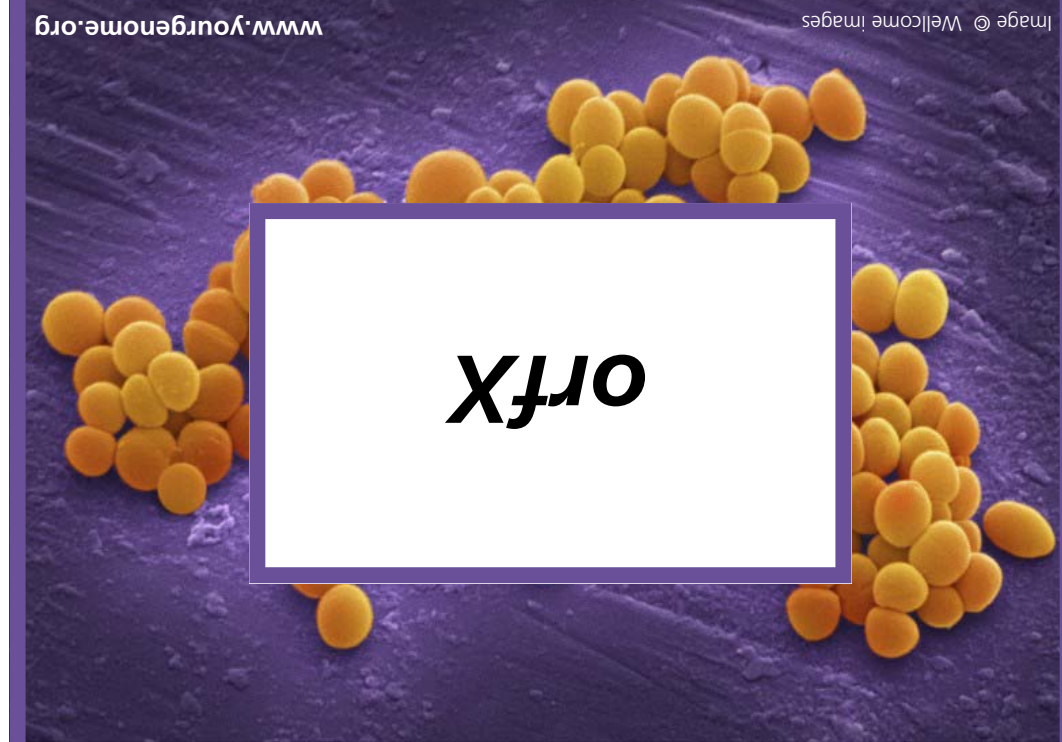
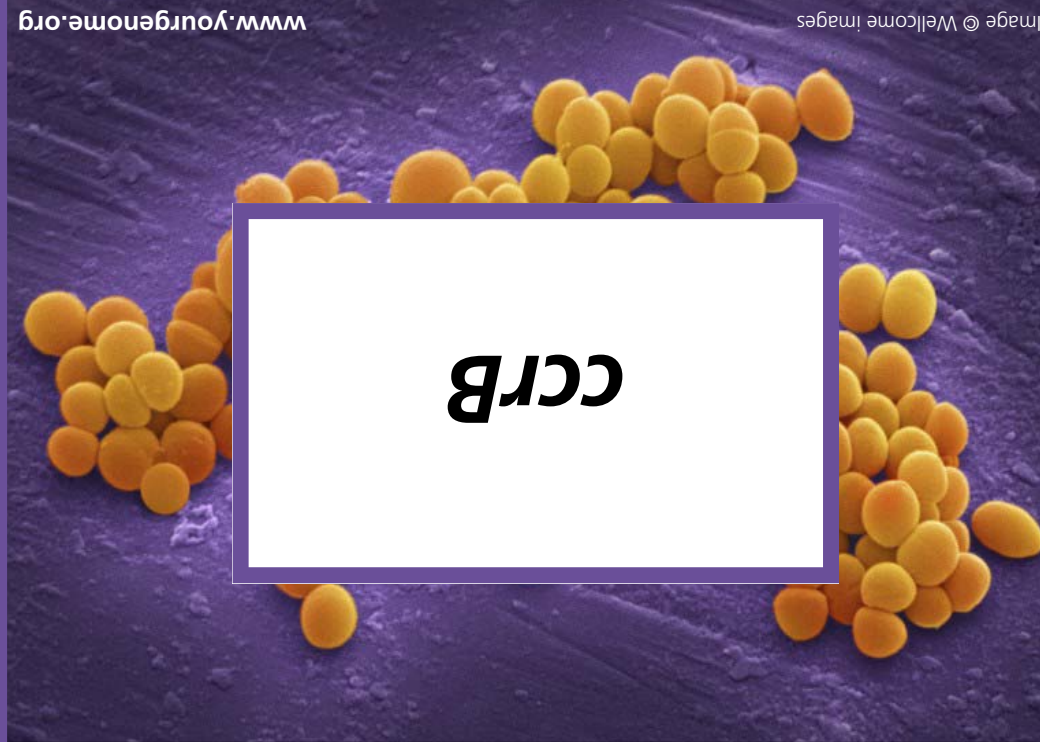
Staphylococcus aureus
MSSA 476

orfX

This gene is one of a large number in the *S. aureus* genome dedicated to making the molecules on the surface of this bacterium, which allow it to adhere to so many types of cell. The *orfX* gene is the site where SCCmec elements (carrying antibiotic resistance genes for methicillin) insert themselves into *S. aureus* genomes.

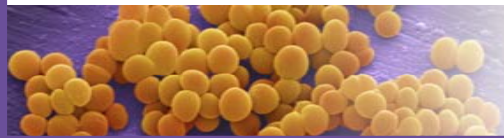


Staphylococcus aureus
MSSA 476



mecA: penicillin-binding protein 2-primer

This gene confers resistance against a wide range of penicillin-based antibiotics, including methicillin. It encodes a penicillin-binding protein (PBP) 2A that is able to continue synthesising the bacterial cell wall in the presence of antibiotics.

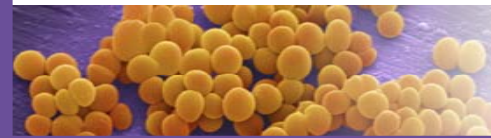


Staphylococcus aureus

MRSA MW2

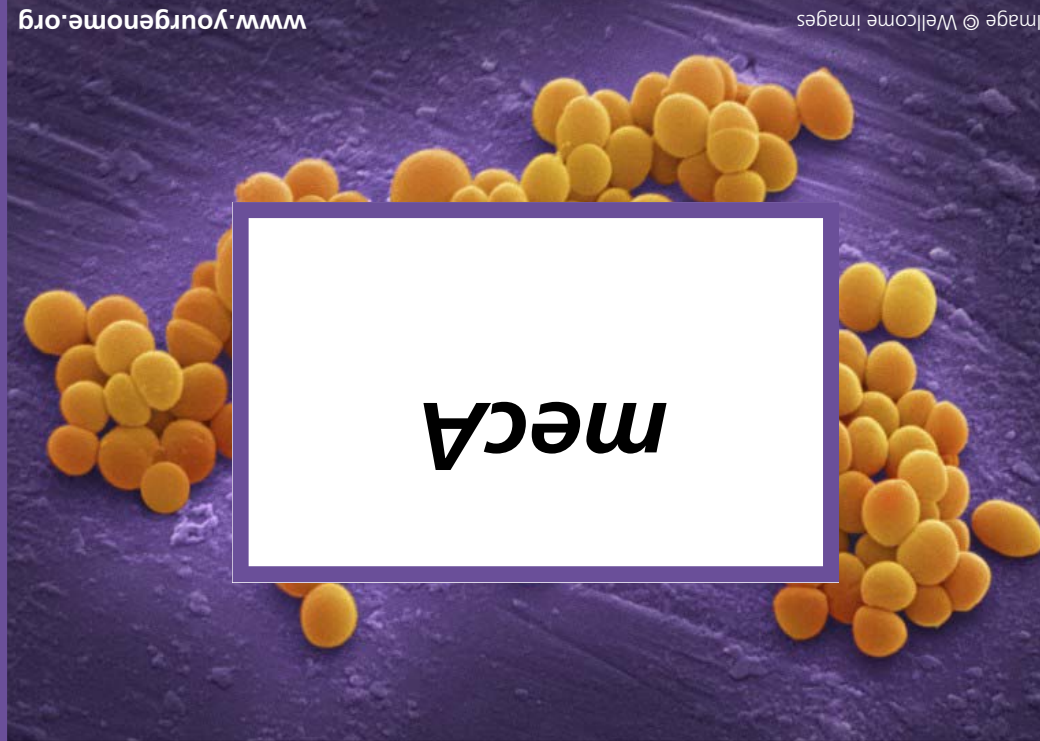
fusB1: fusidic acid resistance gene

fusB1 is a fusidic acid resistance gene. Fusidic acid is an antibiotic that is used in skin creams and ointments to treat minor skin infections. It is not often used in hospitals, but is in common use in the community.



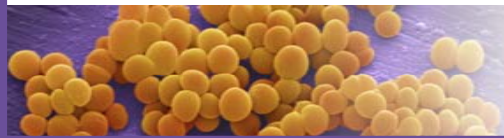
Staphylococcus aureus

MSSA 476



sec4: enterotoxin type C precursor

sec4 encodes a precursor to an enterotoxin. This means that the protein it produces is modified by another enzyme in order to become active. Enterotoxins cause diarrhoea and other symptoms when released in the gut, and other symptoms when released elsewhere in the body.

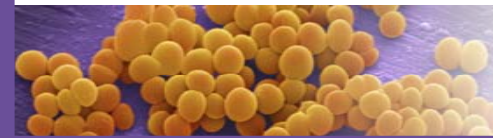


Staphylococcus aureus

MRSA MW2

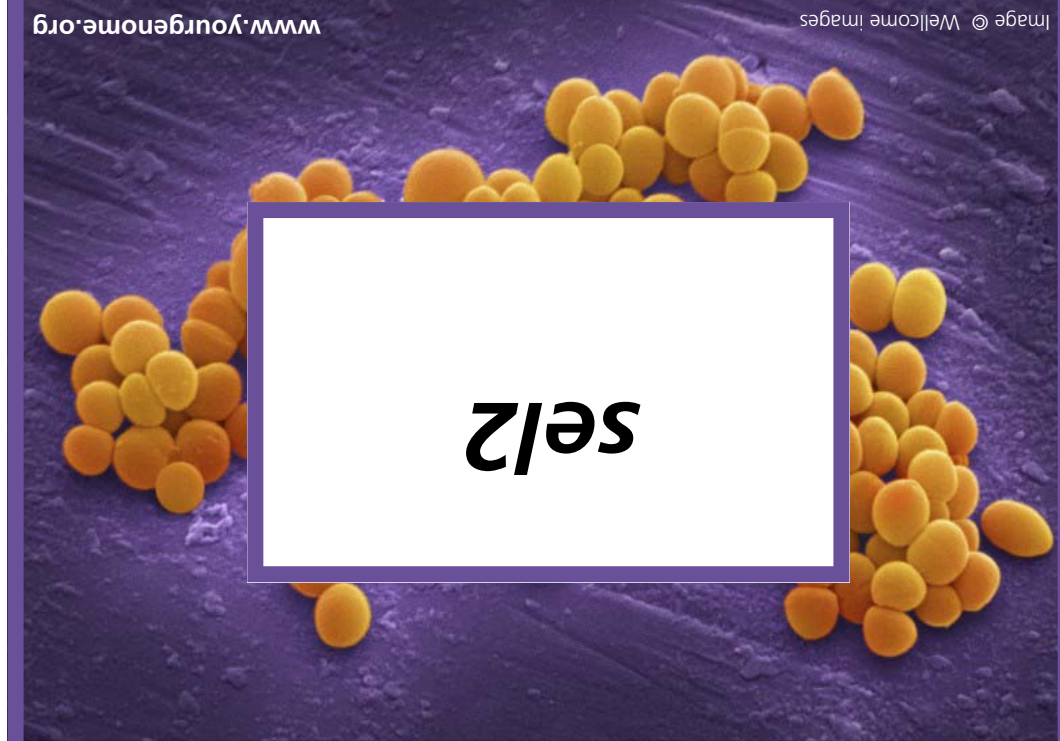
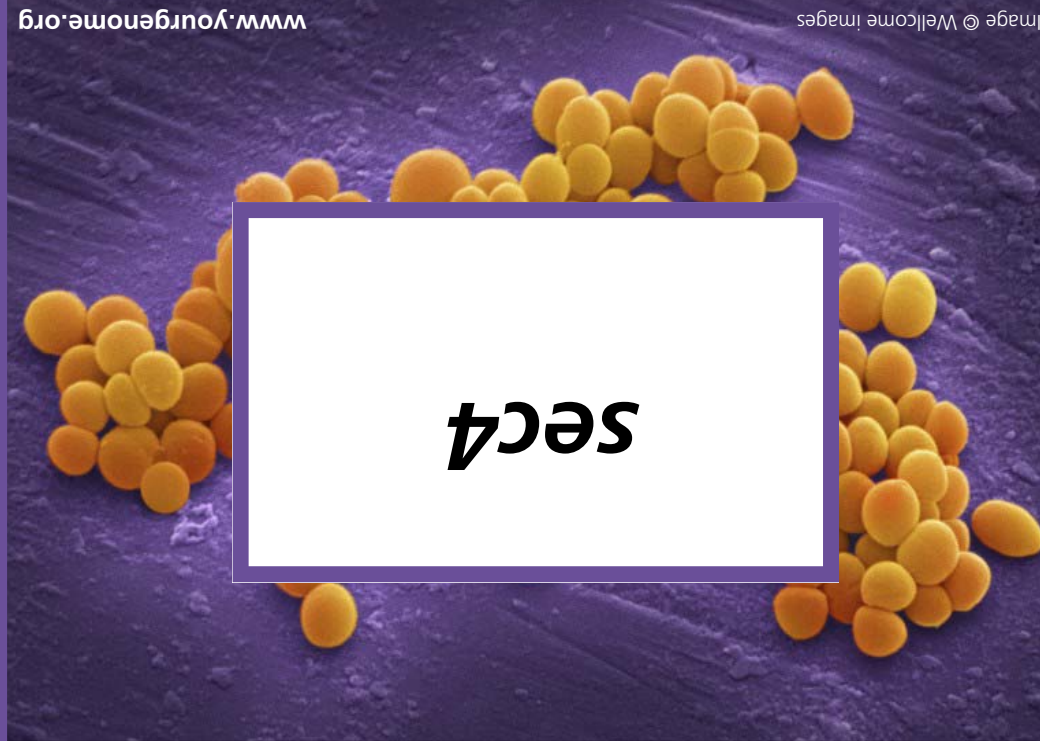
se/2: extracellular enterotoxin L

The protein encoded by this gene is an enterotoxin; a type of superantigen capable of causing a variety of symptoms by destroying the host's cells. It stimulates the body to produce large numbers of T cells which destroy all healthy cells around or near the area infected with *S. aureus*. This can cause extensive damage to tissues and organs sending the body into shock.



Staphylococcus aureus

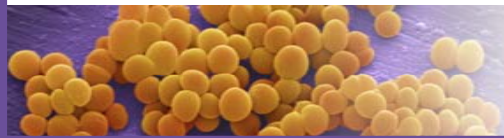
MRSA MW2



int (region3) : Integrase protein

This integrase gene is part of a virus that is parasitic on bacteria (called a 'bacteriophage'). Its purpose is to insert new DNA into the genome that has been copied from viral RNA or DNA.

The *int* gene in MSSA strain 476 is different to the *int* gene found in MRSA strain MW2; the sequence differences of these site-specific integrases may contribute to their different integration locations in the chromosome.



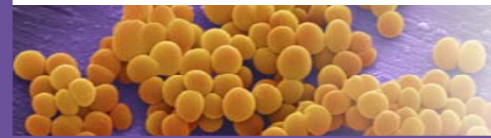
Staphylococcus aureus

MSSA 476

lukF: Pantone-Valentine leukocidin chain F precursor

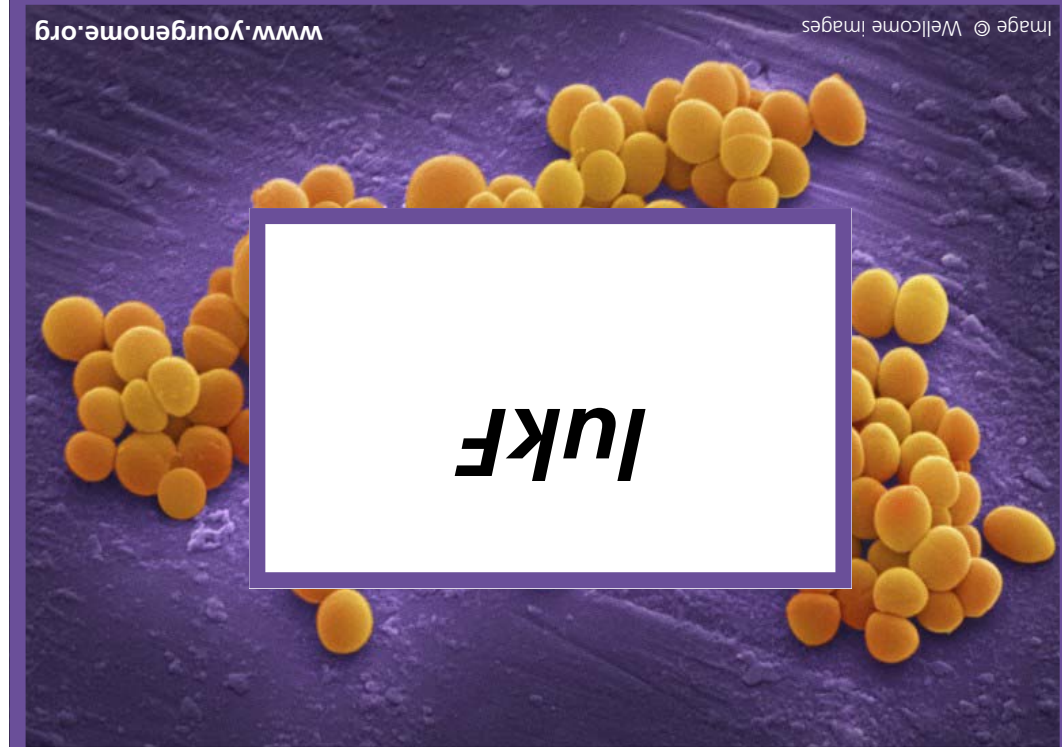
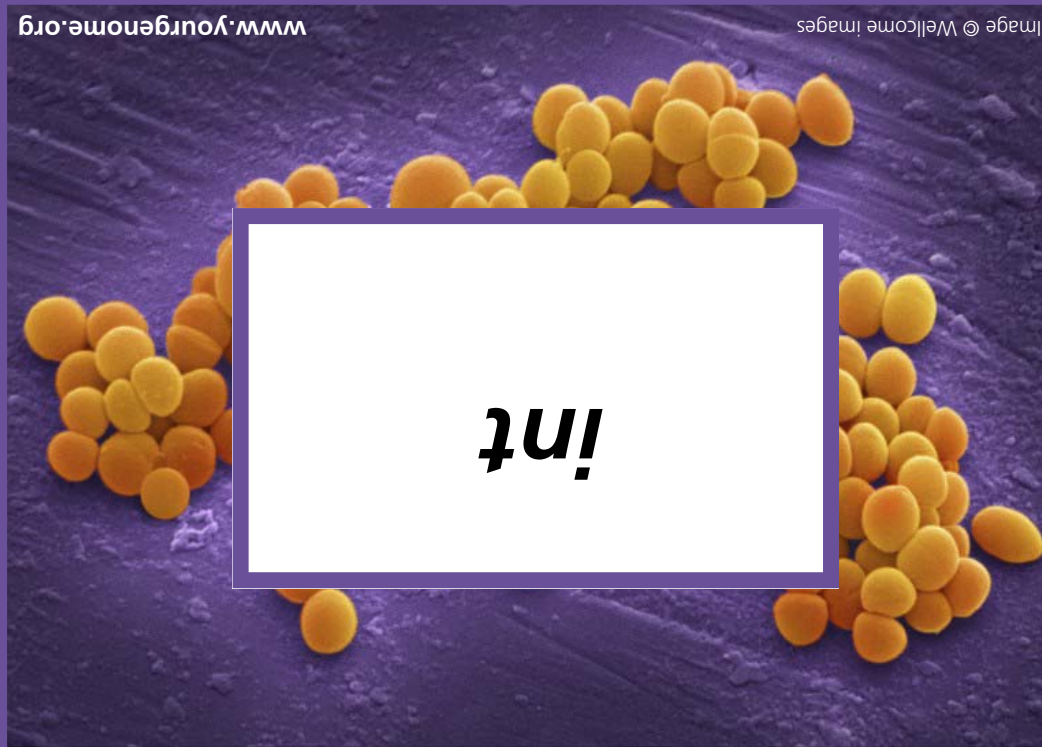
This gene encodes a protein that is part of Pantone-Valentine leukocidin, which is one of a family of haemolysin protein complexes. All of this family are toxic to humans, where they act by killing the white blood cells that make up the immune response to infection. The Pantone-Valentine complex is the most toxic haemolysin protein known and is the cause of necrotic lesions of the skin and sometimes sudden death.

The two sub-units of Pantone-Valentine leukocidin are secreted by the bacterium and meet up in the cell membranes of target cells. There they form into a ring with a hole in the middle, which causes the contents of the cell to leak out and the cell to die.



Staphylococcus aureus

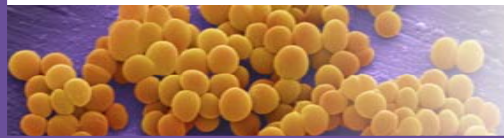
MRSA MW2



int (region 2) : Integrase protein

This is a hypothetical gene with a sequence very similar to integrases encoded by viruses. Its purpose is to insert new DNA into the genome that has been copied from viral RNA or DNA.

This *int* gene is related to the *int* genes elsewhere in MW2 (and MSSA), but is different. Sequence differences of these site-specific integrases may contribute to their different integration locations in the chromosome.



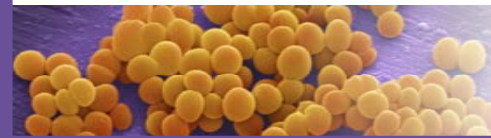
Staphylococcus aureus

MRSA MW2

lukS: Panton-Valentine leukocidin chain S precursor

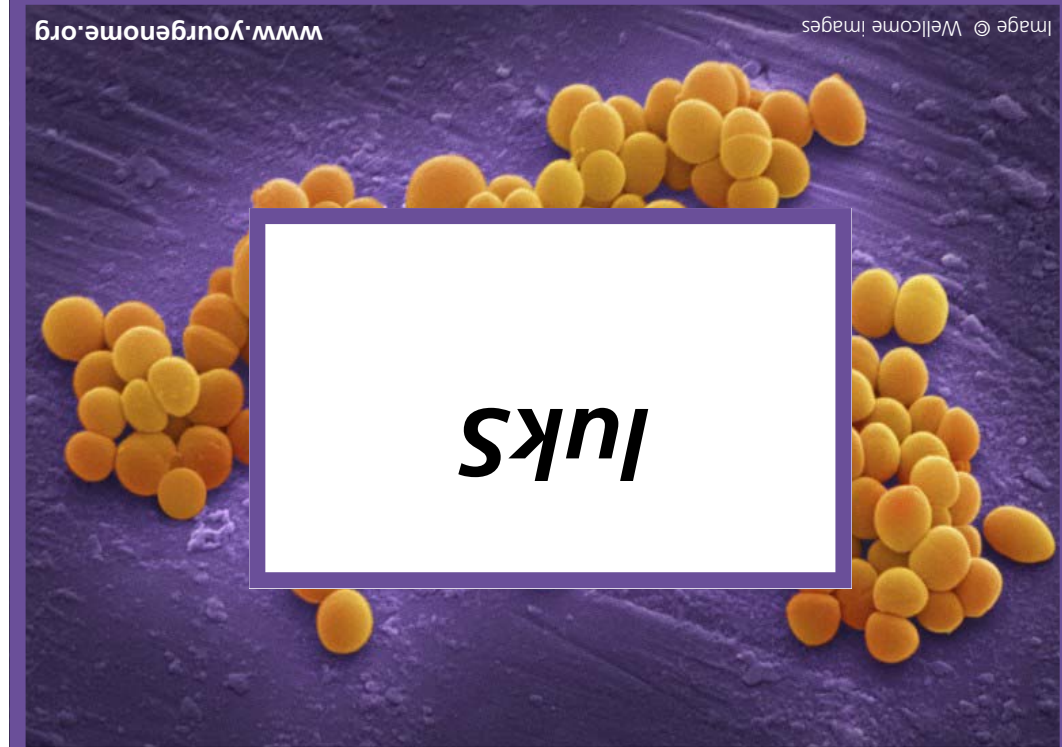
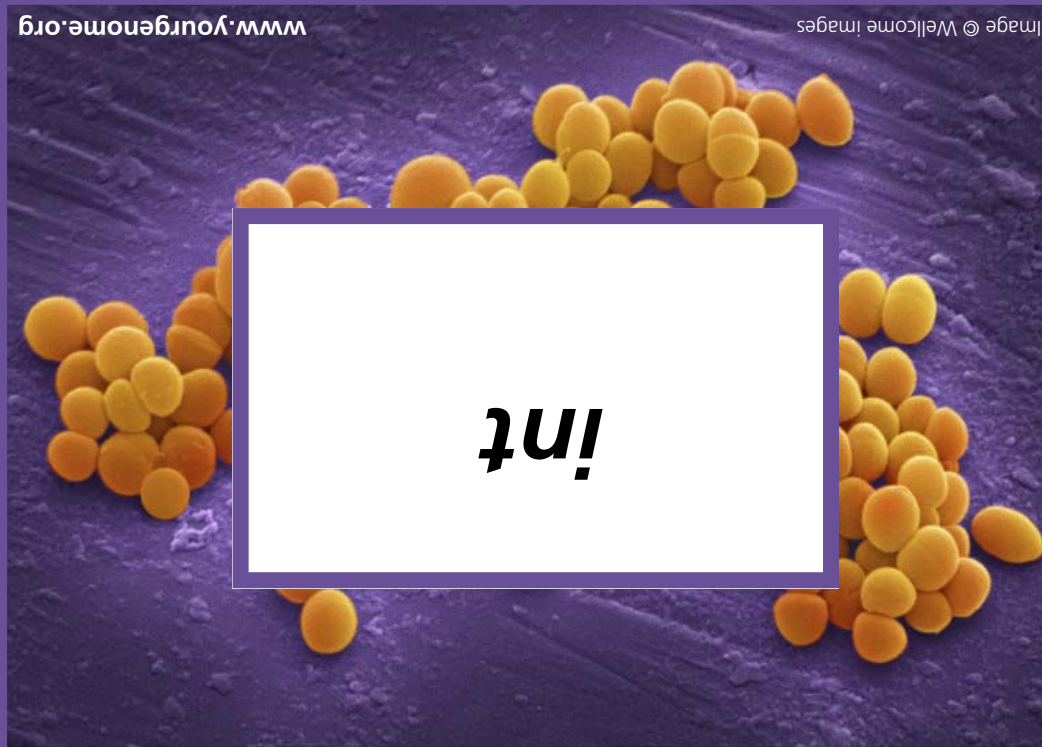
This gene encodes a protein that is part of Panton-Valentine leukocidin, which is one of a family of haemolysin protein complexes. All of this family are toxic to humans, where they act by killing the white blood cells that make up the immune response to infection. The Panton-Valentine complex is the most toxic haemolysin protein known and is the cause of necrotic lesions of the skin and sometimes sudden death.

The two sub-units of Panton-Valentine leukocidin are secreted by the bacterium and meet up in the cell membranes of target cells. There they form into a ring with a hole in the middle, which causes the contents of the cell to leak out and the cell to die.



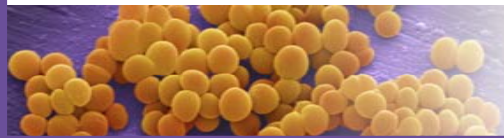
Staphylococcus aureus

MRSA MW2



ear: Enterotoxin B

This gene encodes a protein usually released in the gut of a human host; it attacks cell membranes, making the cells liable to rupture. Enterotoxins cause diarrhoea and other symptoms when released in the gut, and other symptoms when released elsewhere in the body.



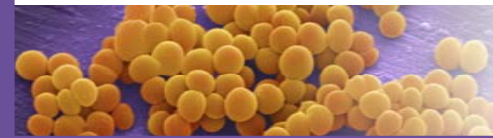
Staphylococcus aureus

MRSA MW2

orfX

This gene is one of a large number in the *S. aureus* genome dedicated to making the molecules on the surface of this bacterium, which allow it to adhere to so many types of cell. The *orfX* gene is the site where SCCmec elements (carrying antibiotic resistance genes for methicillin) insert themselves into *S. aureus* genomes.

Rapid tests to recognise MRSA often focus on the *orfX* gene, as well as the *mecA* gene, due to the possible contamination of other methicillin-resistant bacteria in hospital samples.



Staphylococcus aureus

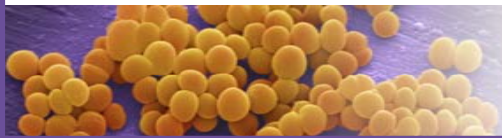
MRSA MW2

ear

orfX

ccrA: cassette chromosome recombinase A2

This gene encodes a protein that allows a genomic 'cassette' of DNA to be inserted into the bacterial chromosome.

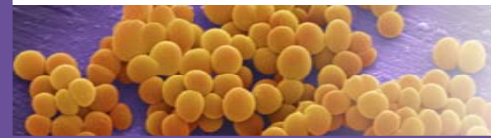


Staphylococcus aureus

MRSA MW2

ccrB: cassette chromosome recombinase B2

This gene encodes a protein that allows a genomic 'cassette' of DNA to be inserted into the bacterial chromosome.



Staphylococcus aureus

MRSA MW2

