

Vibration patterns in cell culture vessels

A common problem in cell culture

Have you ever observed unusual patterns of cell attachment in your culture vessels? At first sight, you may find no logical explanation of the patterns, especially as they are very seldom formed and seem to arise spontaneously. However, on closer examination, you may find a high degree of regularity or symmetry in the pattern, indicating that the cells are moved by physical forces applied at a certain frequency, likely during the initial attachment to the culture vessel. A common cause of the problem due to the vibrations transmitted from the incubator fan to the shelves. Depending on the frequency of the vibration, standing waves may be formed in the culture medium (i.e., when resonance in frequency is attained).

As illustrated in Figure 1, nodes are formed in the standing waves of the medium. Cells grow only at the nodes, where the growth medium is motionless. Between the nodes, the medium moves up and down according to the directions of the waves, thereby preventing the cells from attaching and moving them towards the nodes.

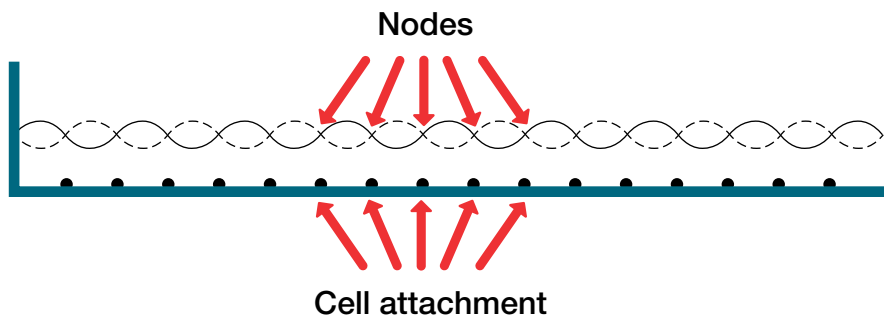


Figure 1. Formation of nodes in standing waves. When resonance occurs during vibration, cell attachment is aligned with the nodes in the waves, resulting in a patterned growth of cells.



Figure 2. Cell culture growth in a dish when standing waves are present.

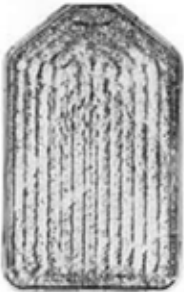


Figure 3. Cell culture growth in a flask when standing waves are present.



Figure 4. Cell culture growth in a spot-like fashion due to incubator vibrations.



Figure 5. Cell culture growth at the center of a flask due to very slow vibrations.

A typical example of standing waves in a cell culture dish is shown in Figure 2, where the cells grow in concentric circles. A similar effect in a flask is shown in Figure 3. In this case, the standing waves have been formed across the flask. A more complex pattern due to incubator vibrations is shown in Figure 4. In this case, the cells grow in a spot-like manner, as a result of two standing waves, one across and one lengthwise in the flask. In Figure 5, the cells grow at the centerline of the flask because of very slow vibrations. In this case, the vibrations do not come from the incubator but from carrying the flask in a horizontal position with slow and gentle shaking (e.g., walking).

How to eliminate the problem?

In a typical cell culture lab, vibrations can come from a number of sources. Aside from the incubator fan, they can come from a centrifuge placed next to the incubator, a freezer or refrigerator turning on and off, and even from the climate control system in the cell culture lab. Eliminating vibrations may not always be possible due to the construction of the fan or placement of the fan motor. Since the problem of vibration is essentially due to resonance in frequency, you can try to alter the frequency of your equipment (e.g., incubator) by, for example, placing something heavy in one corner of the incubator; but be aware of the risk of potential contamination in the incubator and be prepared to take necessary measures to minimize the risk.