Monosaccharides with sym-L-di-triplet backbones

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7 June 2004
http://homepage.mac.com/whitby/

http://web.me.com/whitby/Octahedron/Welcome.html

Reference

1. Octahedron1stEd.pdf
2. LTriplets.pdf

Introduction

The D-fructose backbone consists of two three C-atom components–an L-triplet which is the backbone of D-glyceraldehyde and a symmetrical triplet which is the backbone of dihydroxyacetone. It is a di-triplet.

This paper shows the ways in which an L-triplet can join with a symmetrical triplet to form a di-triplet. It examines each of the di-triplets so formed to see whether it can accommodate an H_2O-group on each of its C-atoms. And it shows each of the ways in which six H_2O-groups can be combined on a given di-triplet.

An L-triplet in the ROB-1 orientation [See Ref. 2, Fig.2] is used as a reference and the symmetrical triplet is cleftly joined to one of the C-atoms, orange or red, at either of its ends. The L-triplet is shown with each orientation of the symmetrical triplet in Figure 1.

Figure 2 shows that the di-triplets formed by the addition of a symmetrical triplet to the orange C-atom of the L-triplet are not the same as the di-triplets formed by the addition of a symmetrical triplet to the red C-atom of the L-triplet. There can be no duplication.

In this paper, the sym-OBR di-triplets are presented first beginning with Figure 6 and ending with Figure 28. The OBR-sym di-triplets begin with Figure 29 and end with Figure 46.

Table 1 shows how many ways there are to join an H_2O-group to each of the C-atoms of each of the di-triplets. There are 640 combinations of O-atom joinings for each of the four sym-OBR di-triplets and 384 combinations for each of three of the four OBR-sym di-triplets. This disparity is a consequence of the structure of the L-triplet. This is shown in Figure 3.

Each of the ways in which a sym-OBR di-triplet can be formed using a given orientation of the symmetrical triplet is shown in Figure 4. The fourteen resulting di-triplets are shown separately in Figure 5.

Each of the twelve distinct orientations of the O-atom is shown in Figure 7.

Each of the ways in which an O-atom in a given orientation can join with a C-atom in a given orientation is shown in the table following Figure 7.

Figures 8 and 9 show how the symmetrical triplet restricts the ways in which an O-atom can join to each of its C-atoms.

Figure 10 shows the ten sym-OBR di-triplets which cannot accommodate an H_2O-group on each C-atom.

Figure 11 shows the four sym-OBR di-triplets which can accommodate an H_2O-group on each C-atom.

The treatment of the OBR-sym di-triplets is the same.

Table 1: Combined ways of adding H_2O-groups to sym-L-di-triplets

Di-triplet code	H_2O-groups by position						Combinations
	1	2	3	4	5	6	
RBR1OBR	4	2	2	2	2	4	640
					2	6	
RGR1OBR	4	2	2	2	2	4	640
					2	6	
GRG2OBR	4	2	2	2	2	4	640
					2	6	
GBG1OBR	4	2	2	2	2	4	640
					2	6	
OBROBO	6	2	2	2	2	4	384
OBROGO2	6	2	2	2	2	4	384
OBRGBG1	6	2	2	2	2	4	384
OBRGOG3	6	2	2	3	2	4	576

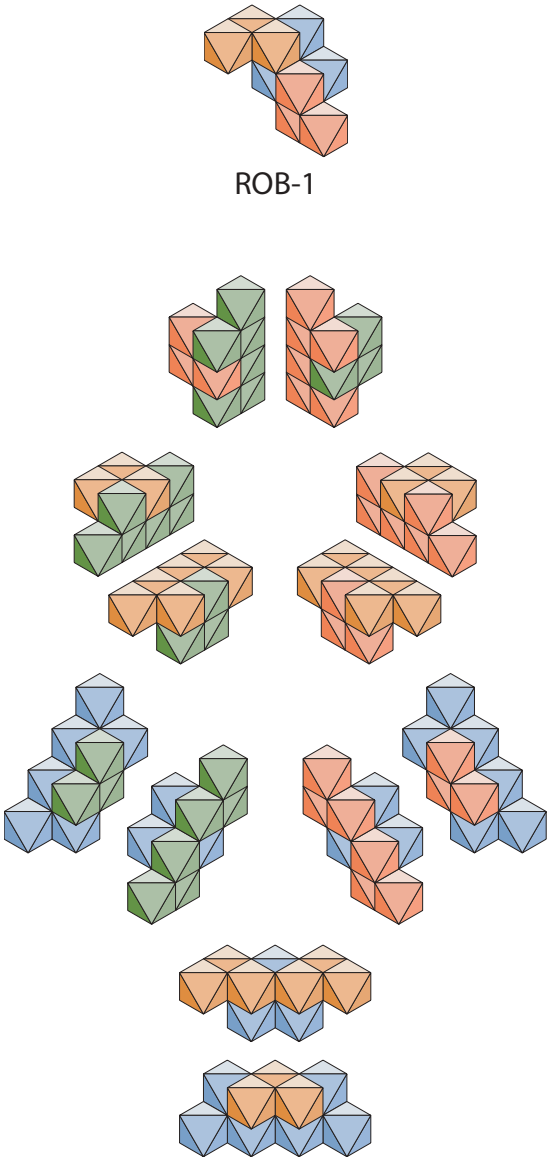


Fig. 1 Symmetrical triplet–twelve orientations

The figure shows the twelve orientations of the symmetrical triplet for the given octahedral view. The three groups of two triplets each at the bottom of the figure are parallel to the viewing plane; the three groups of two triplets each at the top of the figure are at an angle to the viewing plane. The axis of each triplet in a pair is parallel to the axis of the other triplet in the pair. The axis of each triplet is parallel to a pair of octahedral edges. The octahedron has six pairs of edges. A symmetrical triplet cleftly joined with either the orange C-atom or the red C-atom of the ROB-1 L-triplet at the head of the figure forms a backbone which is a candidate for that of D-fructose.

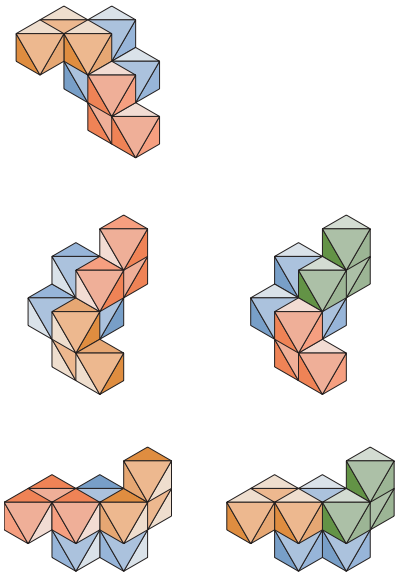


Fig. 2 Non-equivalence of the ends of the L-triplet

In the left column of the figure, the OBR triplet is shown in three orientations which differ by one-third turn. The top triplet in the column is in the ROB-1 orientation. The triplets in each row have the same orientation. The C-atoms of the triplets in the right column have been re-colored to conform to the orientation convention.

The figure shows that adding a symmetrical triplet to the orange C-atom of the OBR triplet produces an assembly which cannot be duplicated by adding a symmetrical triplet to the red C-atom of the OBR triplet.

The L-triplet at the top left differs by one-third turn from each of the triplets below it. The orange C-atom of the second triplet has been rotated into the same orientation as the red C-atom of the top triplet. But the red C-atom of the rotated triplet is not in the same orientation as the orange C-atom of the top triplet. Adding a symmetrical triplet to either end produces different assemblies.

The red C-atom of the third triplet has been rotated into the same orientation as the orange C-atom of the top triplet. But the orientation of the orange C-atom of the third triplet is not in the same orientation as the red C-atom of the top triplet. Adding a symmetrical triplet to either end produces different assemblies.

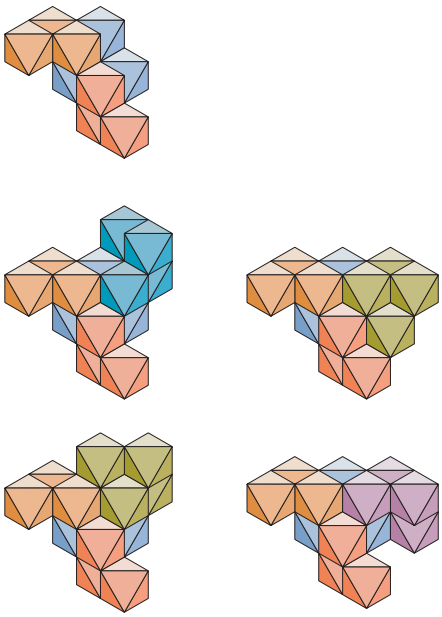


Fig. 3 The difference between the sym-OBR and OBR-sym di-triplets

There are 256 more ways for O-atoms to join with a sym-OBR di-triplet than there are for an OBR-sym di-triplet. This occurs because the O-atom joined to the blue C-atom of the OBR triplet can block one of the clefts of the red C-atom.

There are four ways for an O-atom to cleftly join with the blue C-atom of the OBR triplet shown here. In the left column, neither the aqua O-atom nor the yellow O-atom would prevent the red C-atom from making a join with either of its two free clefts. In the right column, the yellow O-atom is blocking one of the clefts of the red C-atom, while the violet O-atom will block the same cleft if it accommodates an H_2-group.

An OBR-sym di-triplet needs one cleft of the red C-atom for joining with a C-atom of the symmetrical triplet. The other cleft must accommodate an H_2O-group. The number of ways in which an O-atom can join to the blue C-atom of the OBR triplet in this situation is two.

In a sym-OBR di-triplet, the red C-atom has two available clefts while requiring just one for joining an O-atom. The number of ways in which an O-atom can join to the blue C-atom of the OBR-triplet is four.

The number of ways an O-atom can join with the red C-atom of an OBR triplet of a sym-OBR di-triplet is six for each of the two ways the O-atom is joined to the blue C-atom in the left column. This number is reduced to four when a cleft of the red C-atom is blocked by the O-atom attached to the blue C-atom.

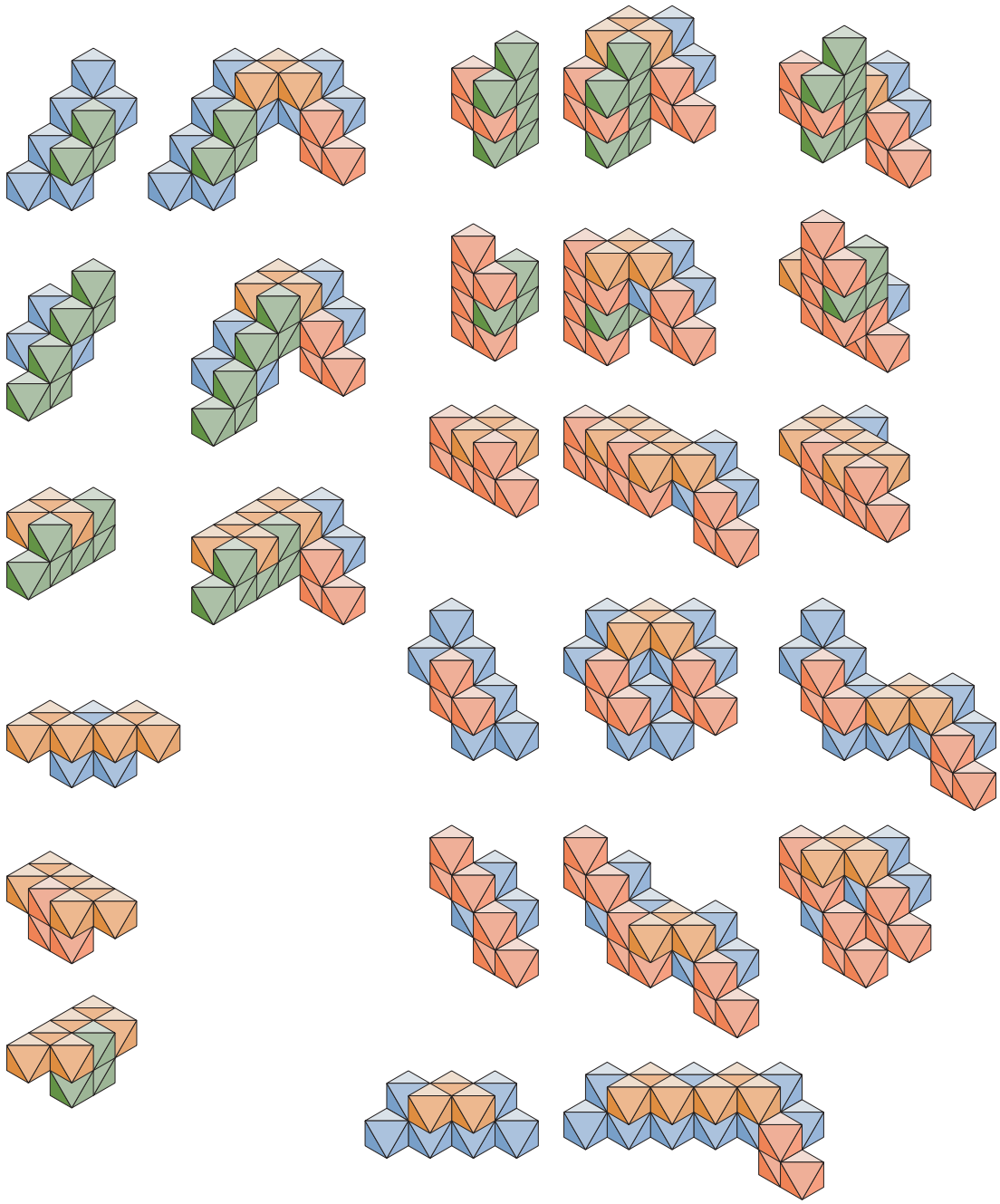


Fig. 4 Sym-OBR di-triplets

The figure shows each of the ways in which a symmetrical triplet can join to the orange C-atom of an ROB-1 L-triplet to form a di-triplet. In each of the assemblies, the L-triplet has a common orientation and a C-atom at either end of the symmetrical triplet is cleftly joined with the orange C-atom of the L-triplet. Three orientations of the symmetrical triplet cannot make a join with the chosen orientation of the L-triplet. Four orientations of the symmetrical triplet make just one assembly each. Five orientations of the symmetrical triplet make two assemblies each. There are fourteen di-triplet assemblies altogether.

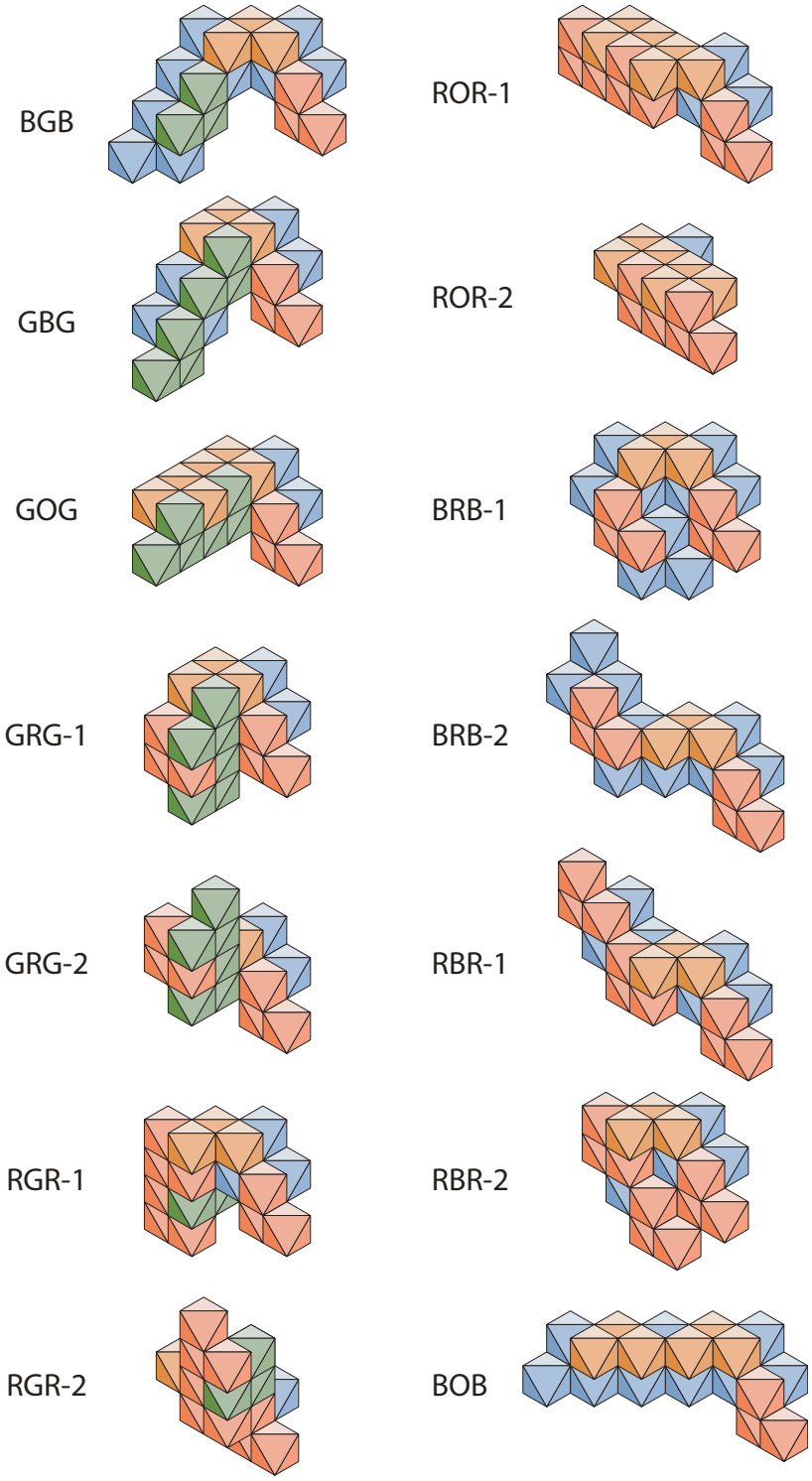


Fig. 5 Sym-OBR di-triplets
The fourteen sym-OBR di-triplets are shown in the figure.

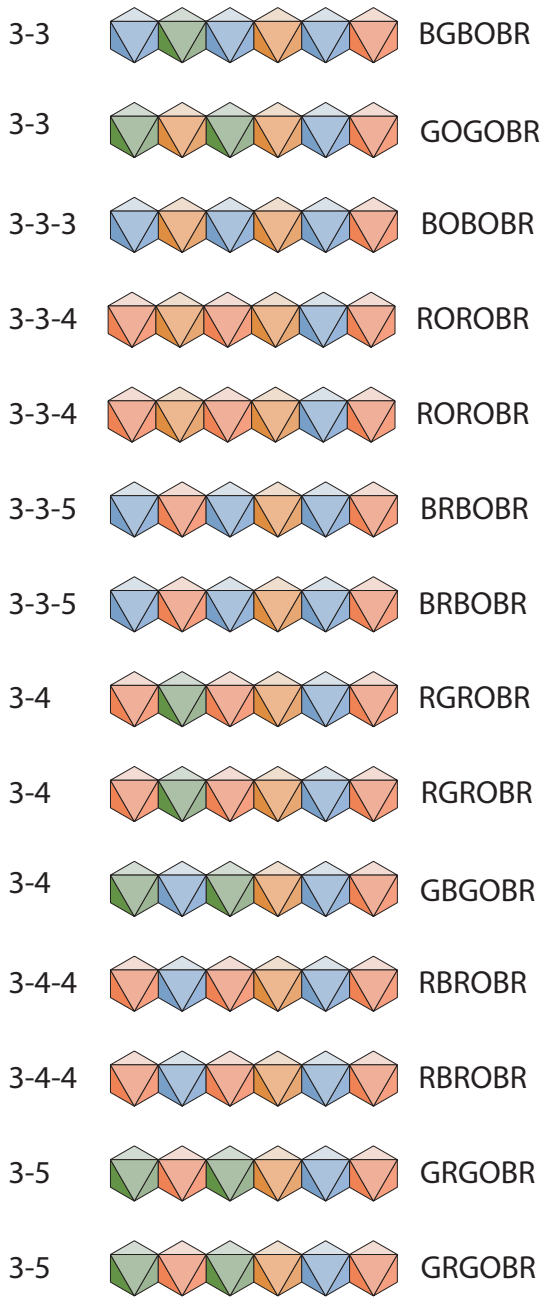


Fig. 6 Sym-OBR di-triplets–patterns of recurring C-atom orientation

Each of the fourteen sym-OBR di-triplets is represented in the figure by a horizontal row of six octahedra. Each octahedron represents one of the C-atoms of the di-triplet. The color of the octahedron conforms to the orientation of the C-atom it represents.

Each of the six letters to the right of an octahedral row represents a C-atom of the di-triplet. It is the first letter of the color of the C-atom and conforms to its orientation.

The numbers to the left of the octahedral row relate to the pattern of repeating orientation of the triplet. Each symmetrical triplet is a “3” because it is a three C-atom group whose first and third atoms have the same orientation. The bottom di-triplet has a “5” which represents the R repeat of the RGOBR segment.

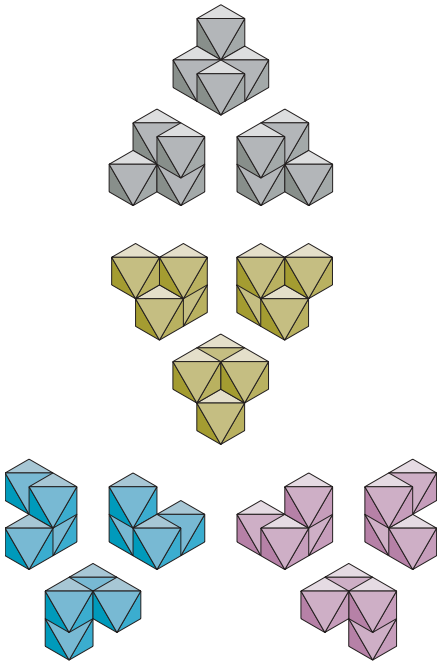


Fig. 7 Oxygen atom–twelve orientations

The figure shows the twelve orientations of an O-atom for the given octahedral view. They are arranged in four groups of three each. Each atom in a group differs from each of the other atoms in its group by one-third turn.

The following table shows how each of the twelve orientations of the O-atom joins cleft-to-cleft with each of the four orientations of the C-atom for the given octahedral view. Empty table cells indicate that no cleft join is possible between the two atoms when they are in their respective orientations.

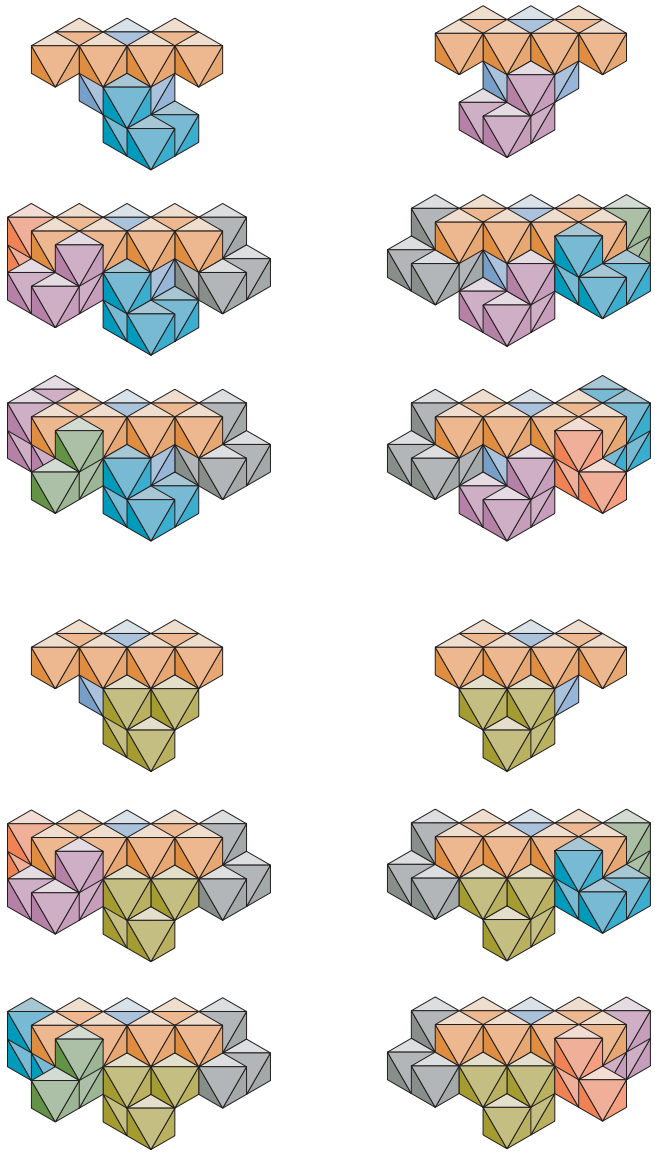


Fig. 8 Symmetrical triplet–O-atom accommodation

An O-atom joined to the middle atom of a symmetrical C-atom triplet in one orientation blocks a cleft of an adjoining C-atom or will not be able to accommodate an H_2-group if an O-atom is attached to an adjoining C-atom. If the O-atom on one C-atom blocks a cleft of a neighboring C-atom that is attached to a third C-atom, the third C-atom cannot accommodate an H_2O-group. The figure shows four ways in which an O-atom can join with the blue middle atom of a symmetrical triplet. Two examples show how each joining can be incorporated into a di-triplet.

The O-atom in the aqua orientation of the upper left could not accommodate an H_2-group if an O-atom or a C-atom were attached to the upper cleft of the orange C-atom to its right. So, the orange C-atom must be at the end of the di-triplet where it can accommodate only an O-atom as shown in the two assemblies in the second and third rows of the left column. The violet O-atom has the same effect as is shown on the upper right.

The yellow O-atom in the lower left is blocking the upper cleft of the orange C-atom to its right. Here, too, the orange C-atom must be at the end of a di-triplet where it can accommodate only an O-atom. The yellow O-atom in the lower right blocks the upper cleft of the C-atom to its left. This C-atom must be at the end of the di-triplet.

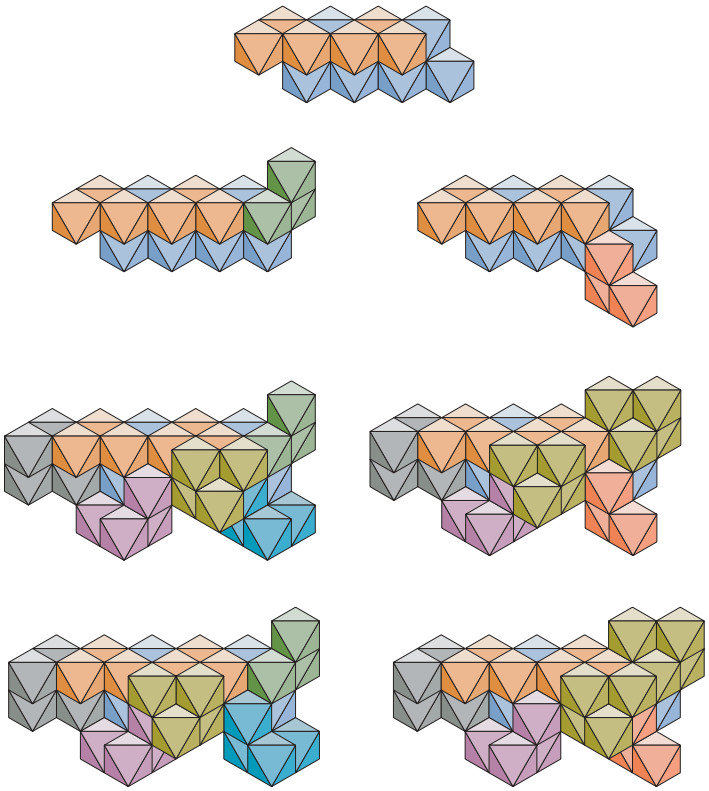


Fig. 9 O-atoms on C-atoms of segment OBOB of a sym-L-di-triplet

The figure shows that sym-L-di-triplets having the sequence OBOB-- cannot accommodate an H_2O-group on each of its C-atoms. In each of the four assemblies containing O-atoms, the yellow O-atom joined to the orange C-atom cannot accommodate an H_2-group.

Four C-atoms having the sequence OBOB are shown at the top of the figure. The rightmost C-atom belongs to an L-triplet; the other three C-atoms constitute a symmetrical triplet. The two ways for a C-atom of an L-triplet to join with the rightmost blue C-atom are shown in the first row. In the middle row, a yellow O-atom has been joined with the rightmost orange C-atom, an aqua C-atom has been joined to the rightmost blue C-atom, a gray C-atom has been joined to the leftmost orange C-atom, and an aqua O-atom has been joined with the rightmost blue C-atom

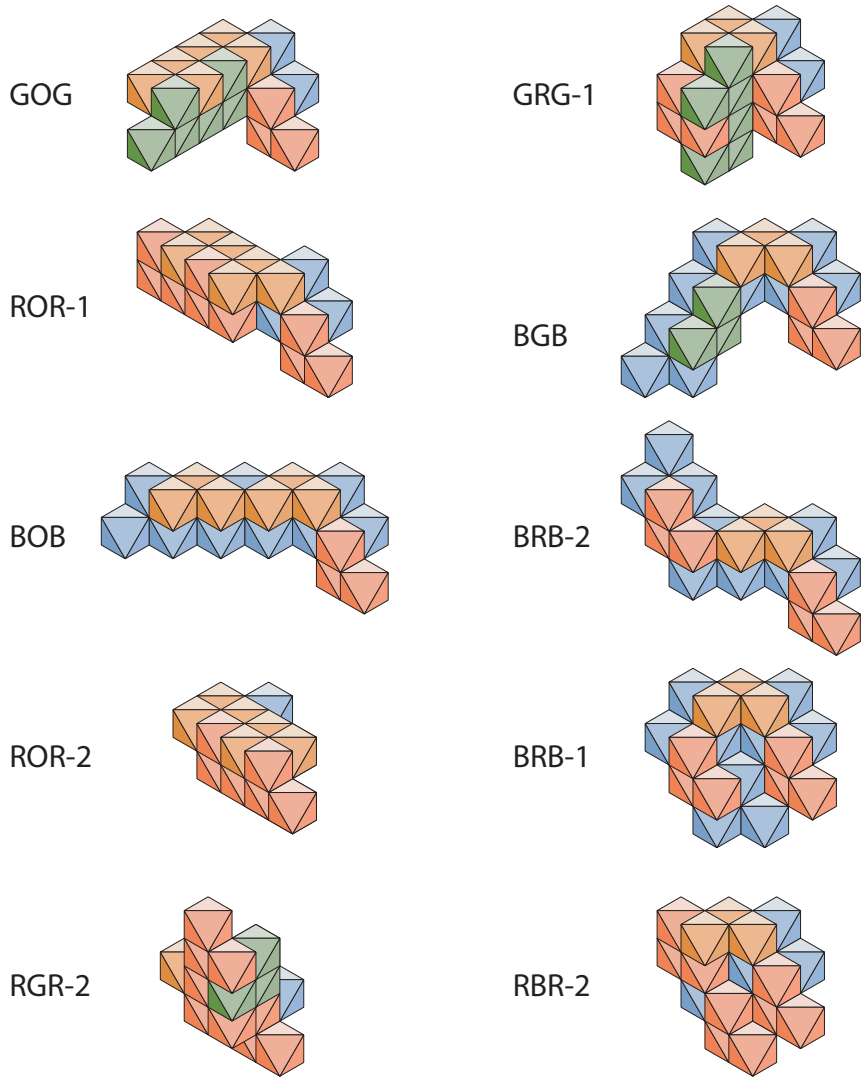


Fig. 10 Sym-OBR di-triplets that cannot accommodate an H_2O-group on each C-atom.

GOGOBR–The inner green C-atom cannot accommodate an H_2-group.

ROR1OBR-The inner red C-atom cannot accommodate an H_2-group.

BOBOBR–The orange C-atom of the L-triplet cannot accommodate an H_2-group.

ROR2OBR–An O-atom joined to the inner red C-atom cannot accommodate an H_2-group.

RGR2OBR–The red C-atom of the L-triplet blocks the third cleft of the inner red C-atom of the symmetrical triplet.

GRG1OBR–An O atom joined to the orange C-atom blocks the third cleft of the red C-atom of the symmetrical triplet.

BGBOBR–An O-atom joined to the orange C-atom cannot accommodate an H_2-group.

BRB2OBR–An O-atom joined to the orange C-atom cannot accommodate an H_2-group.

BRB1OBR–An O-atom on the orange C-atom blocks the third cleft of the red C-atom of the symmetrical triplet.

RBR2OBR–The blue C-atom of the L-triplet blocks the third cleft of the blue C-atom of the symmetrical triplet.

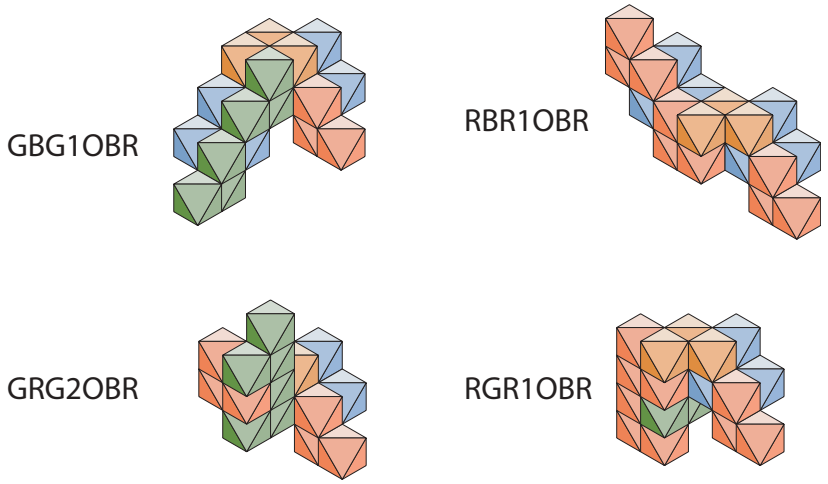


Fig. 11 Sym-OBR di-triplets

Each of the four sym-L-di-triplets which are shown in the figure can accommodate an H_2O-group on each of its six C-atoms

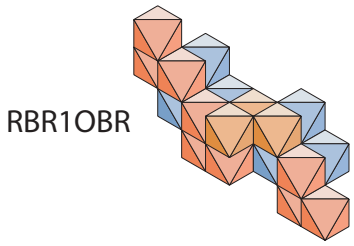


Fig. 12 The RBR1OBR di-triplet

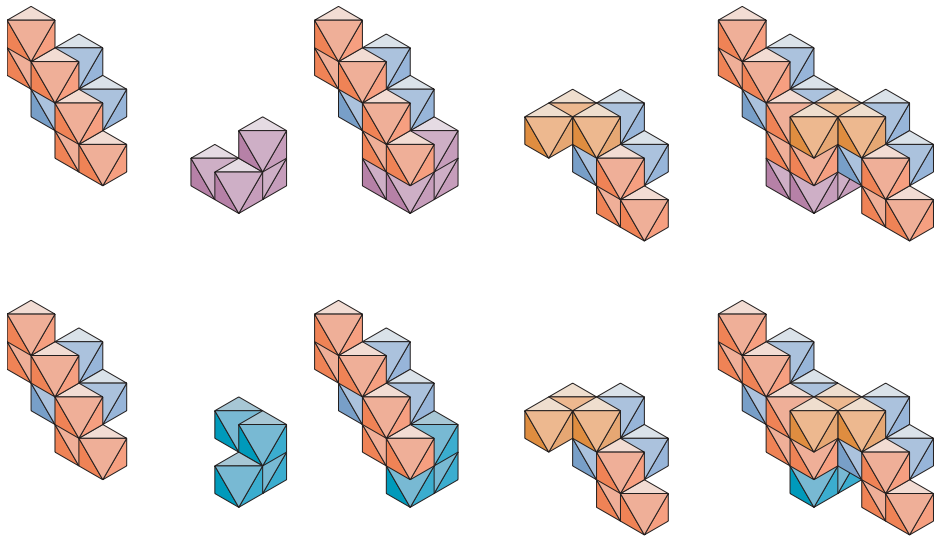


Fig. 13 RBR1OBR di-triplet–O-atom joinings with the inner red C-atom

The figure shows two ways for an O-atom to join with the inner red C-atom of the symmetrical triplet of the RBR1OBR di-triplet. In each case, the symmetrical triplet is shown on the left. with the O-atom to its right. The O-atom is joined with the red C-atom in the next step to the right. The L-triplet is shown next. In the rightmost view, the L-triplet has been joined to the symmetrical triplet.

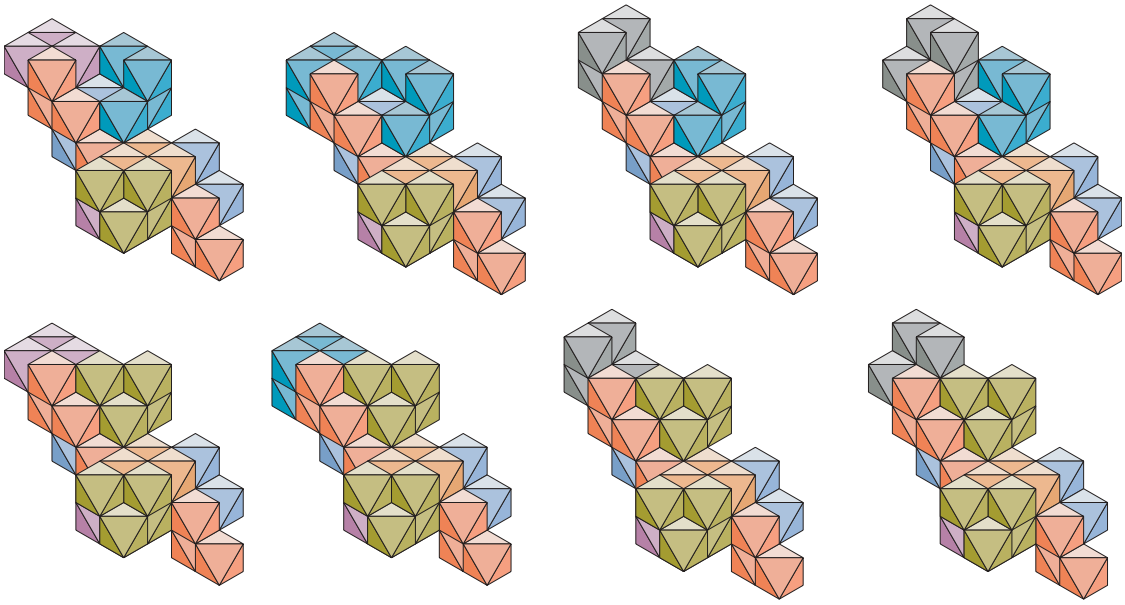


Fig. 14 RBR1OBR assemblies–additional O-atom joinings to the symmetrical triplet

In each of the assemblies shown in the figure, the violet O-atom is attached to the inner red C-atom of the symmetrical triplet. In-addition, a yellow O-atom is joined to the orange C-atom of each of the assemblies. Thirdly, an aqua O-atom is joined to the blue C-atom of the symmetrical triplet of each of the four assemblies in the top row; and a yellow C-atom is joined to the blue C-atom of the symmetrical triplet of each of the four assemblies in the bottom row. Each assembly in the left column has a violet O-atom attached to the outer red C-atom of the symmetrical triplet while an aqua O-atom occupies the same position in the assemblies of the second column and a gray O-atom occupies the same position in each of the other columns. The gray O-atom of the third column has an orientation which differs from that of the gray O-atom of the right column.

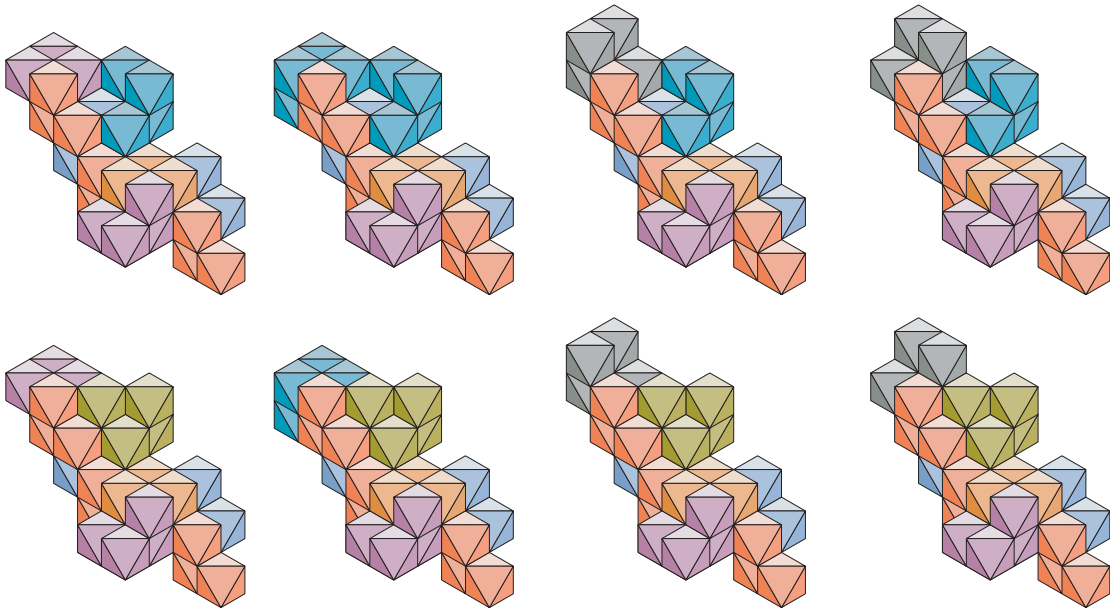


Fig. 15 RBR1OBR assemblies

Each of the six assemblies shown here has its counterpart in the previous figure. Each differs from the assembly in the same position of the previous figure by the orientation of the O-atom joined to the orange C-atom. Here it is in one of the violet orientations; in the previous figure it is in one of the yellow orientations.

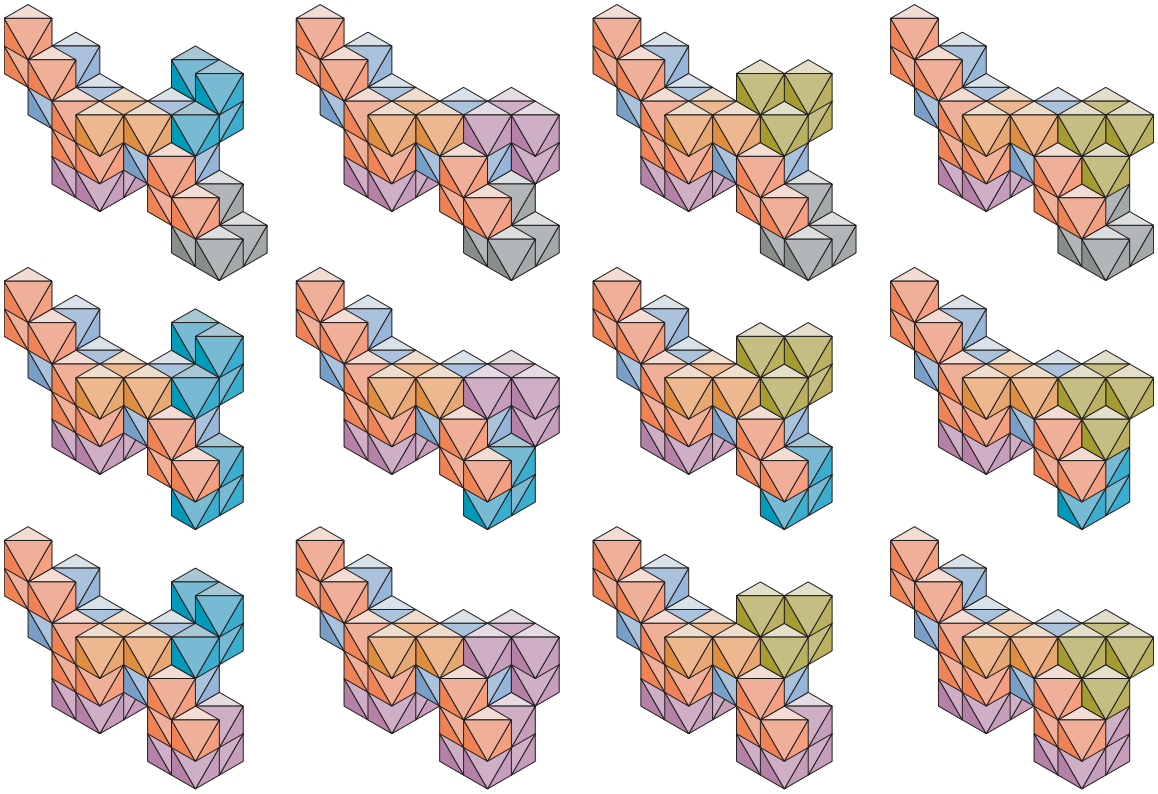


Fig. 16 RBR1OBR assemblies–O-atom joinings on the asymmetrical triplet

Each of the twelve assemblies shown in the figure has an O-atom in a violet orientation joined to the inner red C-atom of the symmetrical triplet. In each row, an O-atom is joined to the red C-atom of the L-triplet in the same way for each of the four assemblies. In each column, an O-atom is joined to the blue C-atom of the L-triplet in the same way for each of the three assemblies.

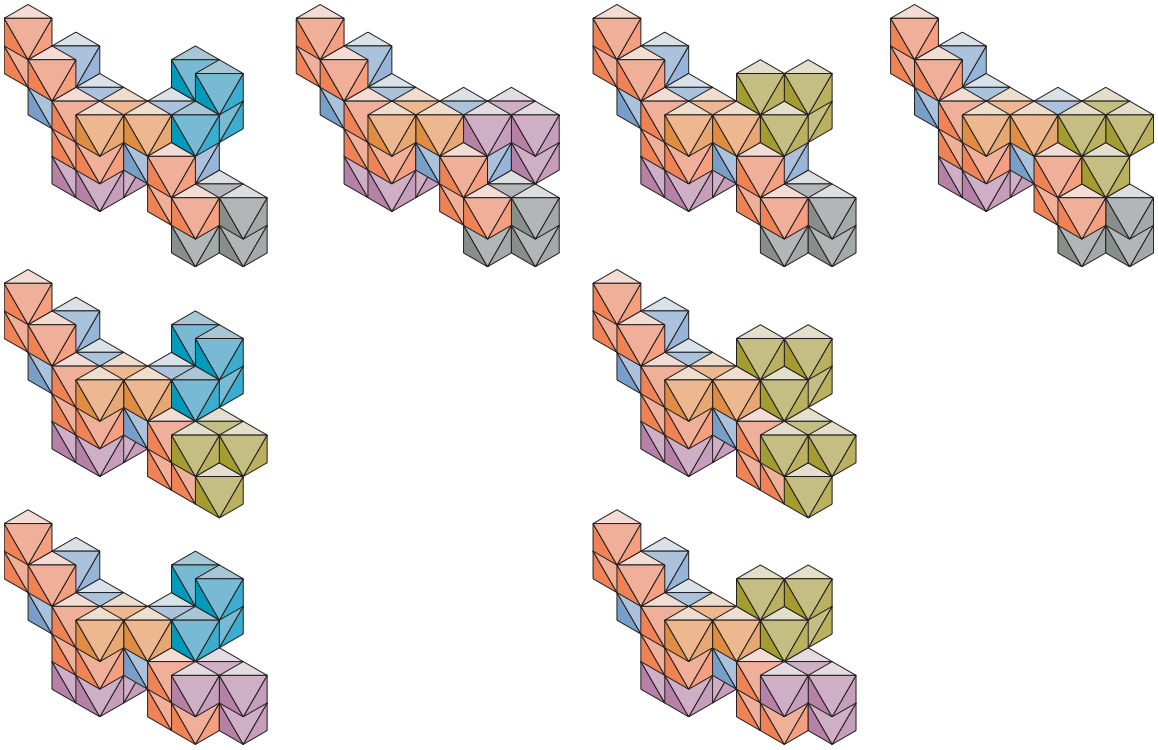


Fig. 17 RBR1OBR assemblies–O-atoms on the asymmetrical triplet

The assemblies of this figure follow the same order as the assemblies of the previous figure–the O-atom is joined to the blue C-atom of the L-triplet in the same way for each of the assemblies in a column, and the O-atom is joined to the red C-atom of the L-triplet in the same way for each of the assemblies in a row.

There are two fewer assemblies in the second and fourth columns because the O-atom of the blue C-atom of the asymmetrical triplet is blocking a cleft of the red C-atom of the asymmetrical triplet.

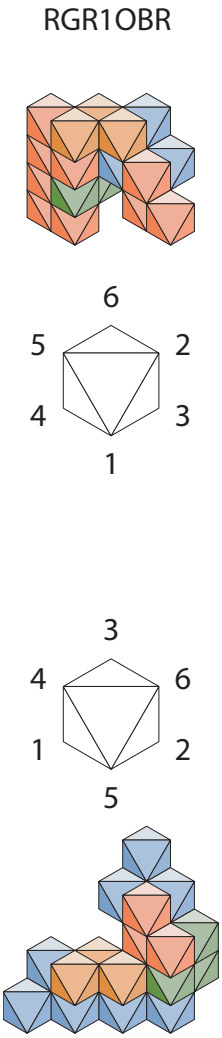


Fig. 18 The RGR1OBR di-triplet

Two orientations of the RGR1OBR di-triplet are required to show how the O-atoms are joined to its six C-atoms.

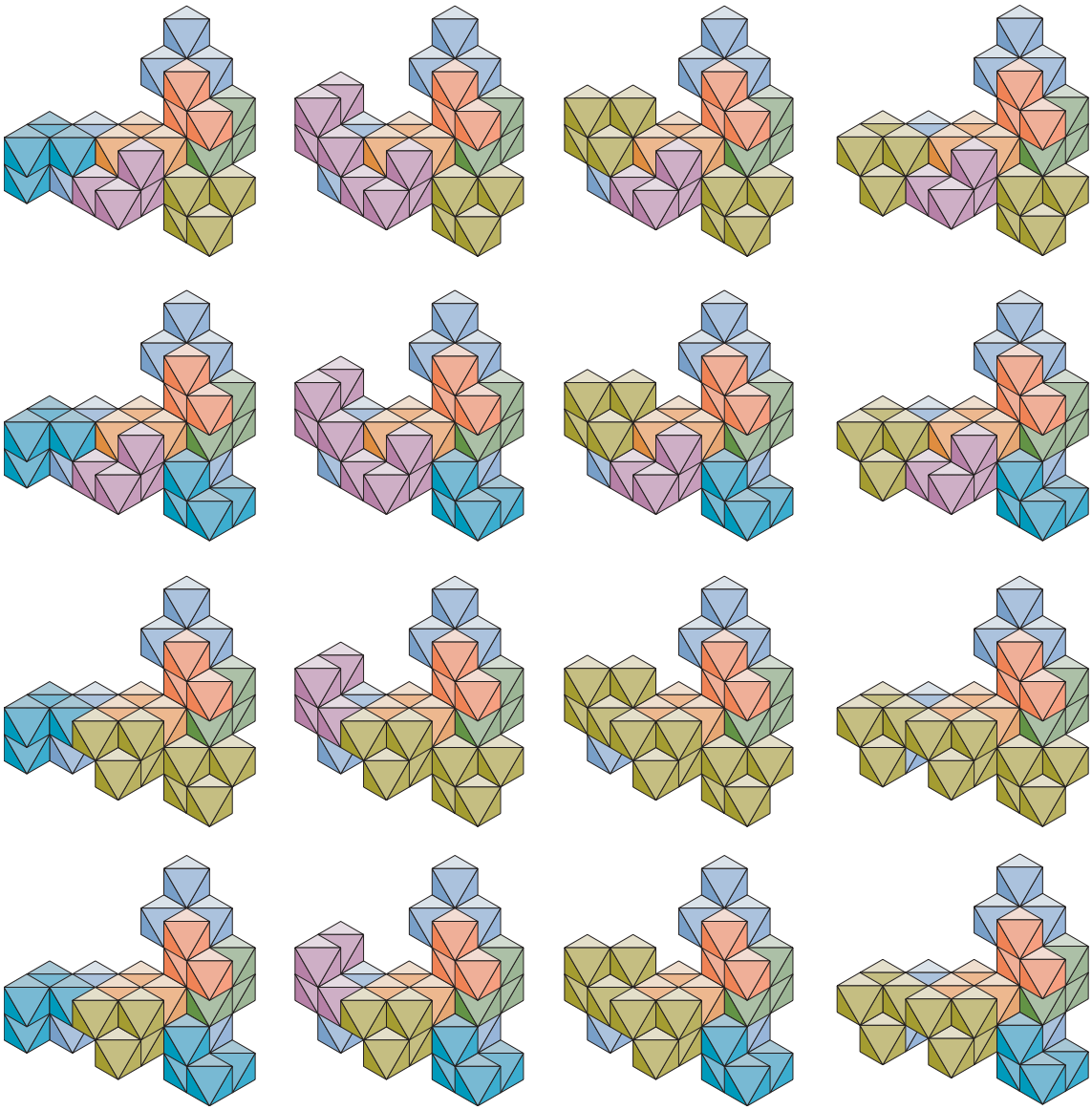


Fig. 19 RGR1OBR–O-atoms on the C-atoms of the symmetrical triplet

There are sixteen ways in which three O-atoms can be joined to the three C-atoms of the symmetrical triplet of RGR1OBR. The assemblies are arranged in columns according to the orientation of the O-atom adjoined to the leftmost C-atom of the symmetrical triplet. The O-atom adjoined to the orange C-atom is the same for each of the assemblies in the two top rows; the same is true for the bottom two rows. The orientation of the O-atom joined to the inner blue C-atom is the same for each of the assemblies in the first and third rows; the orientation of the O-atom at the same position is the same for each of the assemblies of the second and fourth rows, but differs from that which is common to the assemblies of the first and third rows.

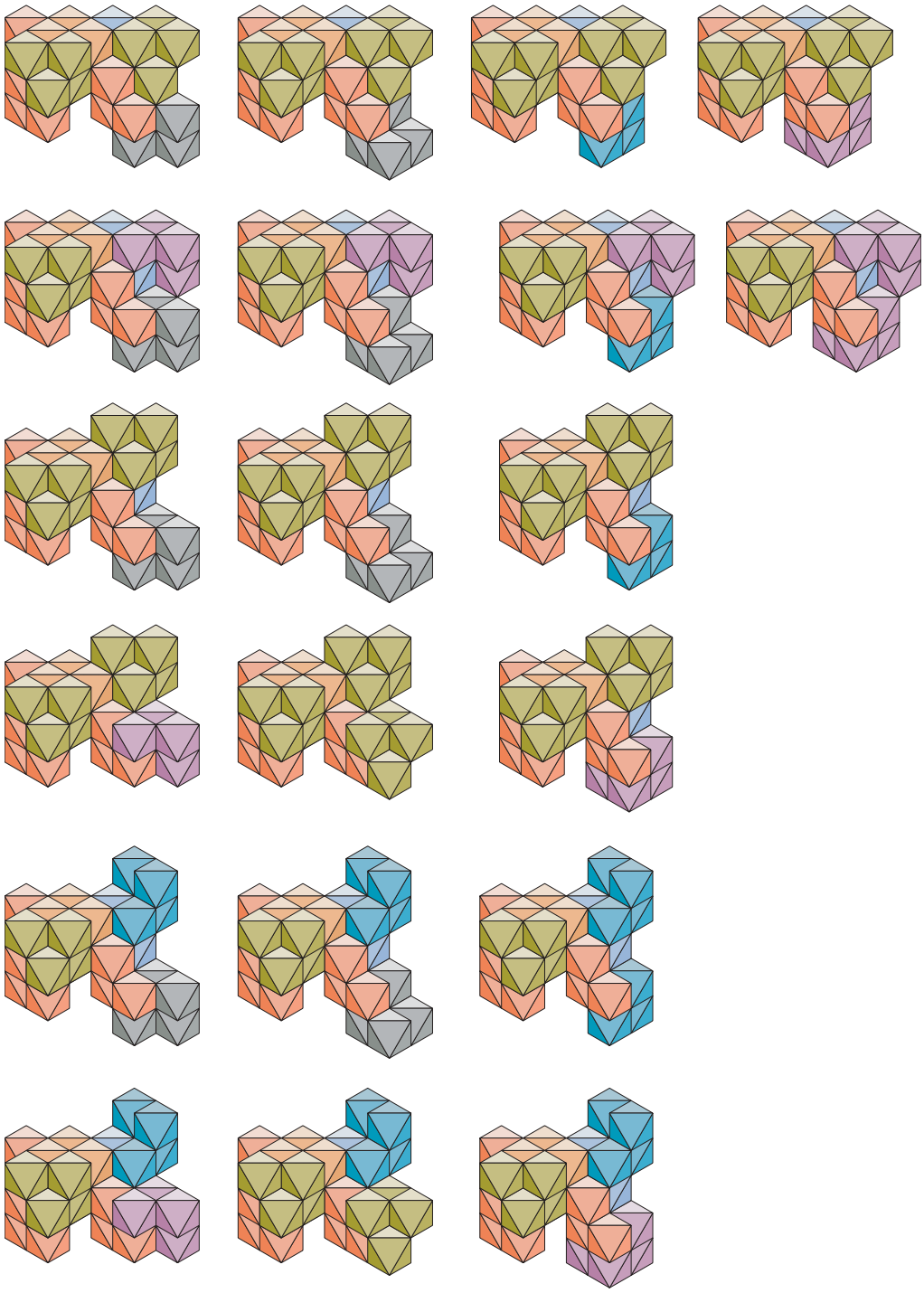


Fig. 20 RGR1OBR–O-atoms on the C-atoms of the asymmetric triplet

The twenty assemblies shown in the figure have a common O-atom at the leftmost position of the asymmetric triplet which is colored yellow.

The assemblies in each row have a common O-atom at the middle position.

The assemblies in each row have a different O-atom at the rightmost position.

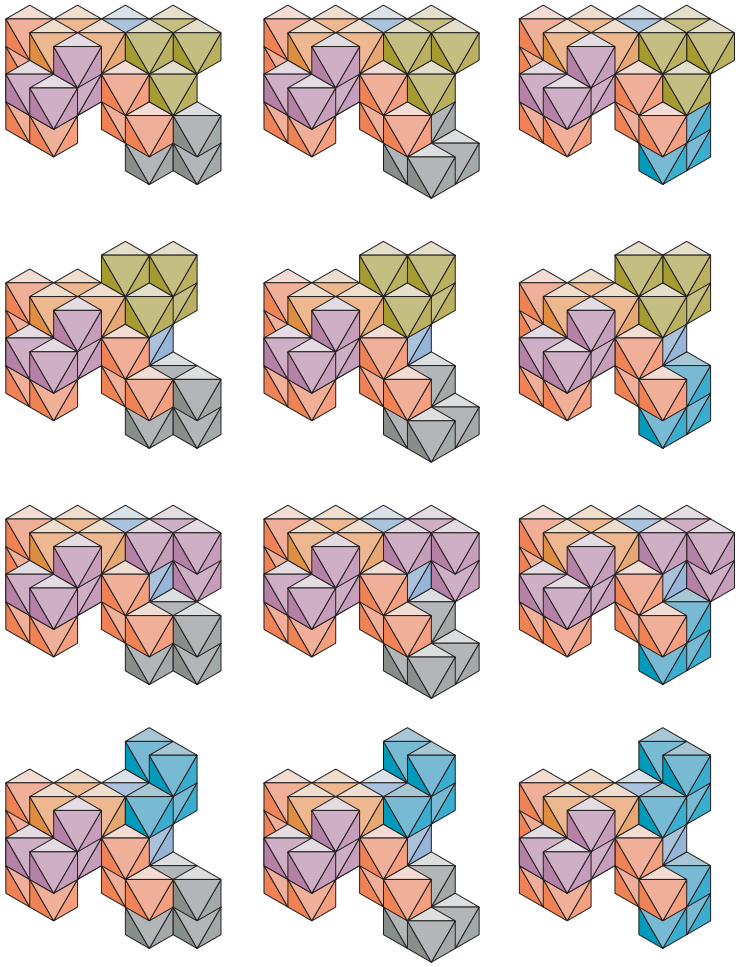


Fig. 21 RGR1OBR–O-atoms on the C-atoms of the asymmetric triplet

The twelve assemblies shown in the figure have a common O-atom at the leftmost position of the asymmetric triplet which is colored violet.

The three assemblies in each row have a common O-atom at the middle position.

The four assemblies in each column have a common O-atom at the rightmost position.

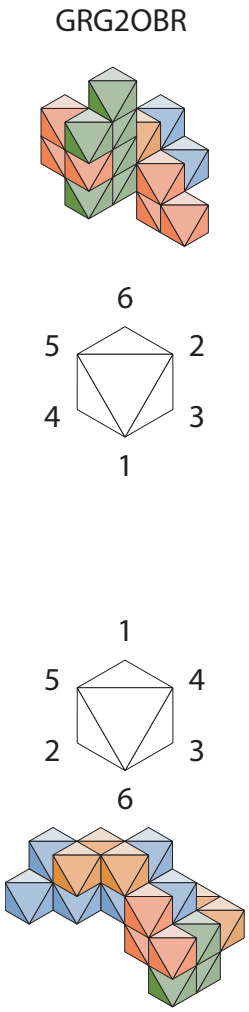


Fig. 22 The GRG2OBR di-triplet

The GRG2OBR di-triplet is depicted in two orientations. Each of the orientations is required to show how the O-atoms are attached to its six C-atoms.

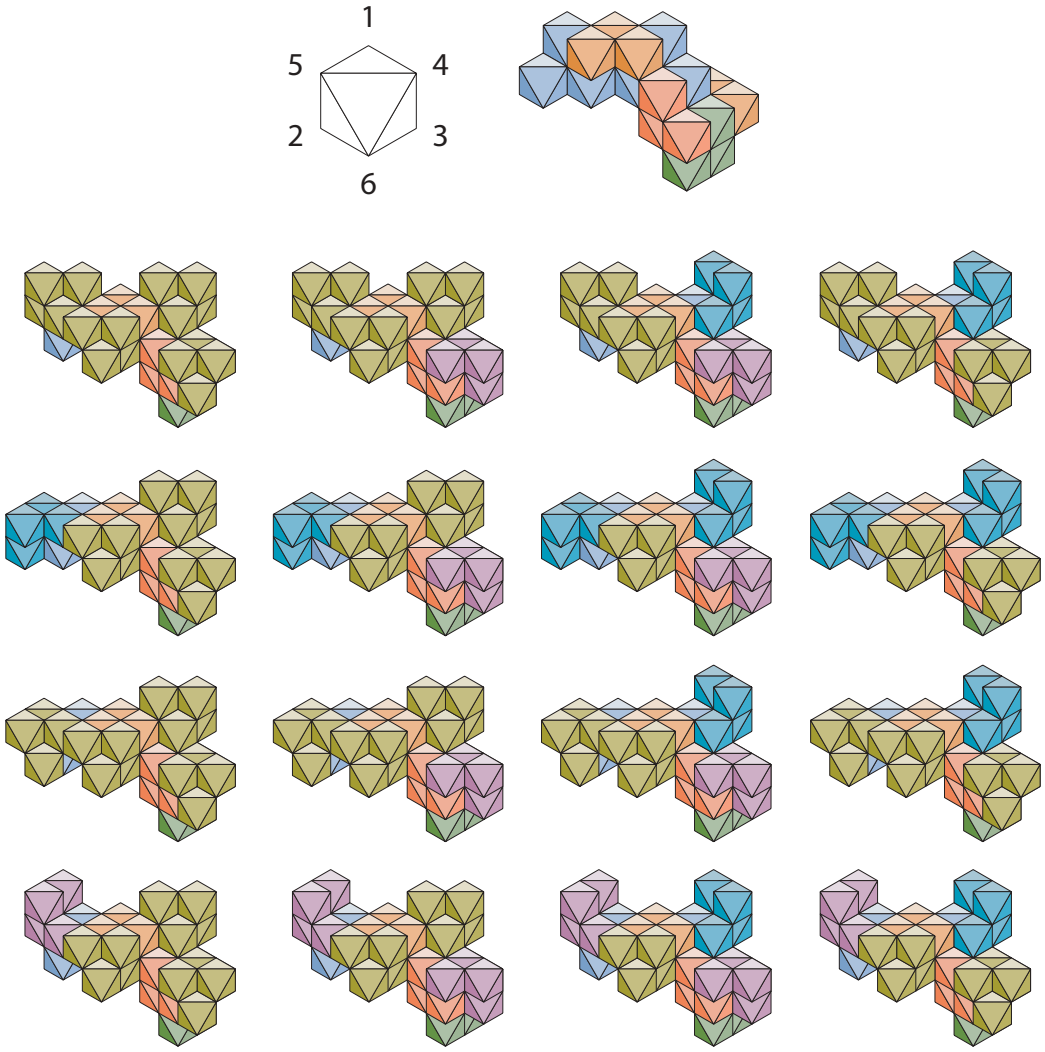


Fig. 23 GRG2OBR

Each of the assemblies shown in the figure has a yellow O-atom joined to the orange C-atom of the symmetrical triplet. Each of these O-atoms has an orientation that is the same as each of the other O-atoms in the same position.

The O-atom joined to the outer blue C-atom is in the same orientation for each of the four assemblies in a given row.

The O-atom joined to the inner blue atom has the same orientation in each of the assemblies in a given column. The orientation of this O-atom is common to each of the assemblies of the two columns to the left of center, but differs from the orientation of the O-atom at the same position which is common to the assemblies of the two columns on the right.

The O-atom joined to the red C-atom has the same orientation in each of the assemblies of the leftmost and rightmost columns, but differs from the orientation of the O-atom at the same position which is common to the two inner columns.

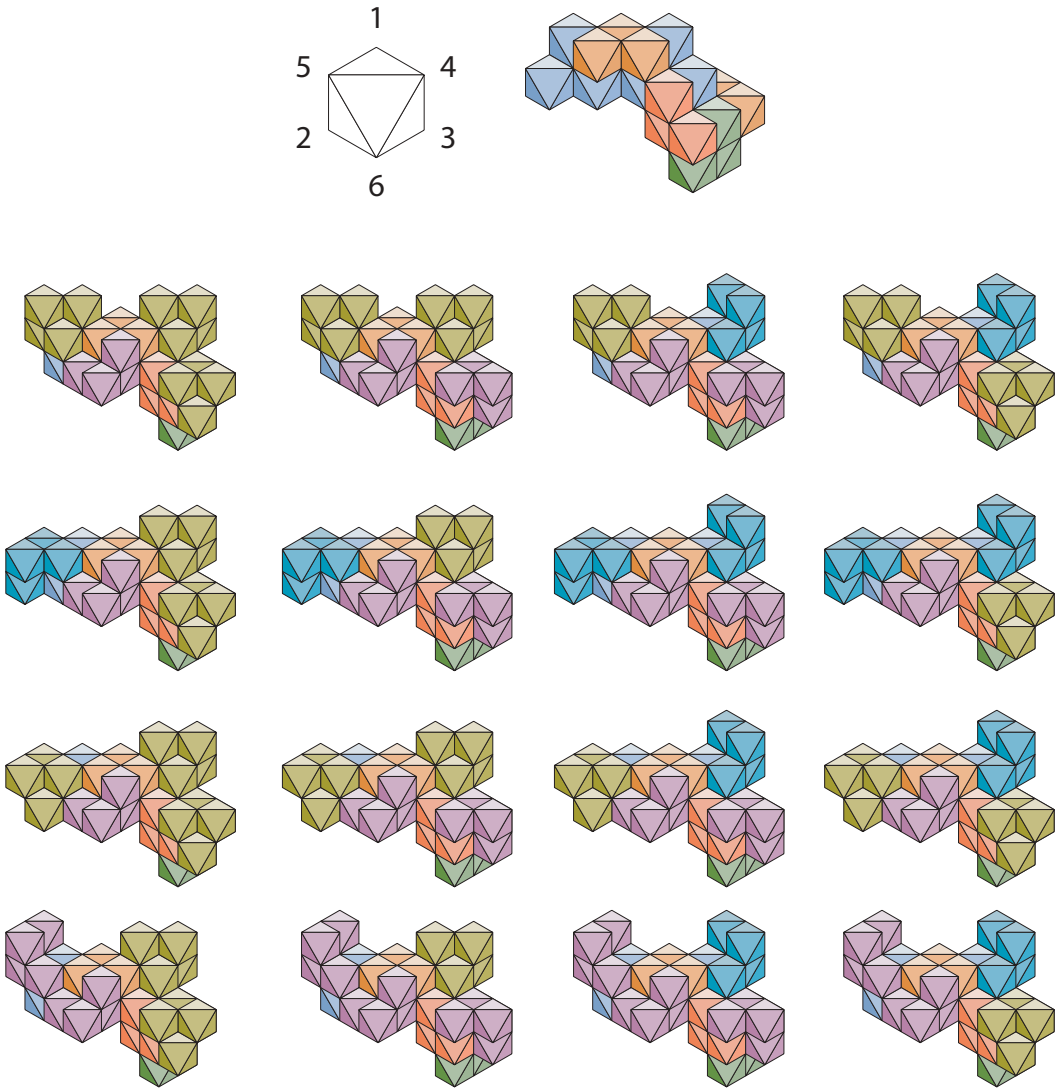


Fig. 24 GRG2OBR

The violet O-atom is joined to the orange C-atom of the symmetrical triplet of each of the assemblies in the same way.

In a given row, the O-atom is joined to the outer blue C-atom of each assembly in the same way.

In the two columns to the left of center, a yellow O-atom is joined to the inner blue C-atom in the same way in each of the assemblies; the aqua O-atom is joined to the inner blue C-atom in the same way in each of the assemblies in the two columns to the right of center.

In each of the assemblies of the two outer columns, the yellow O-atom is joined to the red C-atom in the same way; in each of the assemblies of the two inner columns, the violet O-atom is joined to the red C-atom in the same way.

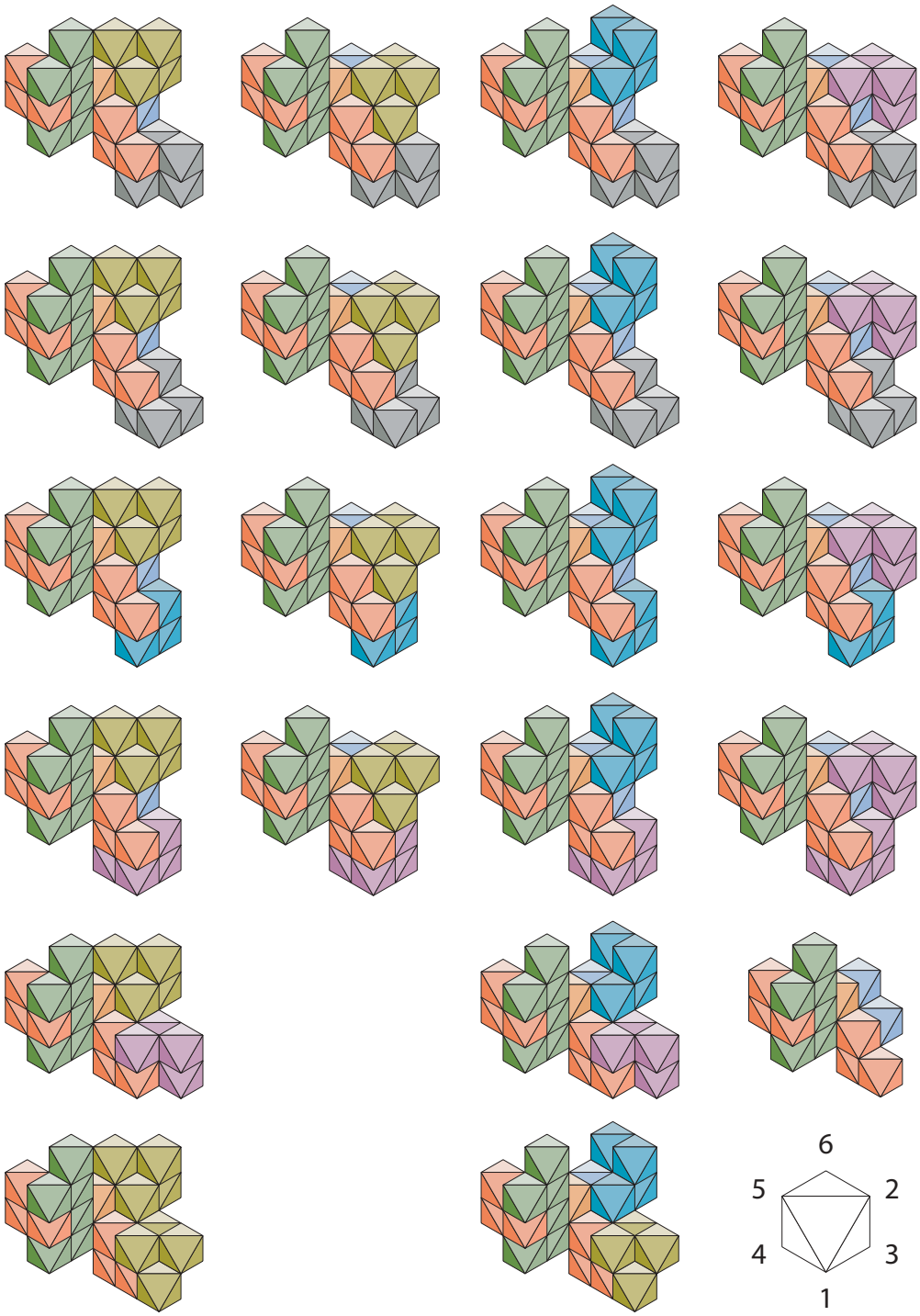


Fig. 25 GRG2OBR

In each of the assemblies in each column, the O-atom is joined to the blue C-atom in the same way; in each of the assemblies in each row, the O-atom is joined to the outer red C-atom in the same way

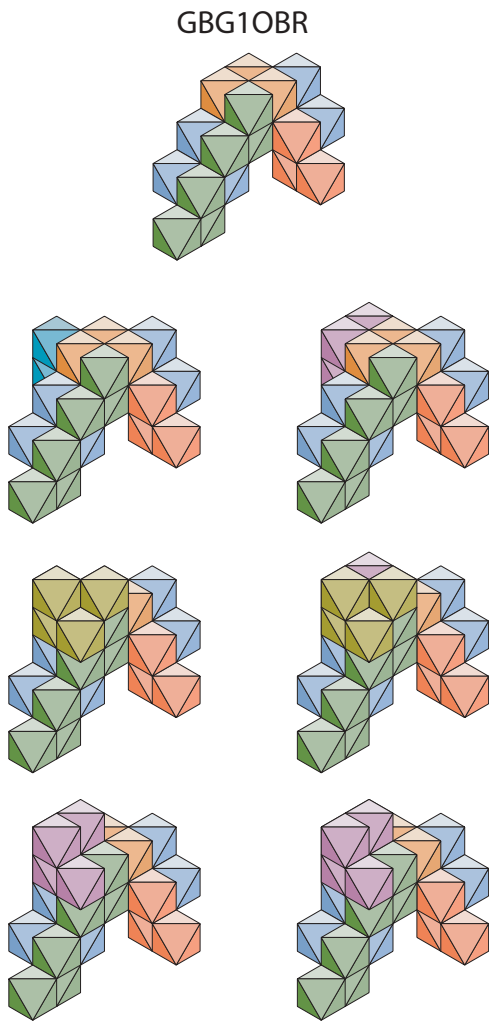


Fig. 26 GBG1OBR

The figure shows the ways in which an O-atom can join to either the orange C-atom or the inner green C-atom of the GBG1OBR di-triplet. The unadorned di-triplet is shown at the top. In the row below it, an O-atom has been joined to the orange C-atom in two ways. In the next row, a yellow O-atom has been joined to the inner green C-atom of each of the assemblies of the row above. In the bottom row, a violet O-atom has replaced the yellow O-atom in each of the assemblies of the row above.

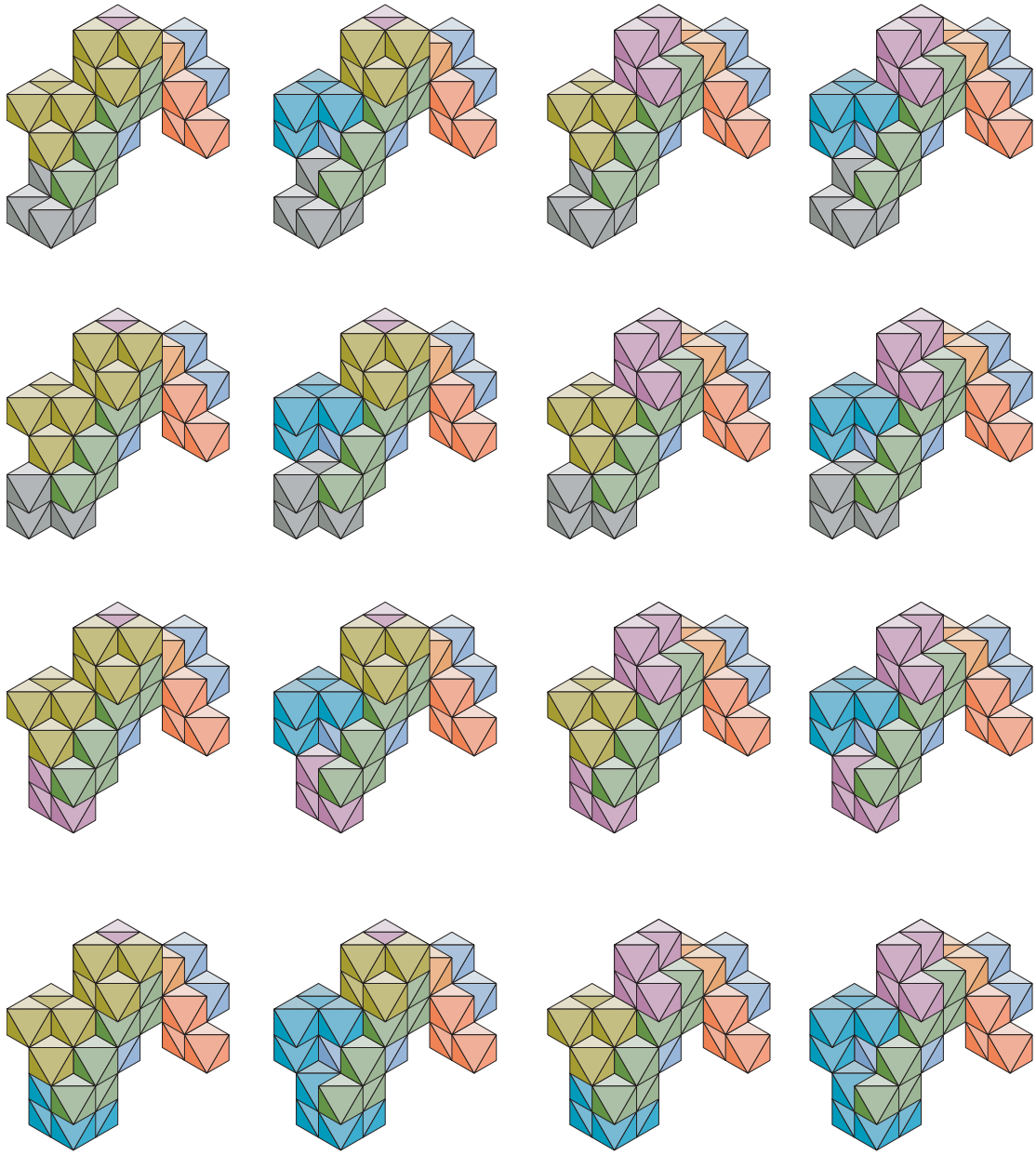


Fig. 27 GBG1OBR

In the two columns to the left of center, the yellow O-atom is joined to the inner green C-atom in the same way in each of the assemblies; in the two columns to the right of center, the violet O-atom is joined to the inner green C-atom in the same way in each of the assemblies.

In the first and third columns, the yellow O-atom is joined to the inner blue C-atom in the same way in each of the assemblies; in the second and fourth columns, the aqua O-atom is joined to the inner blue C-atom in the same way in each of the assemblies.

In each row, the O-atom is joined to the outer green C-atom in the same way in each of the assemblies.

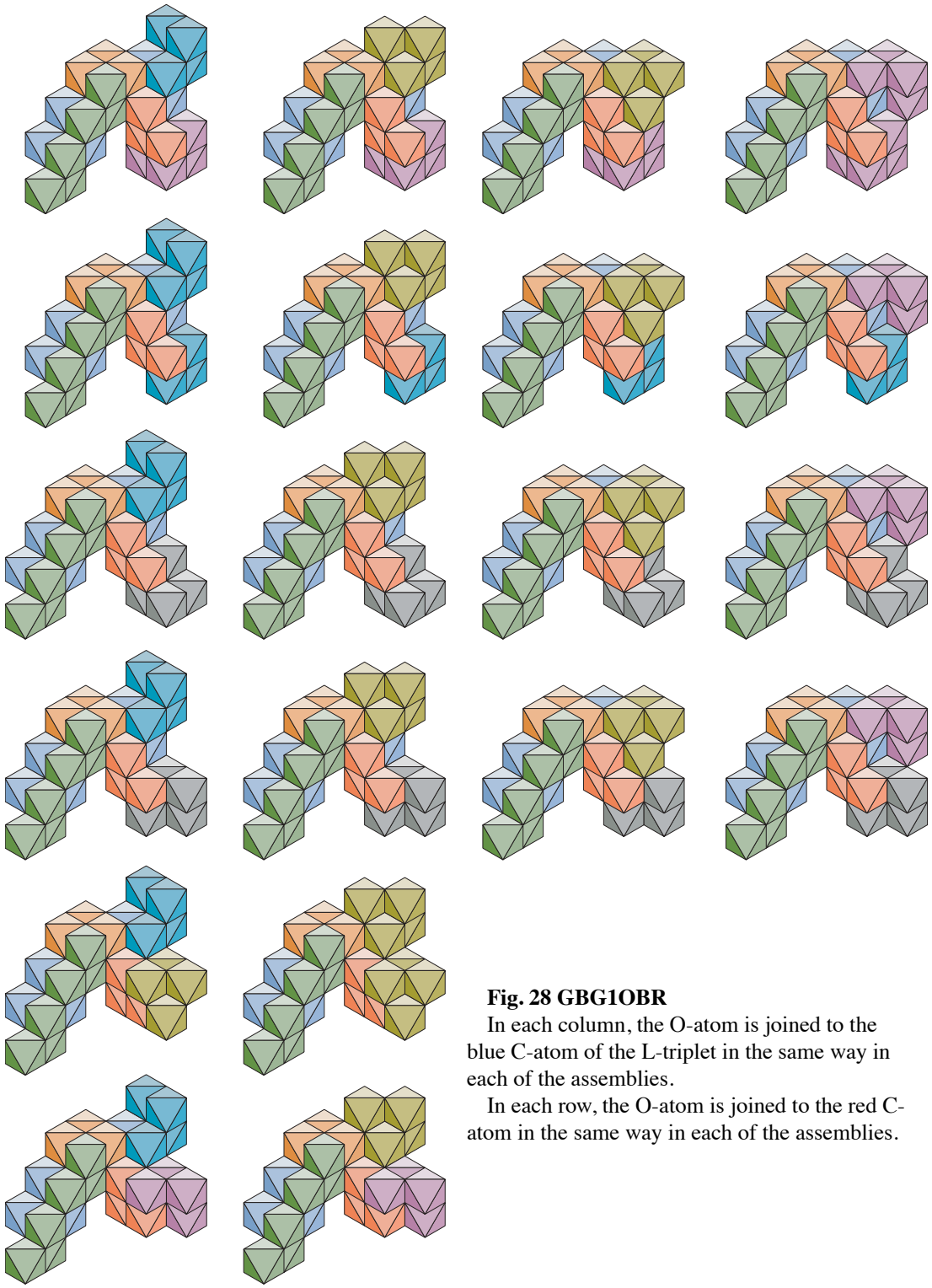


Fig. 28 GBG1OBR

In each column, the O-atom is joined to the blue C-atom of the L-triplet in the same way in each of the assemblies.

In each row, the O-atom is joined to the red C-atom in the same way in each of the assemblies.

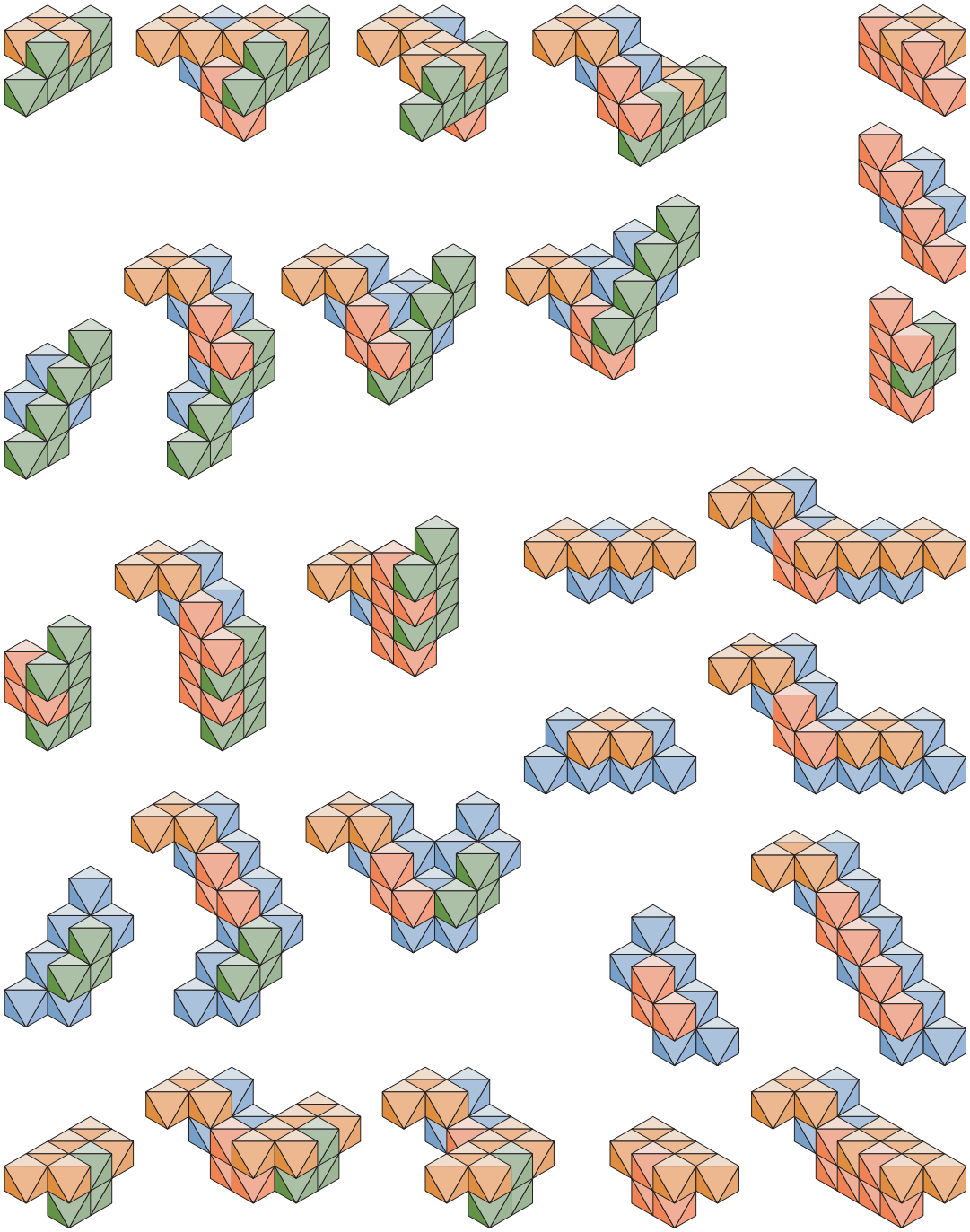


Fig. 29 Di-triplets formed by joining a symmetrical triplet to the red C-atom of L-triplet ROB-1

The figure shows each orientation of a symmetrical triplet and shows each of the ways that it can cleftly join to the red C-atom of an L-triplet.in the ROB-1 orientation.

ROR, RBR, and RGR cannot join to the red atom of ROB-1; OBR, BOB, BRB, and ORO can join in just one way; OGO, BGB, and GRG can join in two ways; and GBG and GOG can join in three ways.

Fig. 30 Coding of the OBR-sym di-triplets

Each of the sixteen OBR-sym di-triplets is represented in the figure by a row of six colored octahedra. Each octahedron represents a C-atom of the di-triplet and its color denotes the atom's orientation. This is coded on the right by the first letter of the orientation color. The numbers on the left represent the orientation repeats. For OBROBO, the "3" refers to GOG, the first "4" refers to OBRO, the second "4" refers to BROB.

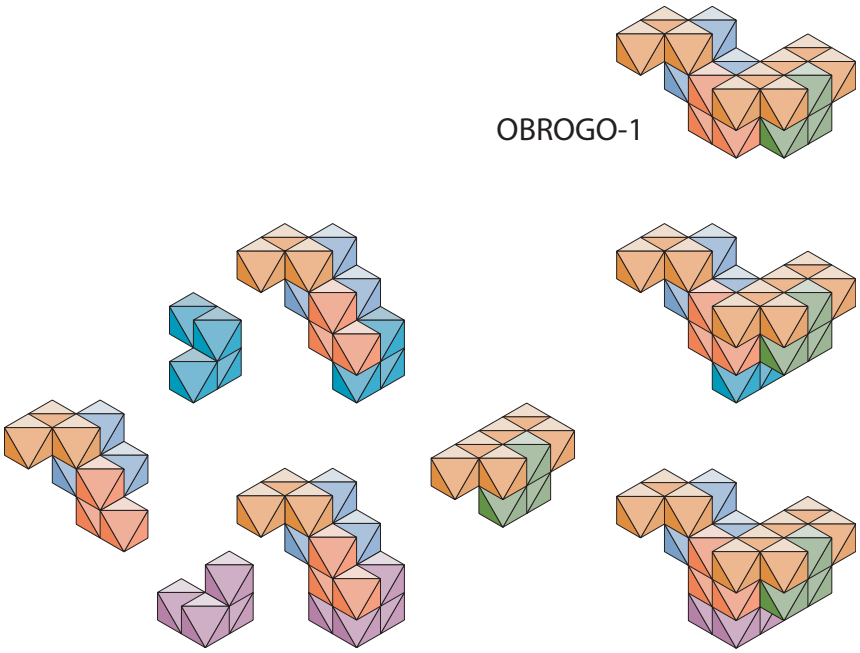


Fig. 31 Sym-L-di-triplet OBROGO-1.

The figure shows the two ways in which an O-atom can join with the red C-atom of the sym-L-di-triplet OBROGO-1. The asymmetrical triplet is shown on the left. An O-atom in two orientation is joined to the red C-atom and then the symmetrical triplet is added to form the two assemblies on the right.

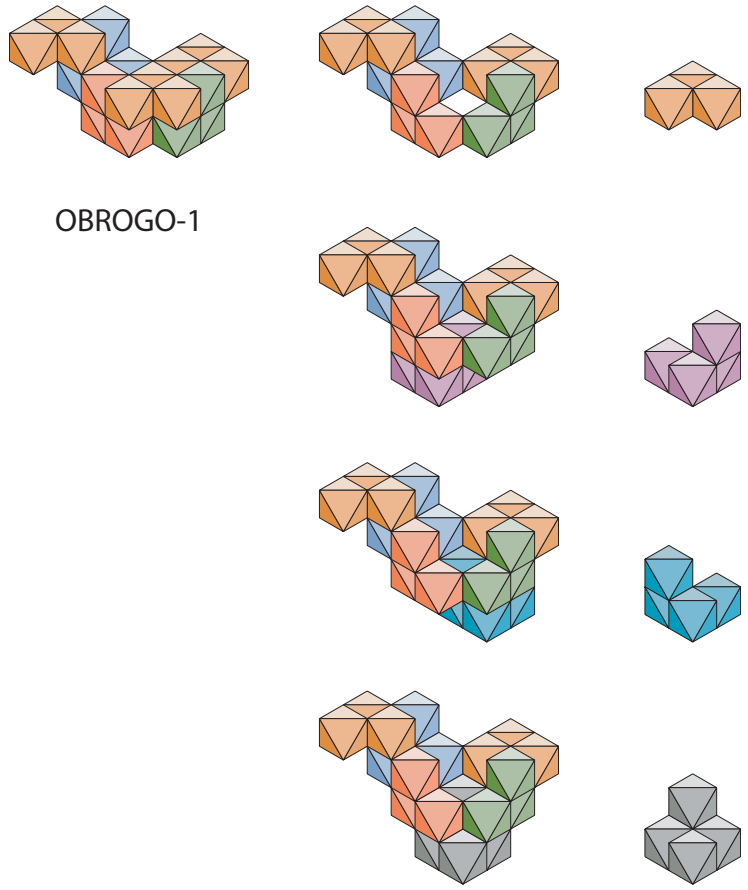


Fig. 32 The OBROGO-1 di-triplet cannot accommodate O-atoms on each of its C-atoms

The figure shows the OBROGO-1 di-triplet on the left of the top row. The inner orange C-atom has been removed from the di-triplet in the middle of the top row and is shown on the right.

In the second row, the violet O-atom shown on the right is joined to the red C-atom.

In the third row, the aqua O-atom is joined to the green C-atom.

In the fourth row, the gray O-atom is joined to both the red and green C-atoms.

In each case, only one O-atom can be accommodated where two are required which prevents the di-triplet from accommodating an H_2O-group on each of its C-atoms.

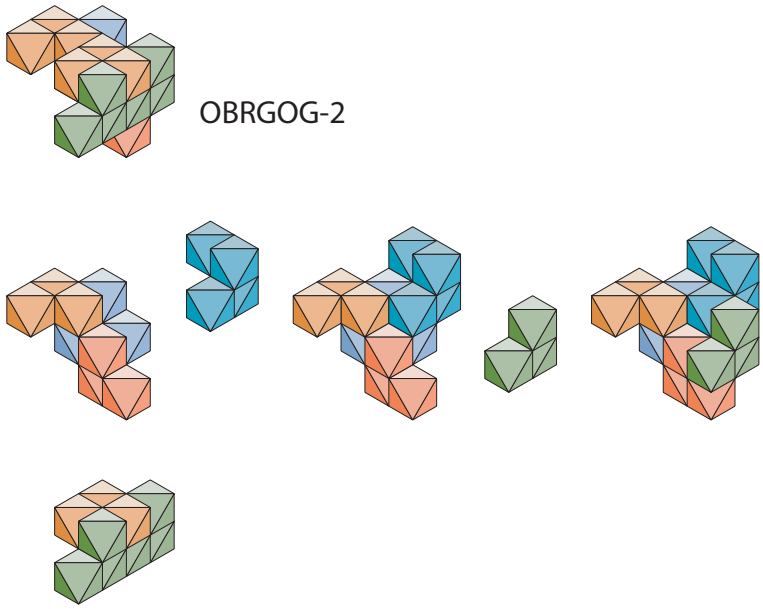


Fig. 33 The OBRGOG-2 di-triplet cannot accommodate an H_2O-group on each of its C-atoms

The green C-atom which is attached to the red C-atom cannot accommodate an O-atom if an O-atom is joined to the blue C-atom. One of its clefts is required for joining to the red C-atom; a second cleft is required for joining to the orange C-atom of the symmetrical triplet; the third cleft is blocked by the O-atom attached to the blue C-atom.

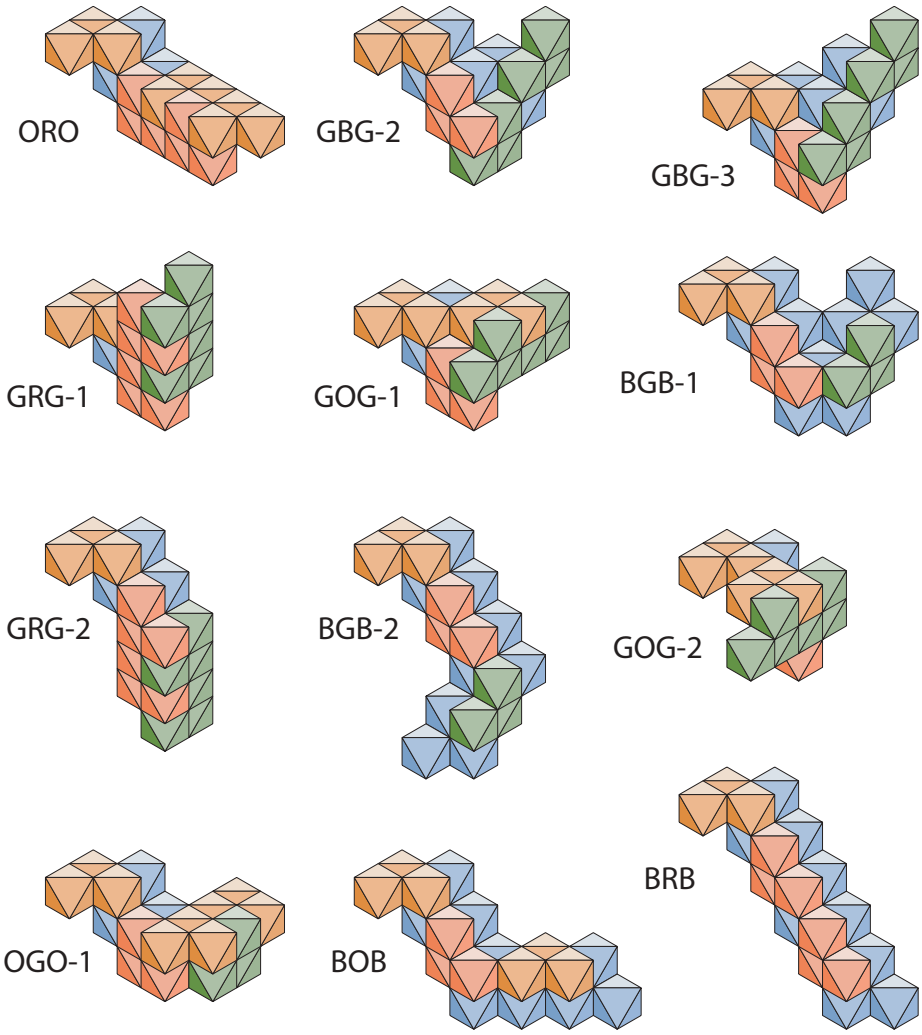


Fig. 34 OBR-sym di-triplets which are not suitable for hexoses
None of the twelve OBR-sym di-triplets shown here can accommodate an H_2O-group on each of its C-atoms

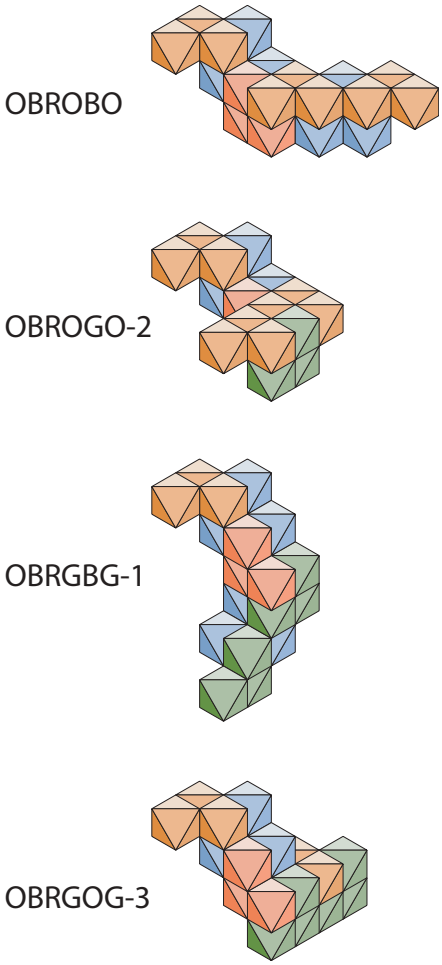


Fig. 35 OBR-sym di-triplets suitable for hexoses

The four OBR-sym di-triplets which can accommodate an H_2O-group on each of its C-atoms are shown in the figure.

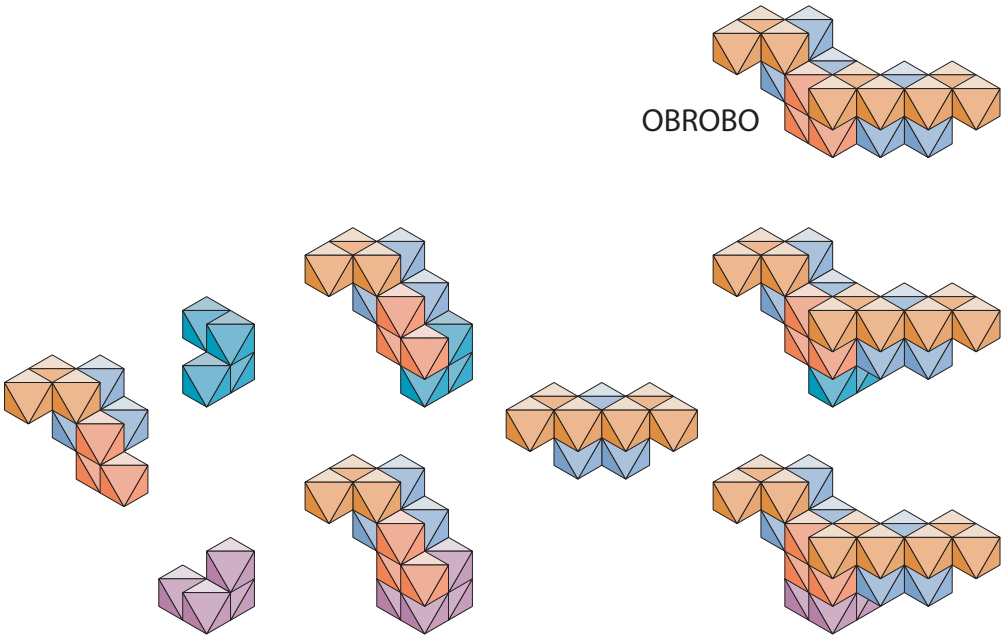
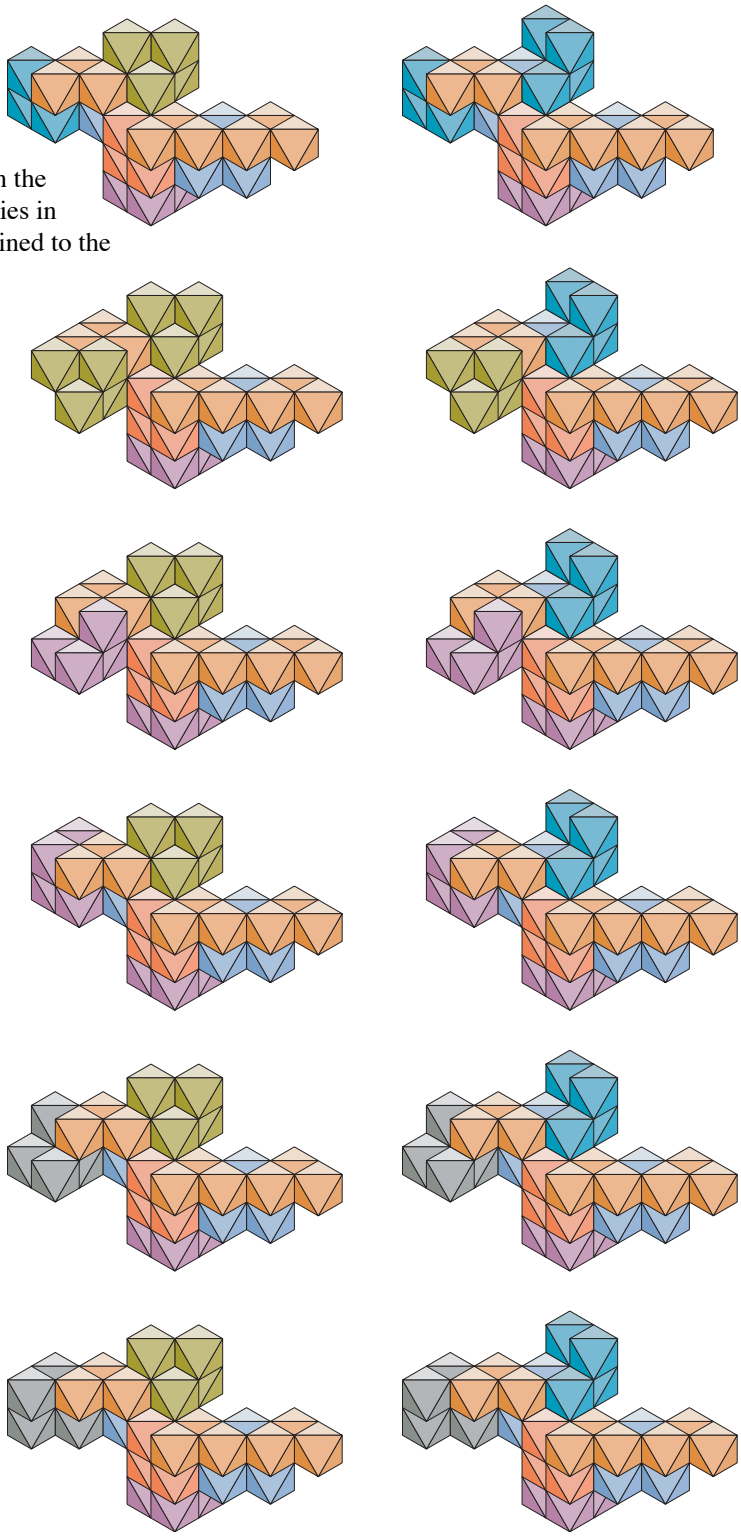


Fig. 36 OBROBO di-triplet–O-atom addition to the red C-atom

The figure shows the OBROBO di-triplet at the top right. At the left, the asymmetrical triplet is shown separately. To its right, two O-atoms of differing orientations are shown, one aqua colored, the other violet. To the right of the O-atoms, an L-triplet has been joined to each of the O-atoms. These are the only ways in which an O-atom can be joined to the red C-atom of the triplet while still permitting the formation of the OBROBO di-triplet. The OBO triplet is shown to the right of the L-triplet-O-atom assemblies. The OBROBO di-triplet with an O-atom adjoined in each of two possible ways to the red C-atom is shown on the lower right.

Fig. 37 OBROBO di-triplet-O-atom additions to the orange and blue C-atoms of the L-triplet

The figure shows how O-atoms can be joined to the blue C-atom and the orange C-atom of the L-triplet. There are two ways to join an O-atom to the blue C-atom of the L-triplet. Each type of join is shown with the six ways in which an O-atom can join to the orange C-atom of the L-triplet. The left column shows the blue C-atom with an O-atom in the yellow orientation; the right column shows the blue C-atom with an O-atom in the aqua orientation. The two assemblies in each of the rows has an O-atom joined to the orange C-atom in the same way.



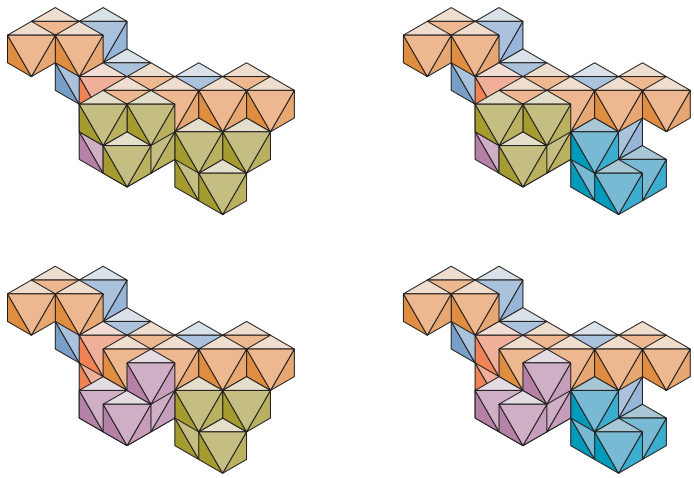


Fig. 38 OBROBO di-triplet–joining of O-atoms to the inner orange and blue C-atoms of the OBO triplet

The figure shows how O-atoms can join with the inner orange C-atom and the blue C-atom of the symmetrical triplet of the OBROBO di-triplet.

In each row, the O-atom is attached to the inner orange C-atom in the same manner in each assembly.

In each column, the O-atom is attached to the blue C-atom of the symmetrical triplet in the same manner in each assembly.

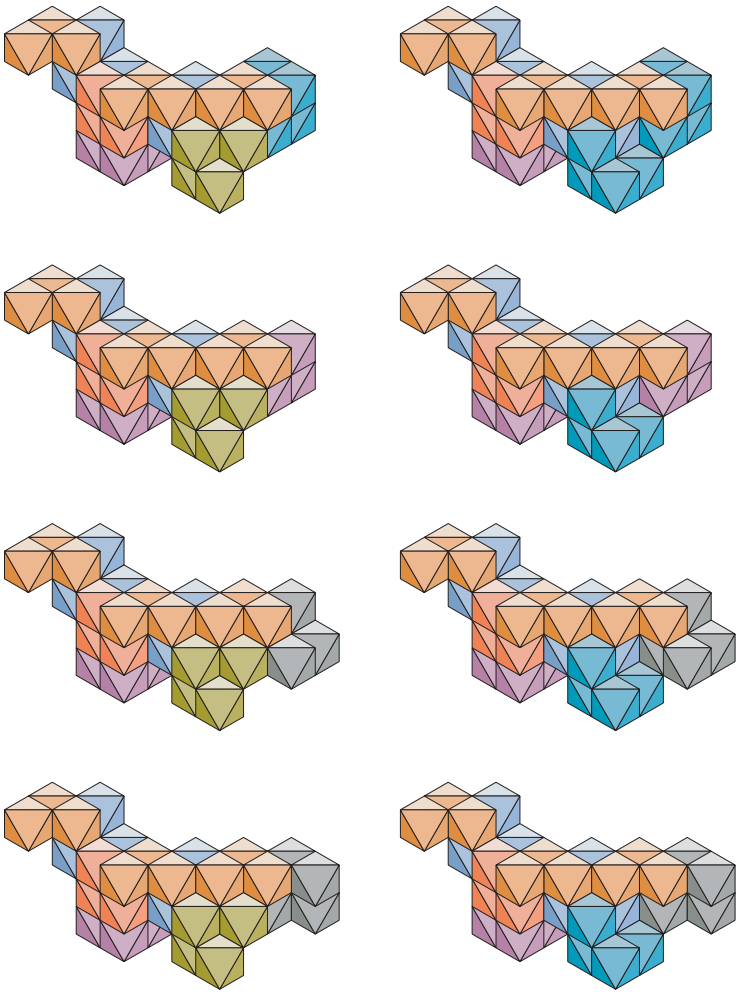


Fig. 39 OBROBO di-triplet–O-atom additions to the end C-atom of the symmetrical triplet

The figure shows how an O-atom can join with the outer orange C-atom of the symmetrical triplet of the OBROBO di-triplet.

Each of the assemblies has a violet O-atom attached to its red C-atom.

In each column, an O-atom is attached to the blue C-atom of the symmetrical triplet in the same way in each of the assemblies.

In each row, an O-atom is attached to the outer orange C-atom of the symmetrical triplet in the same way in each of the assemblies.

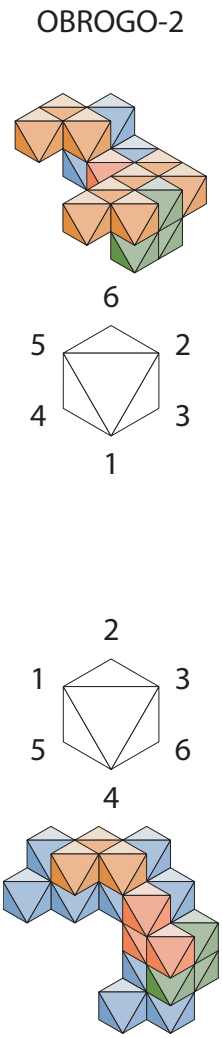


Fig. 40 OBROGO-2 di-triplet

The figure shows the OBROGO-2 di-triplet in two different orientations. The lower view is required to show how the O-atoms join with the C-atoms.

There are 384 ways in which the OBROGO-2 di-triplet can accommodate an H_2O-group on each of its six C-atoms.

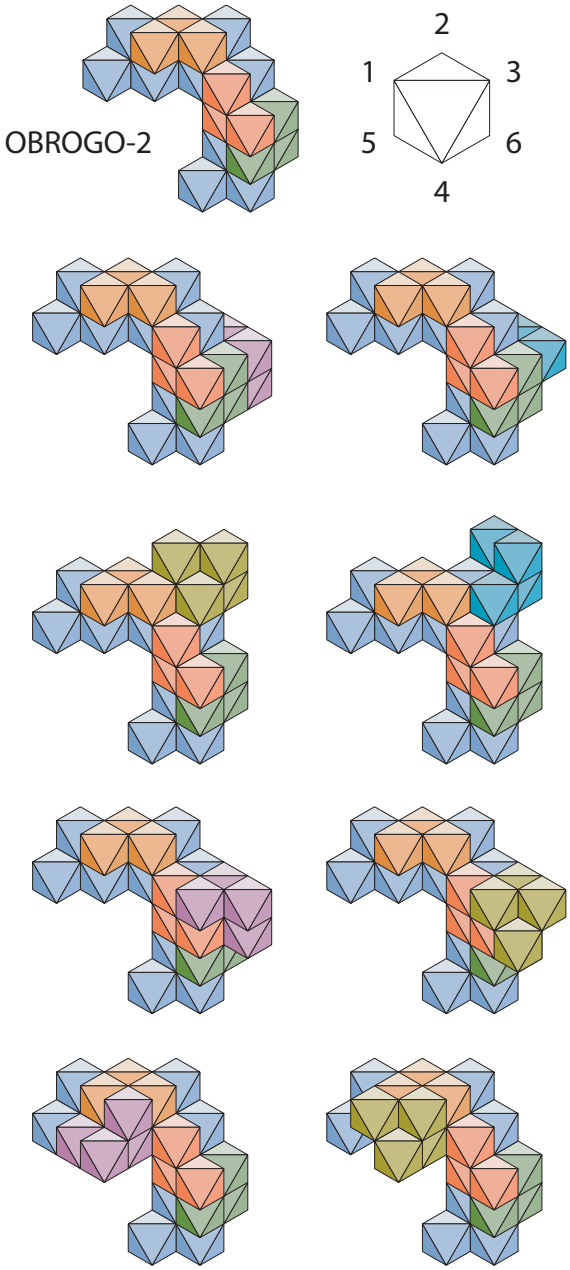


Fig. 41 OBROGO-2 di-triplet–O-atom joinings to the inner C-atoms

The figure shows how an O-atom can join to the green C-atom (row 2), the inner blue C-atom (row 3), the red C-atom (row 4), and the orange C-atom (row 5). In each case, there are two ways in which an O-atom be joined without interfering with the ability of the di-triplet to accommodate an H_2O-group on each of its six C-atoms.

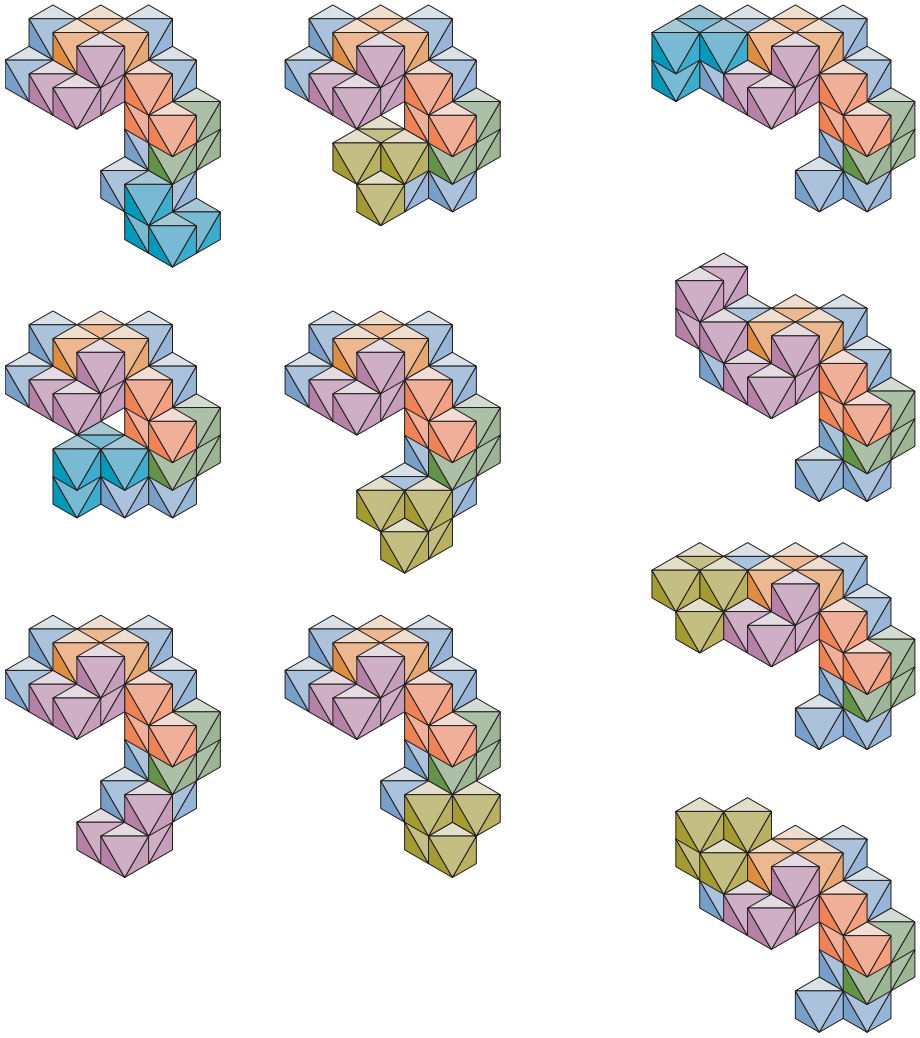


Fig. 42 OBROGO-2 di-triplet–O-atom joining to the outer C-atoms
The figure shows how an O-atom can join to the outermost C-atoms of the di-triplet OBROGO-2. There are six ways to join an O-atom to the blue C-atom of the L-triplet (columns 1 and 2), and four ways to join an O-atom to the outer blue C-atom of the symmetrical triplet (column 3).

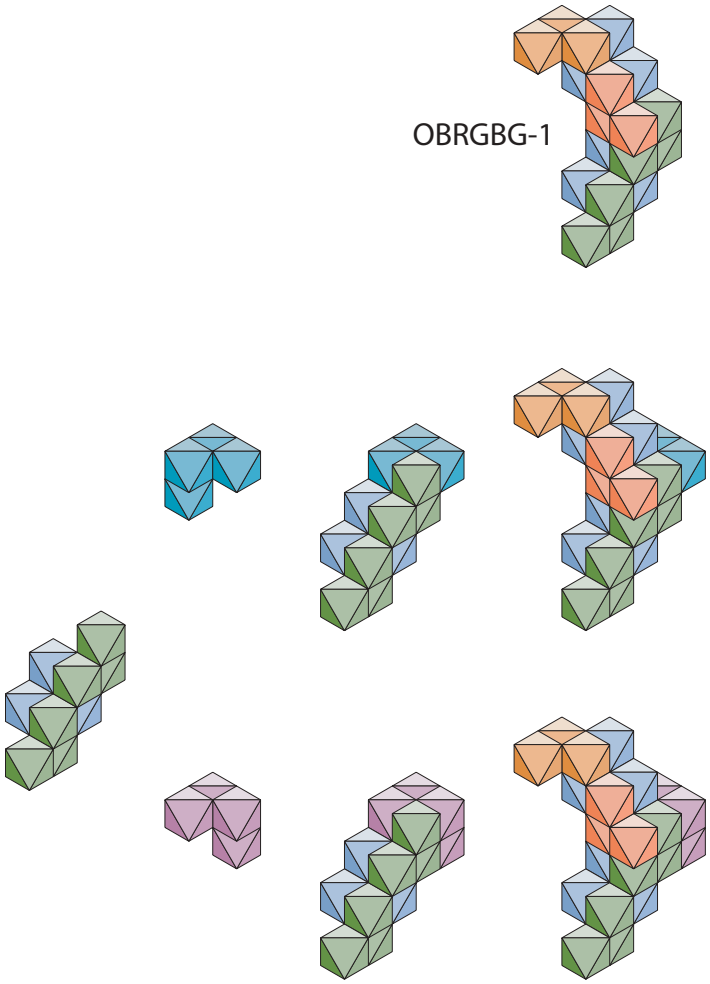


Fig. 43 OBRGBG-1 di-triplet

The figure shows two ways in which an O-atom can join with the inner green C-atom of the OBRGBG-1 di-triplet. The GBG triplet is shown on the left.

(1) An aqua colored O-atom is joined to the inner green atom of the triplet. The triplet is then joined to the red C-atom of the L-triplet to form the di-triplet.

(2) A violet O-atom is joined to the inner green C-atom of the GBG triplet which is then joined to the red C-atom of the L-triplet.

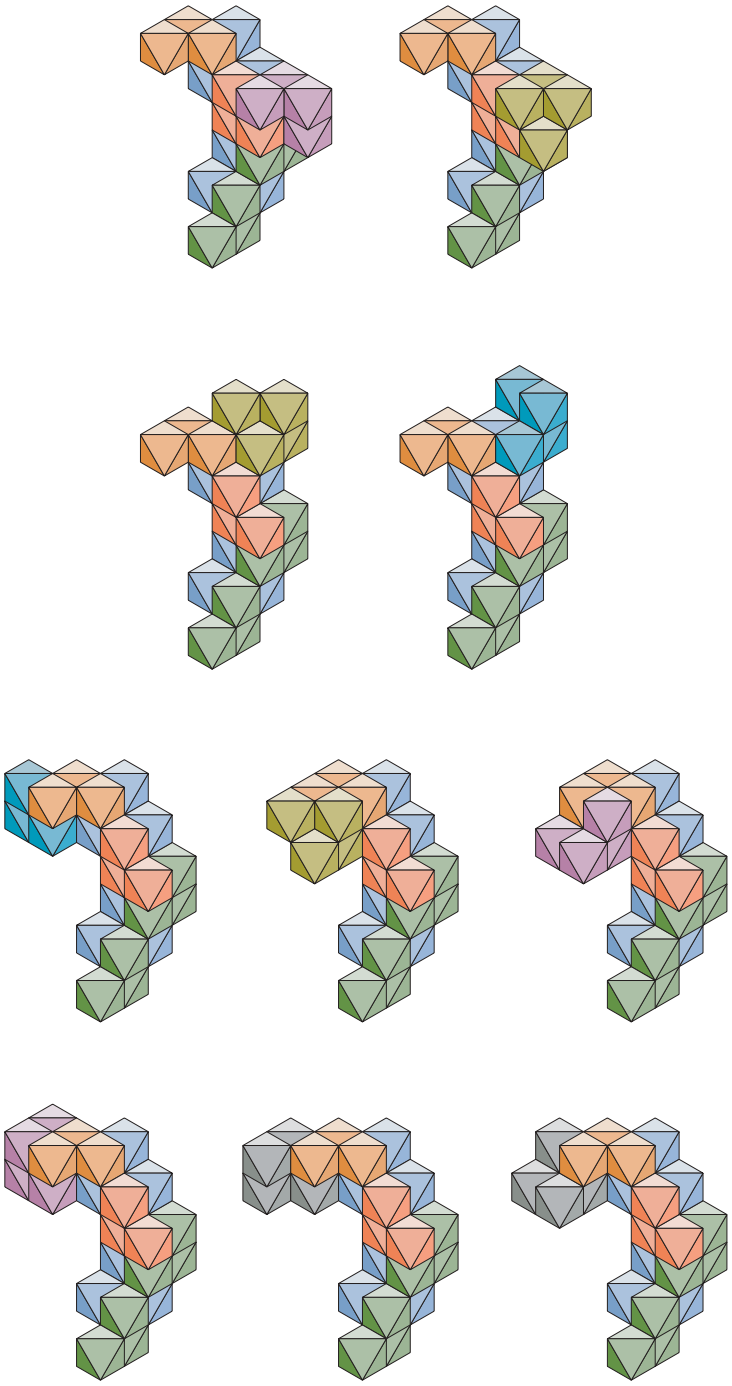


Fig. 44 OBRGBG-1 di-triplet–positions of the O-atoms on the L-triplet
Two ways of joining an O-atom to the red C-atom of the L-triplet are shown at the top of the figure.
Two ways of joining an O-atom to the blue C-atom of the L-triplet are shown in the next row of the figure.
The six ways in which an O-atom can cleftly join with the orange C-atom of the L-triplet are shown in the bottom two rows of the figure.

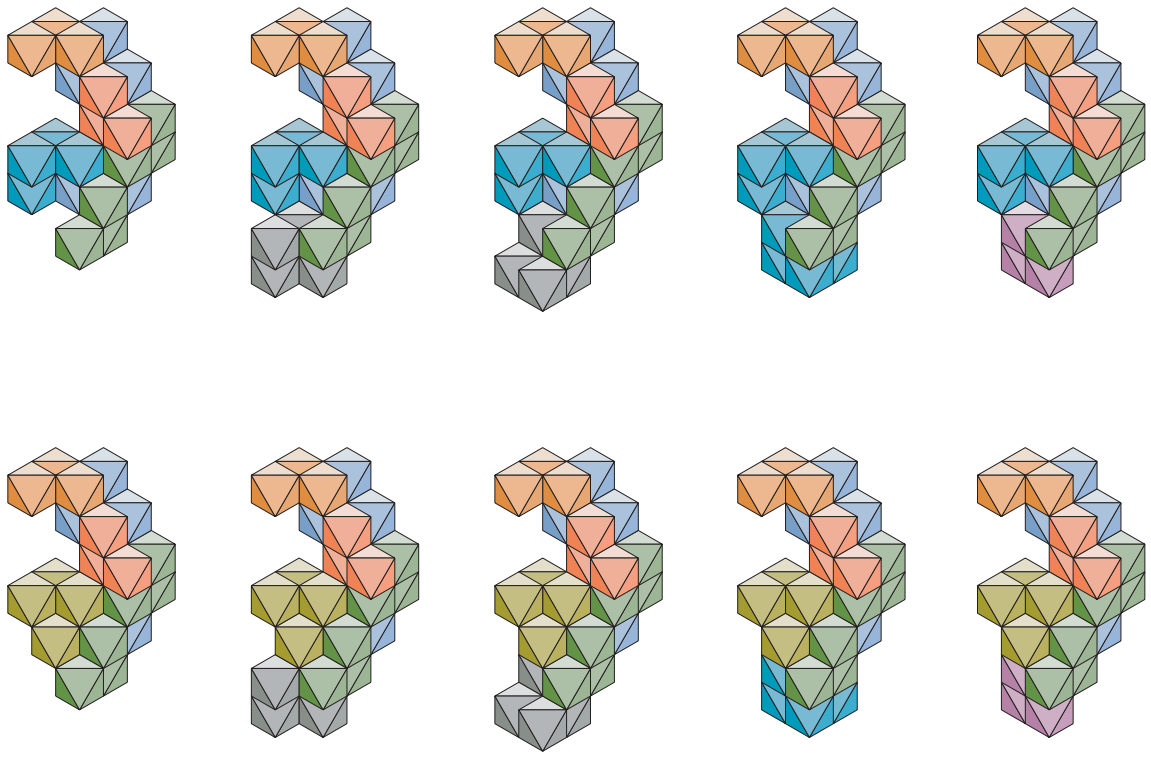


Fig. 45 OBRGBG-1 di-triplet–positions of the O-atoms on the GBG-triplet

Each of the assemblies in the top row of the figure has an aqua O-atom joined to the blue C-atom of the GBG triplet. Each of the assemblies to the right of the leftmost assembly has an O-atom joined to the outer green C-atom. The orientation of the O-atom of one assembly differs from the orientation of the O-atom of each of the other assemblies for that position.

The assemblies of the bottom row differ from the assemblies of the top row by the orientation of the O-atom joined to the blue C-atom of the GBG triplet.

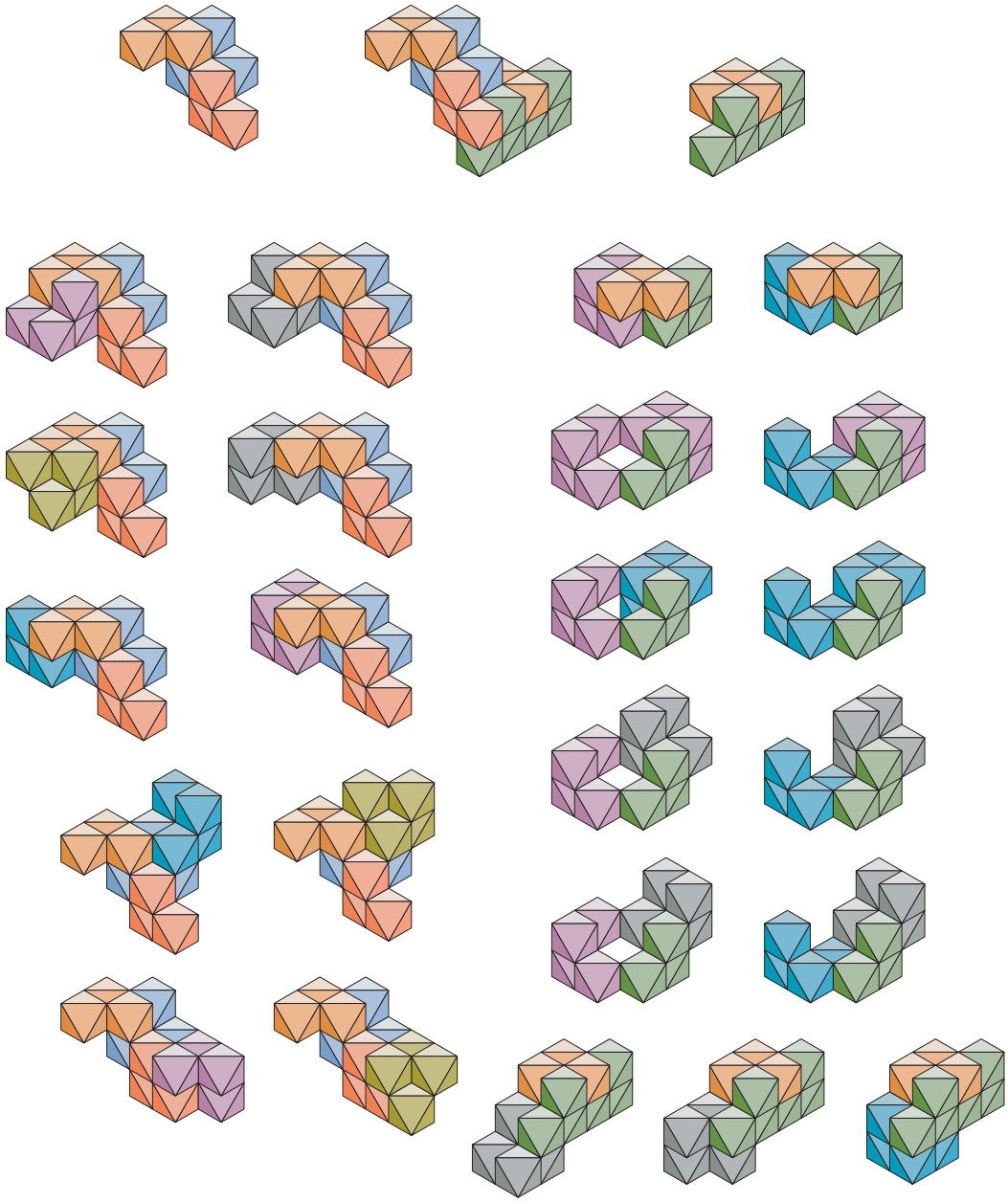


Fig. 46 OBRGOG-3 di-triplet–O-atom joinings with each of its six C-atoms

The figure shows each of the ways in which an O-atom can join with a C-atom of the OBRGOG-3 di-triplet. The di-triplet is shown in the middle of the top row. To its left is the L-triplet OBR; to the right is the GOG triplet. The possible joinings of O-atom to L-triplet C-atoms are shown in the two columns on the left; the possible joinings of O-atom to symmetrical triplet are shown in the columns on the right.

There are four ways for an O-atom to join to the orange C-atom of OBR and two ways each to join with the blue and the red C-atoms. For the symmetrical triplet, there are three ways for the inner green C-atom, two for the orange, and four for the outer green. Altogether, there are 576 combinations.