

[SQUEAKING]

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**PROFESSOR:** In this goodie bag, we'll be exploring atomic packing and solids through the cubic Bravais lattices. We'll make three ball-and-stick models of different cubic unit cells.

For this, you will need 31 balls and 44 sticks-- 24 for FCC, 12 for SC, and 8 for BCC. If you don't have a fancy crystal modeling kit like this, any ball-and-stick equivalents will work. A delicious alternative would be using toothpicks and marshmallows.

The objective of the goodie bag is to explore the different structures of crystalline materials. As you build the models, consider how many nearest neighbors an atom has in an SC, a BCC, and an FCC crystal.

So now we're going to construct our Bravais lattices. We'll start with simple cubing. Begin by taking 8 balls and connecting them with sticks such that each ball sits at the corner of a cube. Then for body-centered cubic, we're going to start with a single ball in the center of a cube and connect to 8 other balls at the corners with sticks.

For face-centered cubic, it's going to be a little more involved. We'll start with the corner of a cube and form tetrahedra to other balls, which themselves will form tetrahedra to another corner of a cube. If we iterate through this process, we eventually end up with a full face-centered cubic lattice.

We've now constructed three ball-and-stick models of cubic Bravais lattices. The simple cubic lattice has atoms at each of the 8 corners of the unit cell. The body-centered cubic lattice has an additional atom in the body center of the unit cell. And the face-centered cubic lattice has an additional atom in each of the 6 face centers of the unit cell.

Each of these lattices has a different coordination number. That is, an atom in each lattice has a different number of nearest neighbors. If we imagine these atoms as hard spheres rather than this ball-and-stick model, we can see that each lattice will also have a different atomic packing factor. That is, each lattice will have a different volume of space occupied in the unit cell.

In general, the coordination number of a lattice correlates with atomic packing factor, which itself correlates with stability. That's why we don't often find simple cubic metallic solids in nature.