VGEC: Tutorial Notes

Chemotaxis in *Campylobacter* –

PowerPoint transcript

Objectives: *the aim of this tutorial is to highlight the significance of motility in C. jejuni's ability to cause disease, understand the process of chemotaxis whilst also visualising these processes in real time.*

Slide 2 – *Campylobacter jejuni* is a Gram-negative, spiral shaped, micro-aerophilic pathogen. The success of *C. jejuni* as a human pathogen is borne from a mutual relationship it has formed with poultry. *C. jejuni* can colonise the guts of poultry without causing disease. If however, we eat uncooked chicken for example, the bacterium makes its way into our guts where it can cause damage.

Slide 3 – *C. jejuni* is the primary cause of food-borne gastroenteritis worldwide. Symptoms of gastroenteritis include: bloody diarrhea, dysentery and abdominal pain. These symptoms are caused by *C. jejuni* damaging the gut epithelium and subsequently altering the osmotic gradient of the gastrointestinal tract. In some cases (>1 in 5000), gastroenteritis can progress into the autoimmune disease

Guillain–Barré syndrome, a flaccid full body paralysis which is fatal in 3% of cases.

Slide 4 – One of the virulence determinants we know to be essential in *C. jejuni's* ability to cause disease is its flagella. Flagella are filamentous 'tail-like' structures encoded by many bacteria. They are the primary mechanisms implicated in bacterial movement (motility). *C. jejuni* have two major flagellin (the major protein constituent of flagella) genes; *flaA* and *flaB.*

Slide 5 – Here we can see a figure taken from a study by Wassenaar *et al* in 1991. In this study, using vector based recombination they constructed strains that had individual flagellin genes interrupted. In addition they isolated strains derived from the wild type which had expression of both genes switched off. The genotypes and phenotypes of strains in the diagram are shown in the table below.

Strain	Flagellin genotype	Flagellin phenotype	Motility
81116 wild-type	A+ B+	A+ B−	+
81116 Fla$^-$	A+ B+	A− B−	−
81116 (R1)	A− B+	A− B+	−
81116 (R2)	A− B−	A− B−	−
81116 (R3)	A+ B−	A+ B−	+
81116 (R4)	A− B+	A− B+	−

Table 1 – genotypes and subsequent phenotypes of constructed strains in the Wassenaar *et al* (1991) study.

From this they decided not only that motility was essential for *C. jejuni* to colonise the gut, but it is in fact *flaA* and not *flaB* that is essential to this process.

Slide 6 + 7 – Unlike some other bacteria, *C. jejuni* express polar motility. The flagella rotate in an energy dependent manor to move the bacterium. In order to move in an appropriate direction then, *C. jejuni* must be able control rotation of their flagella appropriately. As bacteria lack the complex sensory systems of higher organisms, they alter flagellar movement in response to chemical signals from their environment. This process is known as chemotaxis.

Slide 8 – Chemotaxis plays two roles: helping bacteria to detect and move towards positive signals such as nutrients (chemo-attractants) and away from agents poisonous to them (chemo-repellents).

Slide 9 – These various signals form what is known as a chemotactic gradient. The chemotactic gradient determines the general direction of movement of *C. jejuni.*

Slide 10 – *C. jejuni* however do not constantly move along the chemotactic gradient. Periodically the bacteria will display a behaviour called tumbling, a random change in direction. So with tumbling, how do bacteria ever move closer to favourable environments? The answer is that cells will move further down a chemotactic gradient than they will up them.

Slide 11 – This video shows the results of a fluorescent chemotactic assay developed in the department. Cells will move gradually towards the left of the screen whilst periodically tumbling. In this video, off the screen to the left is a small disc soaked in a chemoattractant molecule.

Slide 12 – The signal transduction cascade involved in chemotaxis is extremely complex. This video shows an overview of the mechanisms regulating motility in *E. coli.* This system is similar to that of *C. jejuni*.

Slide 13 – In addition chemotaxis, expression of flagellin genes is also governed by a process known as phase variation. Phase variation is the switching on and off of genes in response to mutations in hypervariable tandem repeats. Cells with flagellin expression in the ‘off’ phase are not motile. More information on phase variation can be found on the link in slide 13.