EDITORIAL

Show me “Bioactive!”
Let’s play the Feud

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What do you think about when you hear the word bioactive? These days, we often see this word used to describe dental materials, but with a rather loose interpretation.

While watching a popular television game show the other day, I reflected on this idea of how people interpret a word or phrase. The Family Feud TV show, which debuted in 1976, playfully pits 2 families of 5 against each other in a competition to identify the most popular answers given by 100 people surveyed in response to a specific question or statement. Watching the current host, Steve Harvey, react to some of the wild answers of the competitors and the actual survey respondents is precious. I have a long history with this show, dating from its origin when the host was actor Richard Dawson. After Richard Dawson would ask the contestant for their response to the question, and, for example, let’s say they said “7,” he would turn to the big board showing the 4 to 8 most popular answers and either yell out, “Survey says!” or “Show me 7!” If they guessed correctly, a panel on the board would flip over, revealing a “7,” accompanied by a loud “DING,” and the team and audience would all cheer. A wrong answer would result in a loud buzzer and a large red X filling the TV screen.

It got me wondering what 100 dentists would say if surveyed about how they would describe a bioactive material.

Merriam-Webster defines bioactive as “having an effect on a living organism.”1 This is a very general definition, and one can see how this could also mean toxicity, which I do not believe is the meaning of bioactive we imagine for dentistry. The definition is too broad and provides little evidence of the expected beneficial effects; we need more specifics.

Many specific definitions have been proposed for bioactive materials.2 Perhaps the earliest use of the word bioactive was associated with bioactive glass, or Bioglass, as described by the inventor, Dr Larry Hench. This specifically addressed implant materials.3 “A bioactive material is one that elicits a specific biological response at the interface of the material that results in the formation of a bond between tissues and the material.”4

The survey says: Bonds to tissues. DING! Providing a bit more context in this case, we would say that bone is the tissue.

The bonding concept was carried forward in more recent definitions specific to dental materials. “Bioactivity of dental materials relates to their potential to induce specific and intentionally desired mineral attachment to the dentin substrate.”5

Survey says: Bonds to dentin through mineralization. DING!

This definition remains narrowly focused on mineralization but does not explicitly suggest any specific interaction with the biology of the host system. So, where is the bio?

However, another definition incorporates biological interaction. “A bioactive material is one that acts upon or interacts with living cells and tissues to produce a specific response, such as biologically directed mineral formation.”6

Survey says: Directs cells to do something, such as form mineral. Again, DING!

This definition is broader: any living cells and tissues may participate in the interaction. In an American Dental Association Clinical Evaluators panel survey of 318 participants, the property most identified with bioactive materials was their ability to induce reparative dentin or favor tooth remineralization through ion release.7

The journal Bioactive Materials has the following definition: “Bioactive materials will feature adaptiveness to the biological environment, being designed to stimulate and/or

direct appropriate cellular and tissue responses, or control interactions with microbiological species. 

Survey says: Directs cells to do something, such as form mineral or control bacteria. DING!

This definition has been modified to be more specific to dental materials.

Dental restorative materials may be called “bioactive” if, in addition to their primary function of restoring or replacing missing tooth structure, they actively stimulate or direct specific cellular or tissue responses, or both, or they can control interactions with microbiological species.

Survey says: Restore teeth and direct cells to do something, such as form mineral or control bacteria. DING!

The latter definitions all focus on biological interactions at many levels. So, here’s the bio!

In a 2022 FDI World Dental Federation Policy Statement, a bioactive dental restorative material can exert an effect in 3 ways: biologically, chemically, or via a mixed mode. The policy describes specific criteria that must be met to refer to a material as bioactive, and it makes 2 very important points: “Bioactive restorative materials should have beneficial/desired effects. These effects should be local, intended, and nontoxic and should not interfere with a material’s principal purpose, namely dental tissue replacement.”

This definition provides freedom to describe bioactive materials as those that generally fall into 1 (or a combination) of 3 categories: mineralizing, antimicrobial, and antibiofilm (antifouling). By this definition, glass ionomers, certain ion-releasing liners, cements, sealants, restoratives, adhesives with added molecules to kill bacteria on contact, materials that release antimicrobial agents, and so on, would all be considered bioactive. This definition has obvious advantages for manufacturers, providing significant leeway in making claims. However, in a stricter sense, with the intent that the material serves its primary function as a restorative material and interacts with living cells within the oral environment to do something positive, perhaps the most fitting definition of those presented thus far would be:

Dental restorative materials may be called “bioactive” if, in addition to their primary function of restoring or replacing missing tooth structure, they actively stimulate or direct specific cellular or tissue responses, or both, or they can control interactions with microbiological species.

In my best impression of Richard Dawson, “Show me bioactive!” DING! DING!

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References