

The Safe Climbing Book of Knots

- Knots and Hitches for Professional Tree Work

Compendium of knots and hitches for use in
Professional Tree Work:

- Basic and Advanced Tree Climbing
- Rigging



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Erasmus+

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A brief introduction to ropes, knots and hitches.

Although mechanical friction devices are used more and more both on climbing ropes and in rigging, knots and hitches are still an all-important part of the Arborist's skills. A great deal of your system will often be tied together with knots of various types. There is a lot of useful knots for use in Professional Tree Climbing and each week, new ones are appearing. You must be able to tie the most important ones: The same way a carpenter must be able to use a hammer when the nail-gun fails, the Arborist must master knots as a part of her or his daily routine. When stress and tiredness set in, your life may depend on your ability to tie your knots correctly.

The knots and hitches in this book are chosen due to their effectiveness, they are easy to tie and easy to undo. Common to all of them are that they must be mastered and used – OFTEN. Otherwise they will be forgotten, and you will be tempted to tie non-descript knots that either undo themselves or are impossible to loosen.

Definitions

A knot is used to join two ropes together or a rope to itself. If done correctly a knot will hold shape regardless of it being fixed to something else.

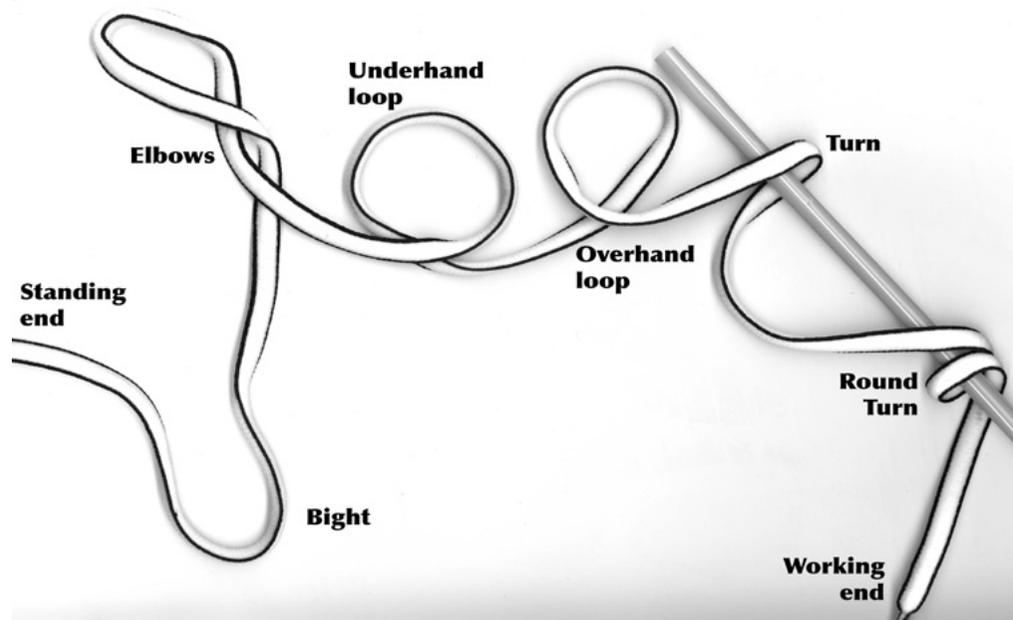
A hitch is used to fix a rope or a line to another object, such as a carabiner or pole, and relies on that object to hold. (By the way: A rope is an un-occupied line. As soon a rope has a purpose, it become a line). You can see this easily by tying a figure-of-eight follow-thru onto a carabiner. Do the same with a clove hitch. Now take the carabiner away and see what happens – one of them will fall apart. Some sources classify a hitch as a class of knot but the general distinction remains the same.

No knot is “Nearly correct”. Tying a knot or a hitch, the result is either correct or hopelessly wrong. A knot or a hitch works through its inner friction (Not to be mistaken with the friction in Friction Knots). This inner friction is a friend and an enemy. The better the friction the better the knot will hold, but the same friction can also make the knot near to impossible to loosen. On some types of rope, certain knots can weld itself together.

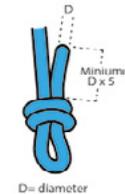
It can also be of great importance if a knot is tensioned or not all the time. Some knots will become undone under cyclic tension.

When tying a knot, remember “Tie, Dress and Set”:

1. Tie the knot.
2. Dress the knot so it looks right and lies neat.
3. Set (tighten) the knot.



When a knot or a hitch is finished, some line will be left. This part is called the tail end or the working end. This is the knot’s safety margin. No matter how hard you set the knot, it will yield or roll under tension. To prevent the knot from becoming undone, the rope manufacturer states a minimum length of the tail end, as a rule 5 times the diameter of the rope. In this compendium, we use this length as a standard. Where the length of the tail end is of certain importance, you will see this little drawing beside the knot:



You will meet the concept “Eye-to-Eye” or “E-2-E”. This is a rope, i.e. a friction line, terminated with a sewn or spliced eye from the manufacturer.



The manufacture and construction of the rope is of great importance of how a certain knot hold. On very smooth ropes (I.e. fishing line and HPME/Dyneema), you will have to use particular knots to assure durability. On other types of rope even simple knots will lock or jam beyond loosening.

In general, a rope is weakened when you tie a knot on it. The reason is that the fibres in the bights and turns you use to form the knot tightens on the outer side and are loose on the inner side. Because of this the outer side carries all the tension, the inner side is slack and carries no weight.

How much the knot weakens the rope depends on the diameter of the rope and which type of knot. Several researches have been made on the subject, and the conclusions differs slightly, but there are some common points:

A knot reduces the strength of a rope.

- Some knots reduce the strength of a given rope more than other.
- Some type of ropes is weakened more with a given knot than other.
- The thinner the rope, the more it will be weakened by a given knot
- There is no big difference in the strength of the knot whether the rope is wet or not.

As a general rule, the weakening on a rope from a tied knot is set to 50%.

When testing a new type of knot, remember: *Low and slow, till you know* how the knot is tied and how it performs. In this book, we will go through the most common Arborist knots and hitches approximately in the order they appear during your training, starting with the overhand knot, ending with the more tricky “French Prusiks”.

When accessing the pages with the various knots, you will see a QR-code: You can either click the QR-code with your mouse, to get to a site where you can see the knot tied, or you can “shoot” the QR-code with a reader on your smartphone or I-phone.

Many knots will have more than one name. These names are often related to trade or country. We have tried to place the most used name first, with the other names in brackets.

Knot Terminology:

Bend:	Joins two ropes or lines.
Bight:	Made by folding a piece of rope so that the two parts lie alongside each other. When tied near the rope's end, the parts will be the Tail lying beside the Standing End. A bight can be used to finish many knots - making them easy to untie by just pulling the tail. The term "Bight" does not imply a "Loop" and does not mean the same.
Dressing a Knot:	Arranging the components of the knot to optimize security and/or strength.
Hitch:	Attaches a rope to something, e.g., a karabiner, branch, tool or equipment.
Knot:	Joins two ropes together or a rope to itself.
Loop:	Made when a rope forms a partial circle with the ends crossing each other.
Round Turn:	Two passes of a rope round an object – to completely encircle it.
Slipped:	A knot is Slipped when it is completed using a loop or loops. The best known example is the Slip Knot or the Slipped Double Overhand. Many of the knots described can be slipped. Using a loop makes them less secure - think of shoelaces - but they are released more easily.
Splice:	A knot made using the strands of a rope rather than the whole rope – stronger than ordinary knots and intended to be permanent.
Standing End:	The long end - the part not knotted. The standing part lies between the standing end and the knot.
Stopper Knot:	A knot in the end of a rope – used to prevent fraying or to prevent the end passing through a hole.
Strands:	The major components of a rope – three in a three-strand rope. Each "Strand" is made up of many separate fibers.
Tail:	The short end – the part getting knotted.
Turn:	One pass of the rope round or through an object.

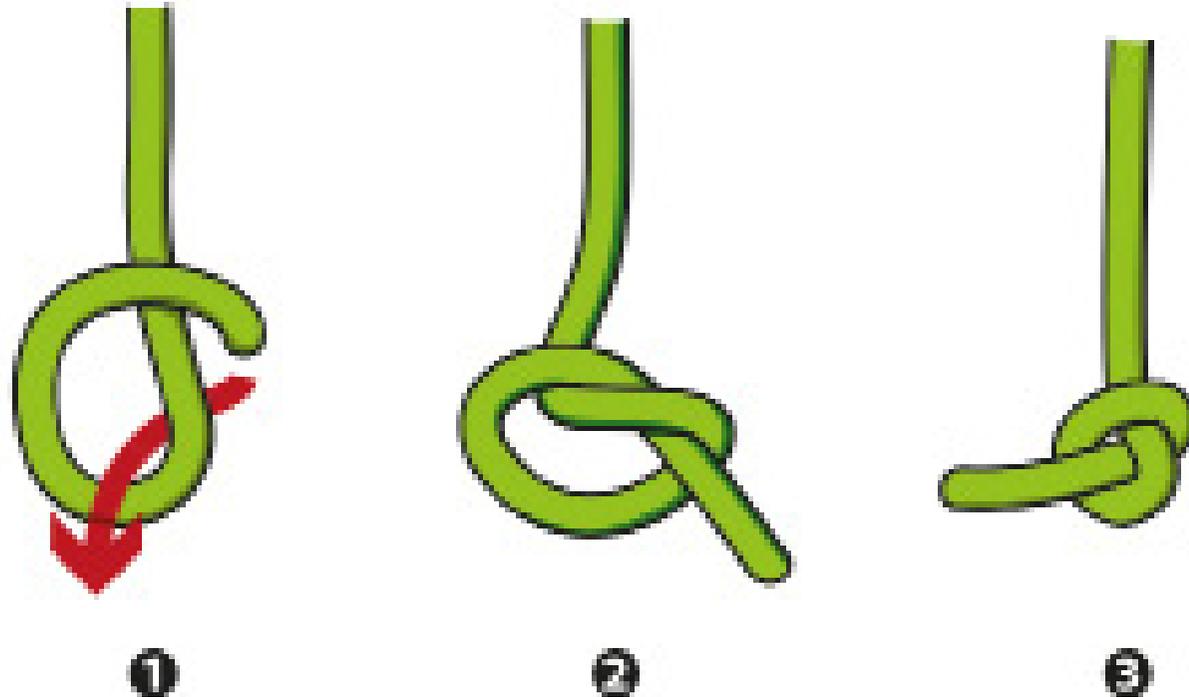
Stopper Knots

Overhand Knot:

”Mother of all knots”. The Overhand Knot is the simplest of the Single-Strand Stopper Knots. It can also be used to prevent the end of a piece of rope unraveling. Not much used in practical Arboriculture.

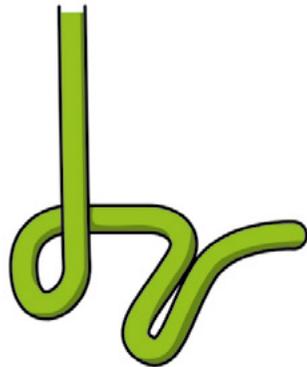
Tying:

Form a loop and pass the end through it. Tighten it to form the Overhand Knot. When pulled tight it can function as a simple stopper knot.

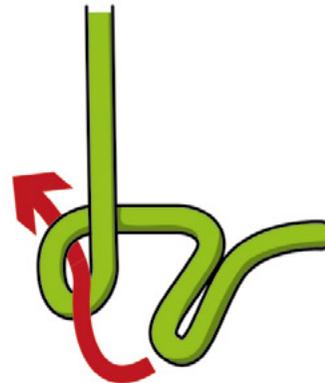


Slip Knot:

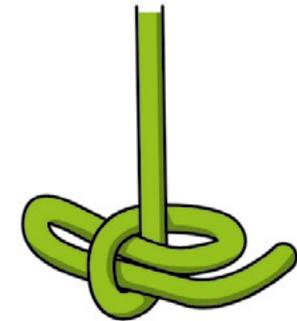
Running Knot and Slip Knot are terms used for a broad array of knots that indicate it can easily be spilled by pulling on the working end of the rope. The Slipped Overhand is the simplest of such knots and is often referred to as a Slip Knot or Running Knot even though those are broad terms. Historically this simple knot has been used to snare birds and other small animals. It can also be used as a stopper knot that can be quickly released.



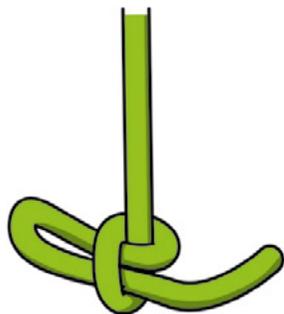
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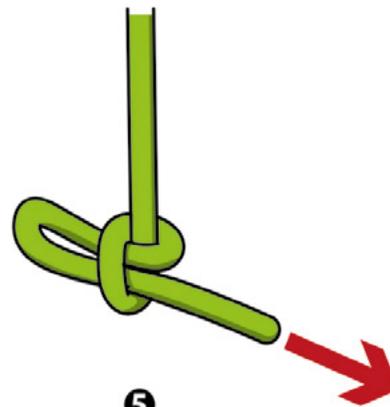
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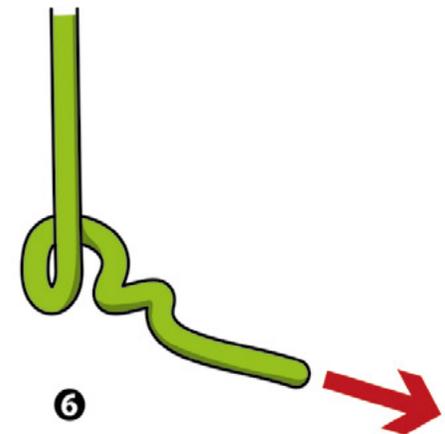
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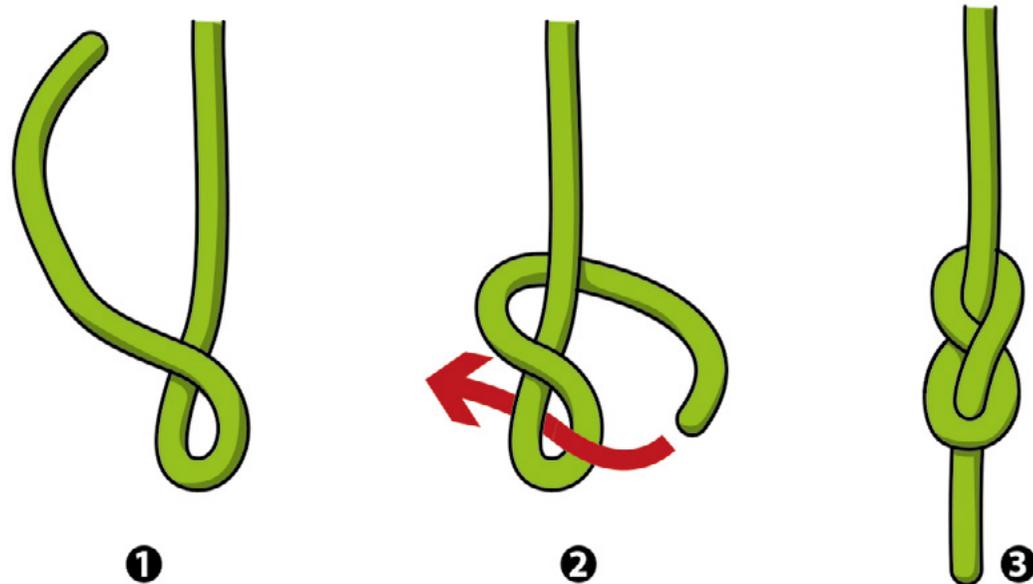
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Figure-of-eight

The Figure Eight is a general-purpose stopper knot that replaces the common Overhand Knot in many uses. It provides a quick and convenient stopper knot, it doesn't bind and it can be undone easily. The Figure-of 8 is also important to climbers because it is the basic for the Double Figure-8 Loop.

Tying:

Pass the tail over itself to form a loop. Continue under and around the standing end. Complete the knot by passing the tail down through the loop.

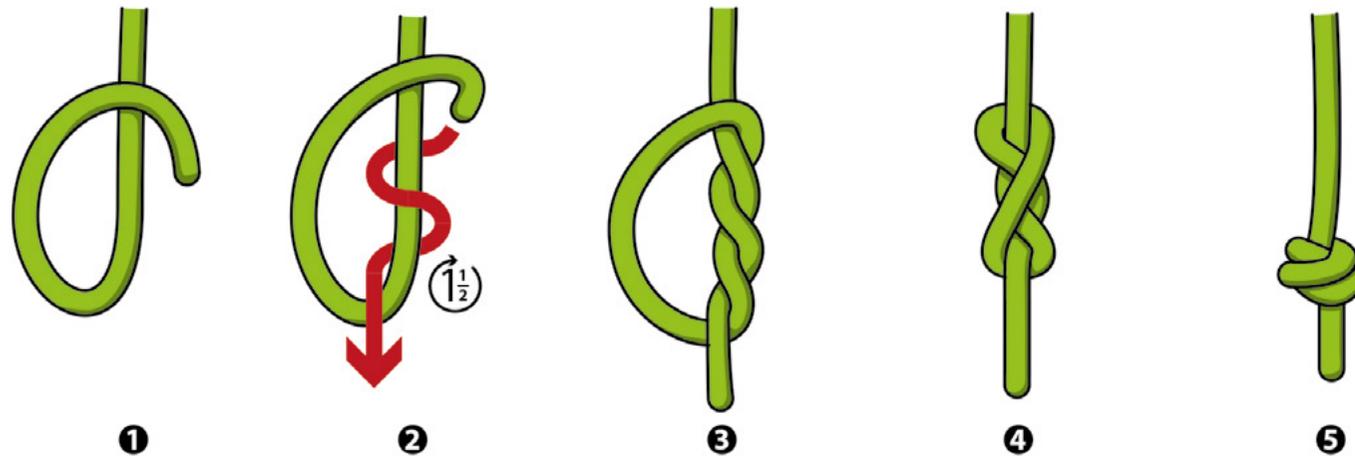


Double Overhand Knot:

The Double Overhand Knot is primarily used as a stopper knot, but is also basis for Double Fisherman's Knot and Double Overhand Loop.

Tying:

As with the Overhand Knot, but with one additional turn.



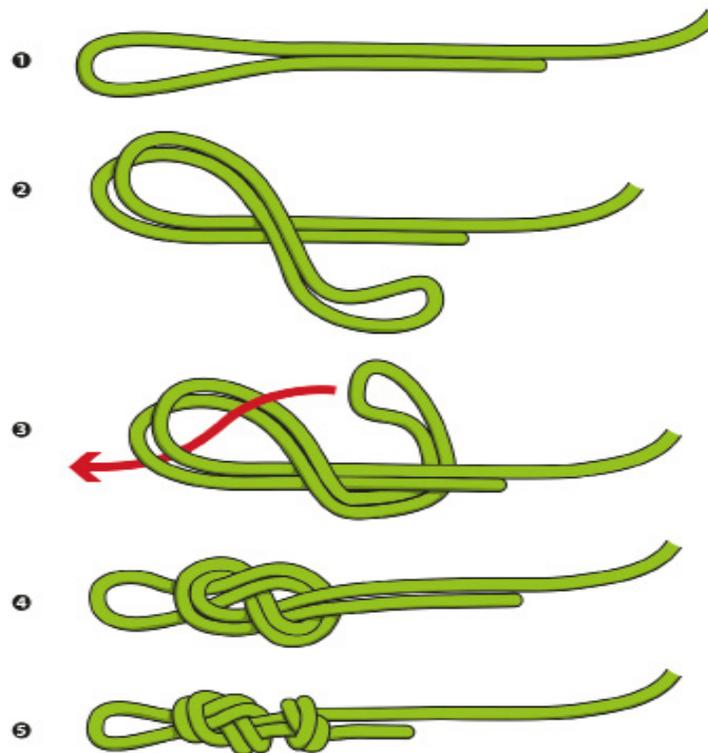
Termination Knots:

Figure-8 Loop

The Figure Eight Loop is used to put a fixed loop in the end of a rope, or around an object. It is relatively easy to tie and is secure, but can become difficult to untie after heavy loading, and can jam badly in any rope type. The Figure-8 Loop is easy to teach to beginners and quickly verify that it has been tied. It can be secured with a Double Overhand Knot.

Tying:

One can easily make a loop by doubling the rope, then tying the standard Figure Eight Knot. The knot can be secured with a Double Overhand Loop

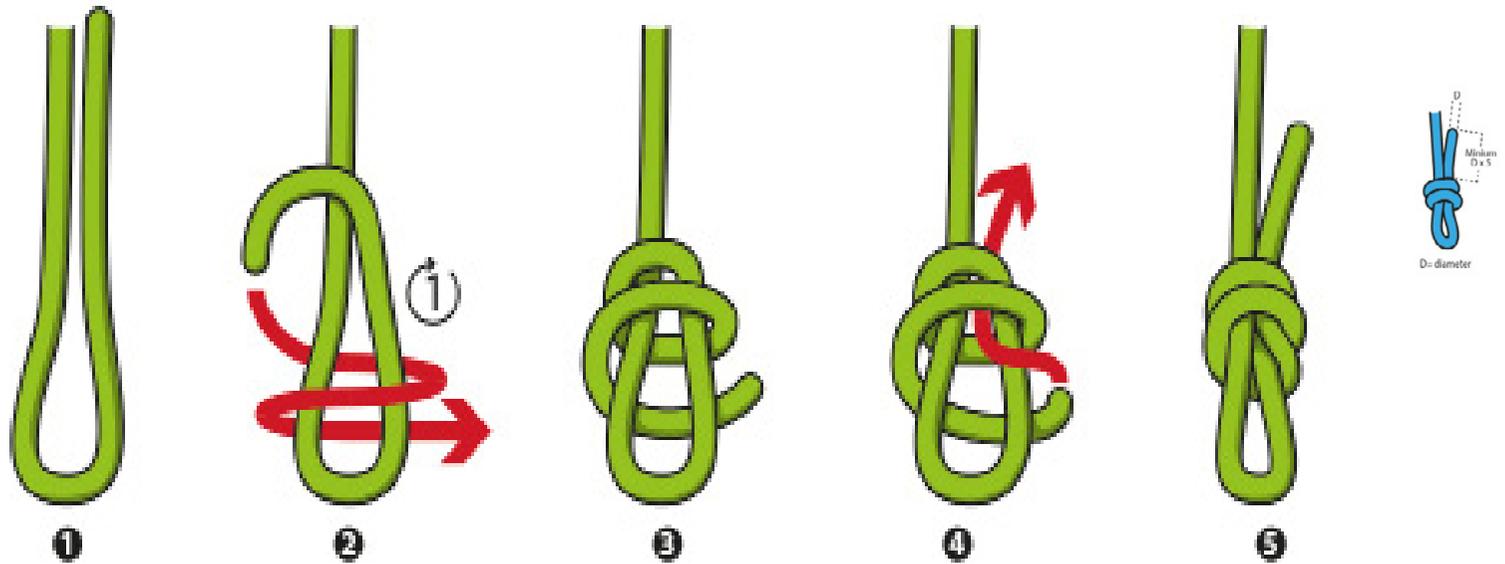


Double Overhand Loop:

Double Overhand Loop is a very secure hitch knot. It is used to bind a line to a carabiner.

Tying:

The technique is to create a Double Overhand Knot around the standing end. A common mistake when learning is failing to complete the second turn, making only a single Overhand knot which is not secure.



Joining Knots:

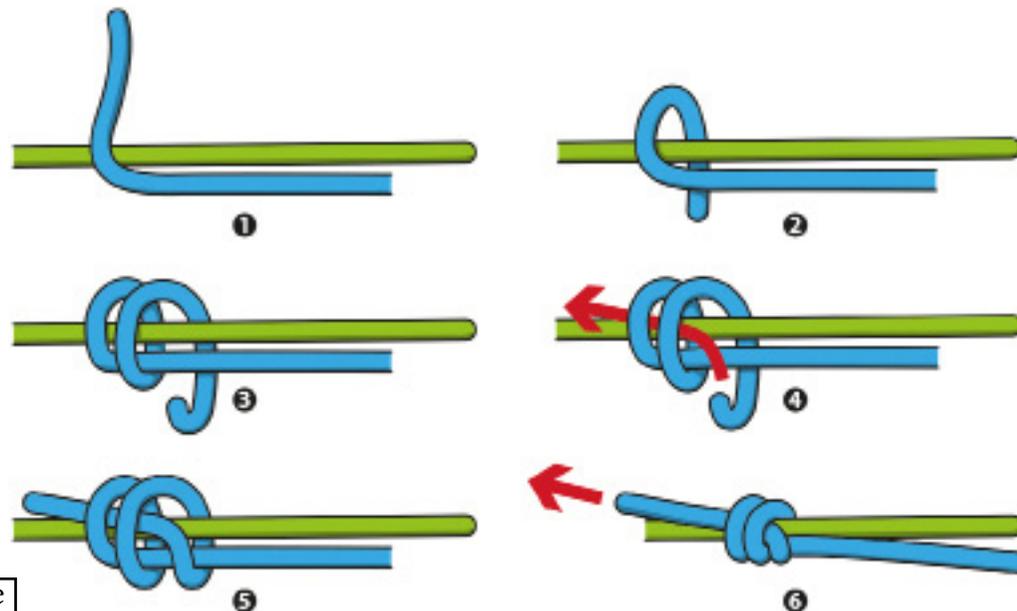
Double Fisherman's Knot:

The Double Fisherman's Knot or Grapevine Knot is a bend used to join two lengths of rope. This knot and the triple fisherman's knot are the variations used most often in climbing, arboriculture, and search and rescue. A primary use of this knot is to form high strength loops of cord, called a Prusik Loop, for connecting pieces of a climber's protection system. The knot can lock up so tightly that it is effectively welded together.

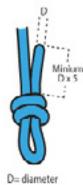
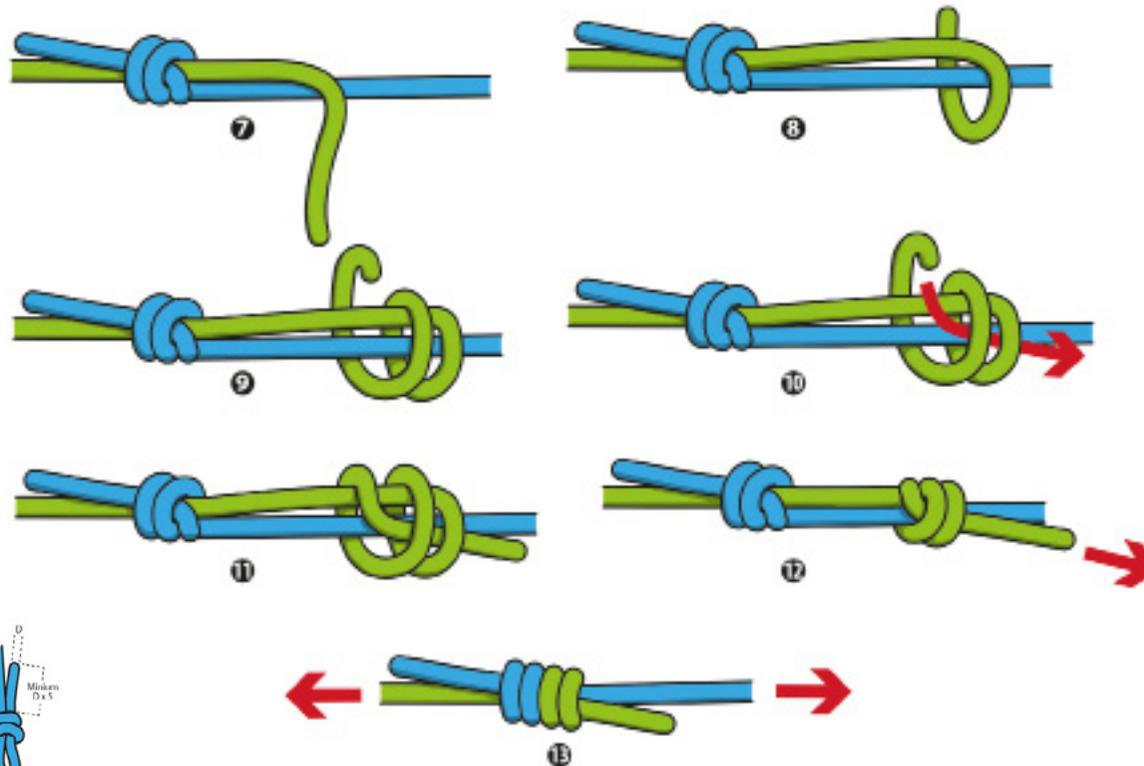
Tying:

The Double Fisherman's Knot consists of two double overhand knots each tied round the other standing end. However, because it is created around another line, this structure may not be obvious.

The Double Fisherman's (Grapevine Bend) is not complicated. Nevertheless, it can be tied wrongly and then fail. If you tie it and your life depends on it, inspect it carefully. If **someone else** ties it, inspect it **extremely** carefully.



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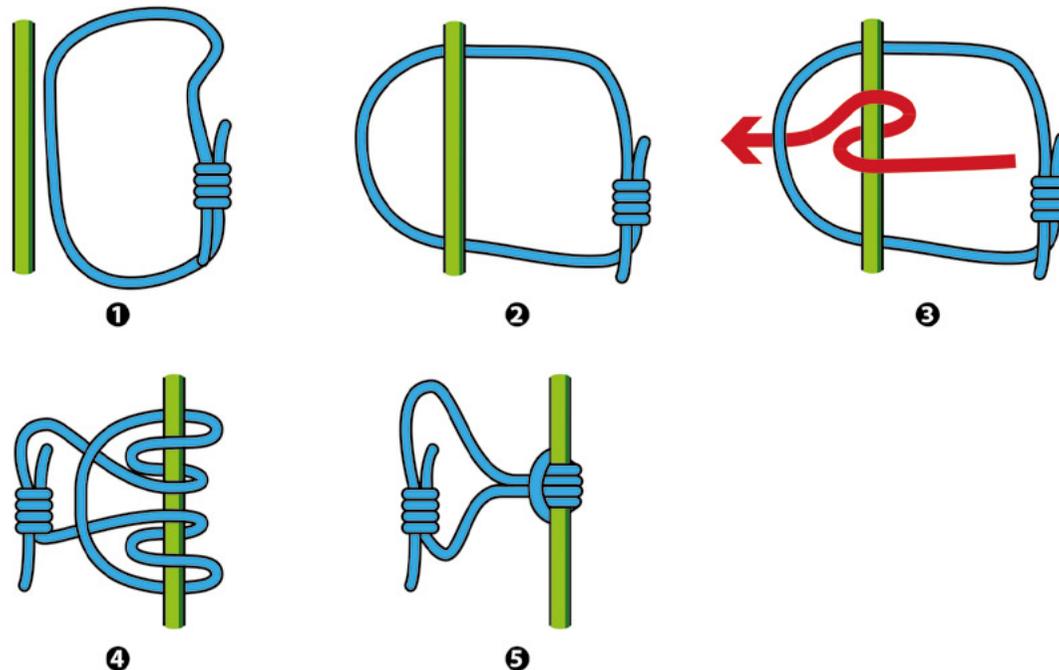
Friction Knots:

Prusik:

A Prusik is a friction hitch or knot used to put a loop of cord around a rope, applied in climbing, canyoneering, mountaineering, caving, rope rescue, and by arborists. The term Prusik is a name for both the loops of cord and the hitch, and the verb is "to prusik".

The Prusik hitch is named for its alleged inventor, Austrian mountaineer Dr. Karl Prusik. It was shown in a 1931 Austrian mountaineering manual for rope ascending.

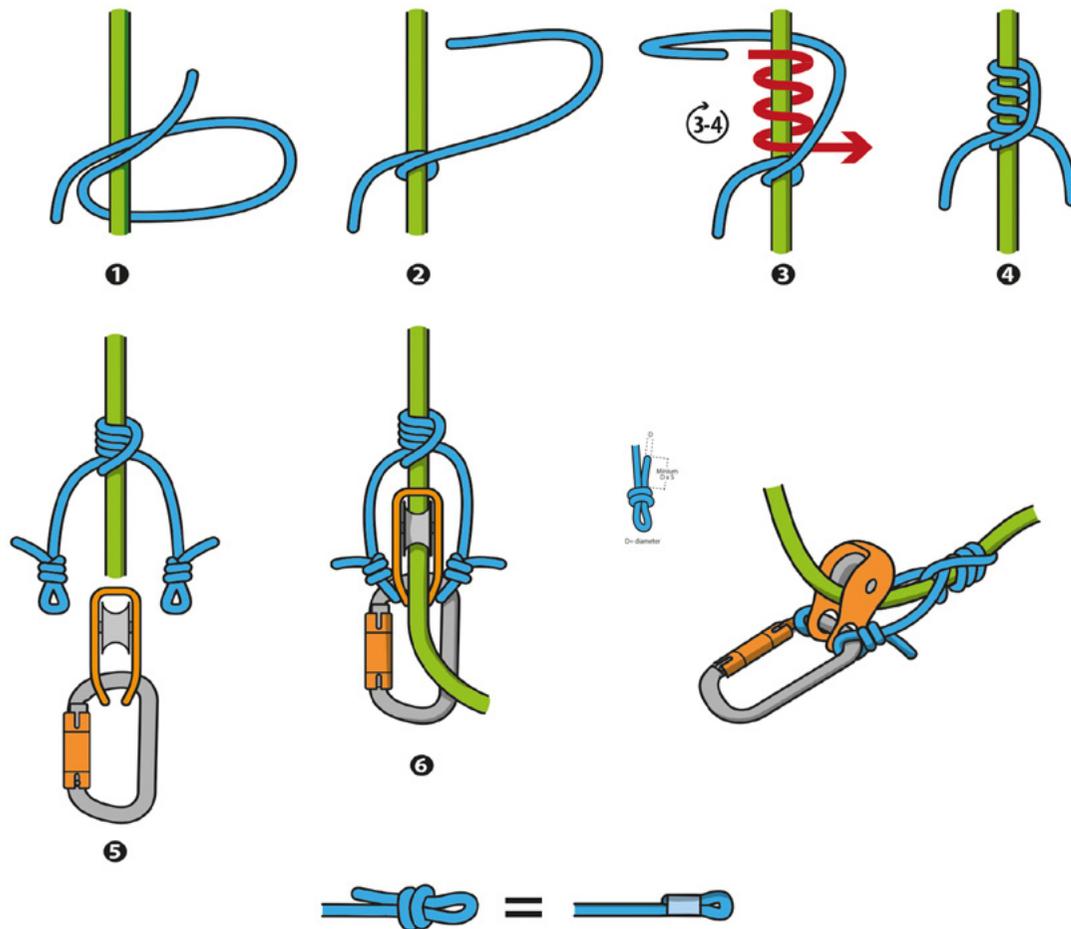
One component of the Prusik Knot is the Prusik Loop. This loop can be made using a short section of rope joined by a Double Fisherman's Knot. Alternatively, the loop may be purchased, already formed, from climbing shops. Due to its symmetric nature, Prusik hitches have the advantage of working in both directions. Most mechanical rope-grabs work like a ratchet, moving freely up the rope, but grabbing when a load is placed down on them. Traditional Prusiks will grab when pulled by the tail, either up or down, and will slide either way when pushed by the barrel. The function of the knot depends on number of turns, size of climbing line, weight of the climber and if the weather is wet or dry. It's important that you find your own combination.



Distel

The Distel Hitch is a directional friction hitch that is often employed by arborists. It is used to attach a carabiner to a rope, allowing a climber to ascend or descend.

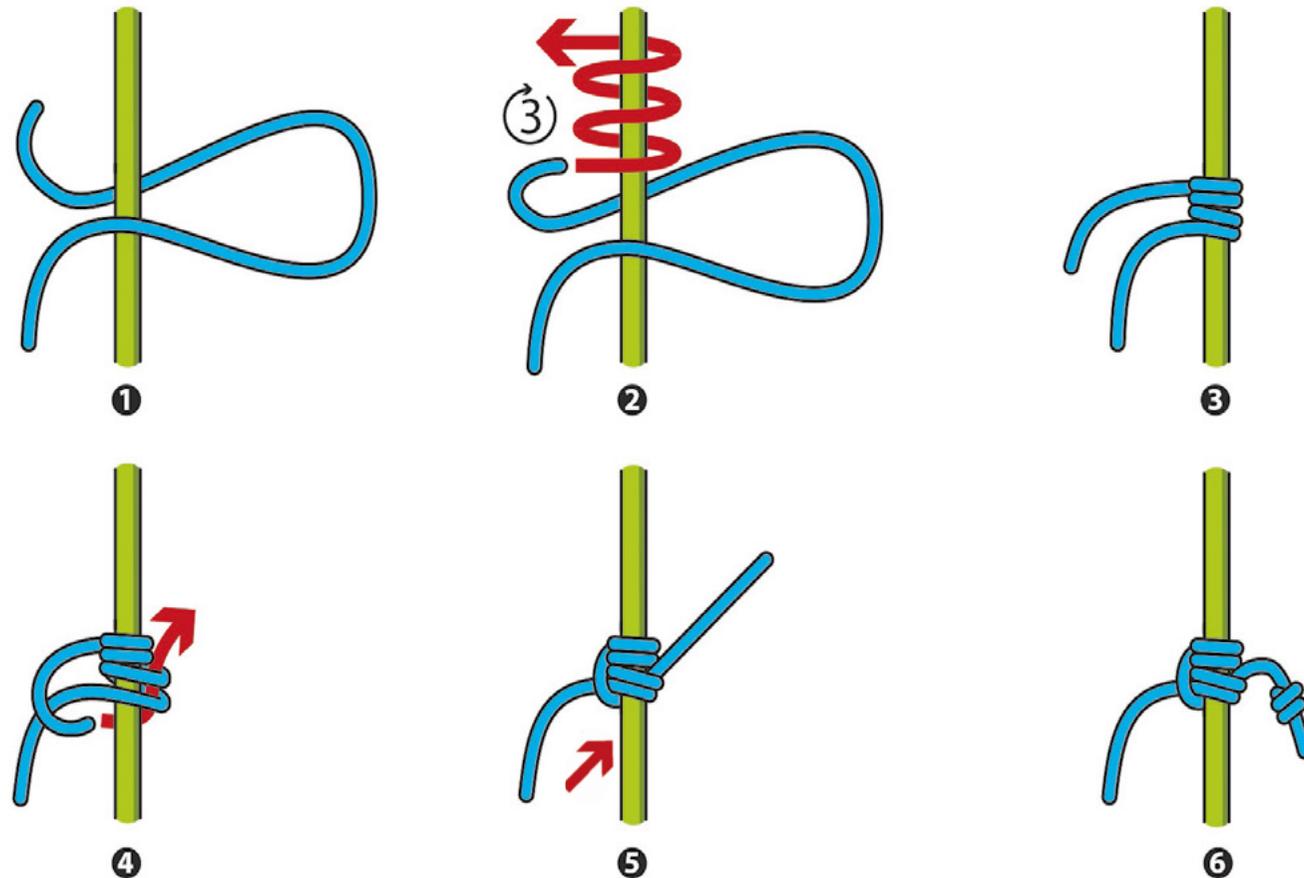
The Distel Hitch is credited to a German climber named Uli Distel who, it has been said, attempted to tie the Schwabisch but neglected to change the direction of the split-tail when he made the turns above the bridge. As it turned out, this arrangement worked well for climbing!



Blake Hitch

The Blake's Hitch is a friction hitch commonly used by arborists and tree climbers as an ascending knot. Unlike other common climbing hitches, which often use a loop of cord, the Blake's hitch is formed using the end of a rope. Although it is a stable knot, it should be backed up with a stopper knot, such as a Figure Eight Knot, for safety. It is used for both ascending and descending, and is preferred by many arborists over other hitches, as it is less prone to binding.

The Blake's Hitch should always employ a stopper knot (not shown in the animation) to prevent the free end from working its way back through the hitch. If the hitch does not hold securely due to slickness of the standing line, an extra turn should be made around the line, with the end still tucked only under two. Additionally, the strain should only be applied from "below" the hitch.

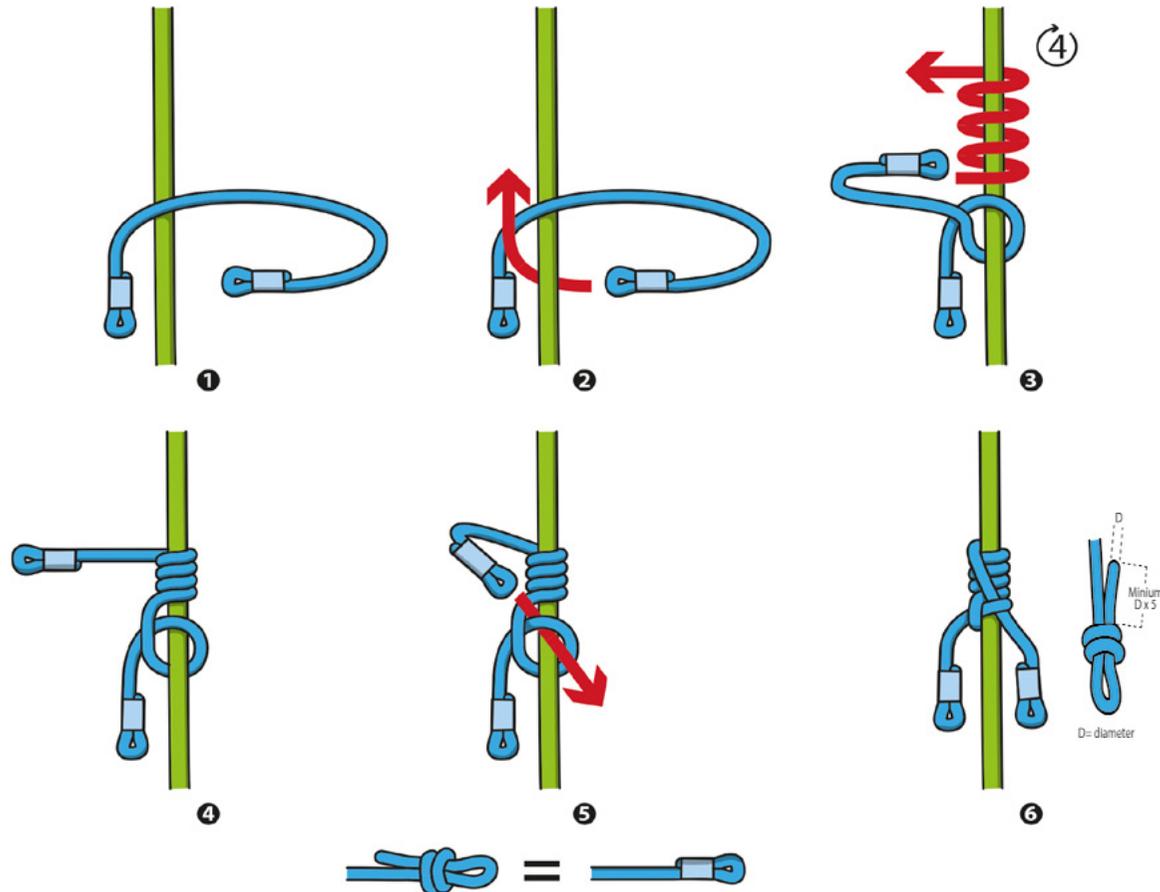


Knut

The knot was introduced by climbing instructor Knut Foppe around the millenium and is therefore one of the "new" friction knots.

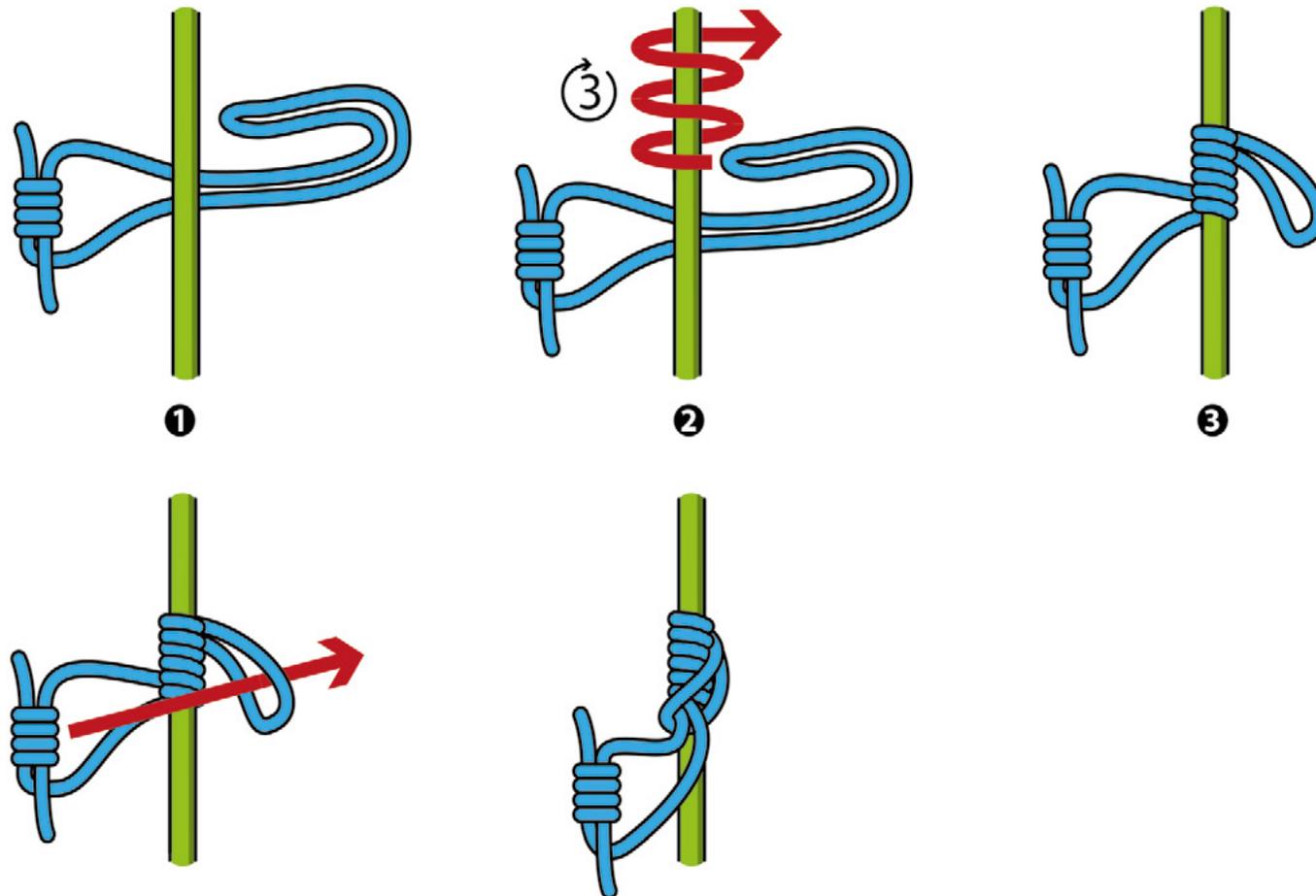
The Knut is a good alternative to the Distel, it has a good grip, is easy to move and binds effectively when you let go of it. The knot can be adjusted by increasing or reduce the number of turns. Ususally, a wheel is added behind the knot to make length reduction easier, but the knot can be moved forward quite easily without the wheel. The Knut is slightly more complicated to tie than the Distel.

When using a wheel on a steel core lanyard, the wheel must be connected with a cut-able link.



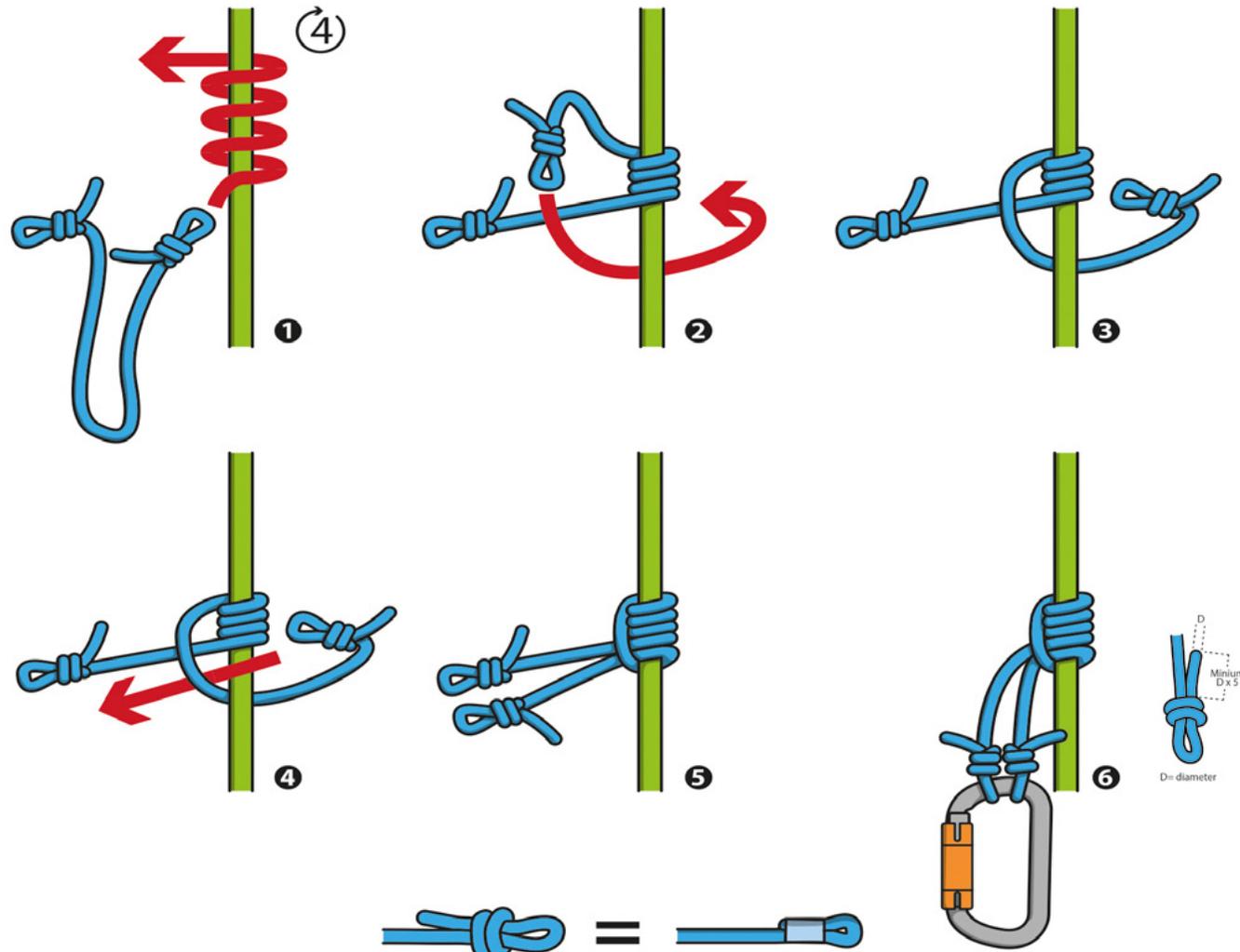
Klemheist

The Klemheist Knot (klem is the Dutch word for "clamp") is a type of friction hitch that grips a rope when weight is applied, and is free to move when the weight is released. It is used similarly to a Prusik knot to ascend or descend a climbing rope. One advantage is that webbing can be used as an alternative to cord. The Klemheist is easier to slide up than a Prusik.



Schwabisch

The Schwabisch is a directional friction hitch that is popular with arborists. It is used to attach a carabiner to a rope, allowing a climber to ascend or descend. Can be confused with the Distel. The Schwabisch moves easier than the Prusik, and is tied from a 60-80 cm long line, with a diameter of 8-10 mm. Friction can be adjusted by adding or removing a turn.



French Prusiks

This group of knots consist of several types of friction knots, where especially two of them are used by arorists: The Valdótain Tresse (abbreviated: VT) and the XT, a development of the VT.

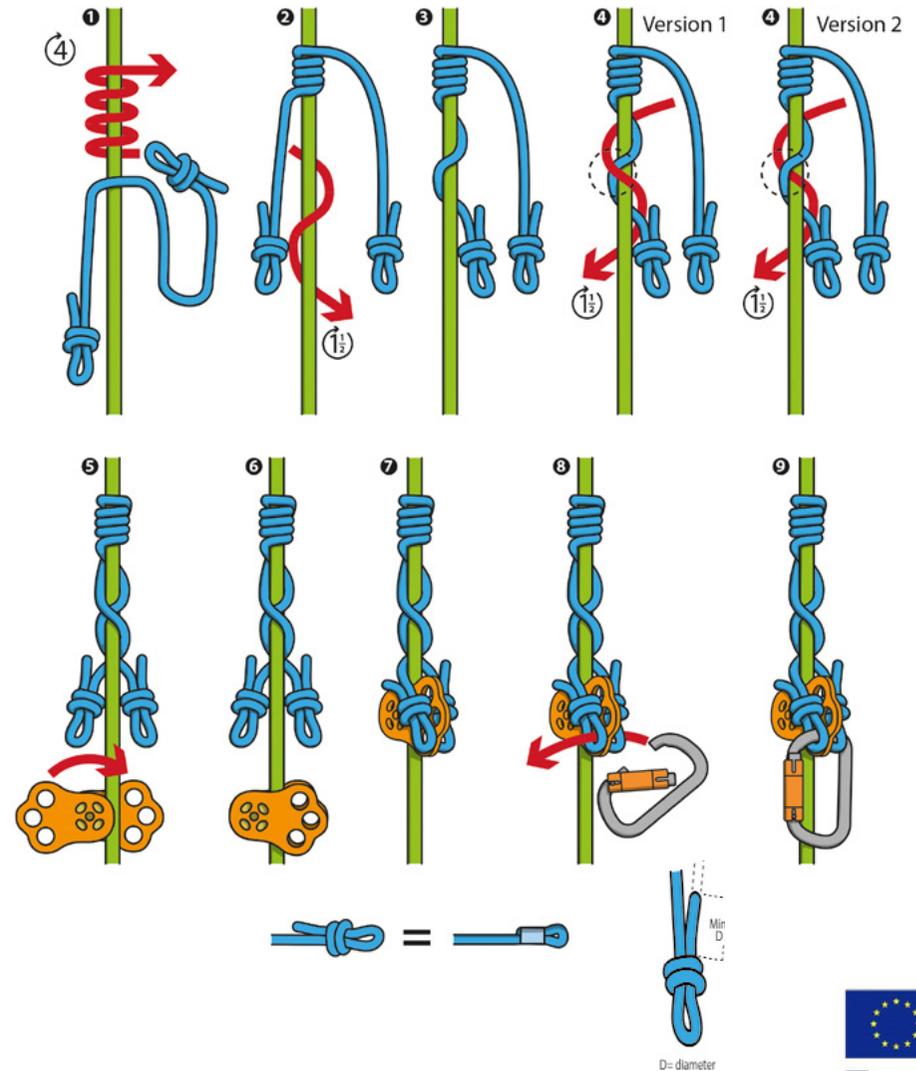
Valdótain Tresse (VT)

The VT has been used for 20 years by climbers with a certain routine. The basis knot is called the "Valdotáin", and since Tresse is meaning "braid", we have a "Braided Valdotáin". Since the VT is quite a temperamental knot, it is not suitable for beginners.

The VT is dependent on the thickness and manufacue of the friction line and the climbing rope, the number of turns above the braid, and if it's dry or wet. It is not unusual for the climber to tighten the knot after ascend, especially if he or she has been using footacsenders.

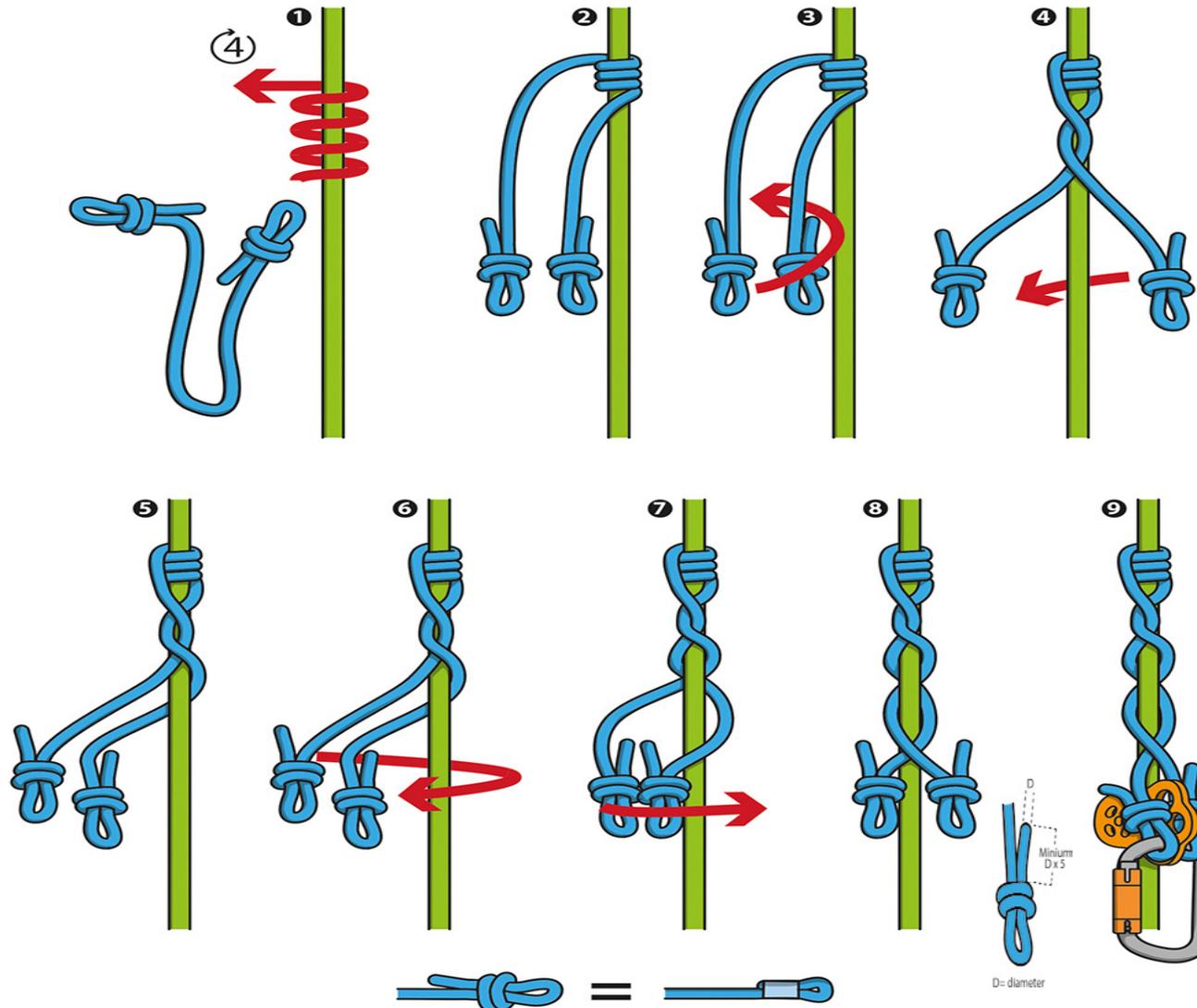
The English are calling the knot "Fast, but unforgiving". Therefore: Start "Low & Slow" if you want to experiment with this knot.

Observe differences between pic. 4, ver. 1 and pic. 4, ver. 2!



XT

As mentioned earlier, the XT is a development of the VT. Many climbers found the VT too soft and imprecise in their daily work. At a time, someone twisted the braid one more time, this made the knot more stiff and responding. As with the VT, be aware of how the braids and the twist are laid.

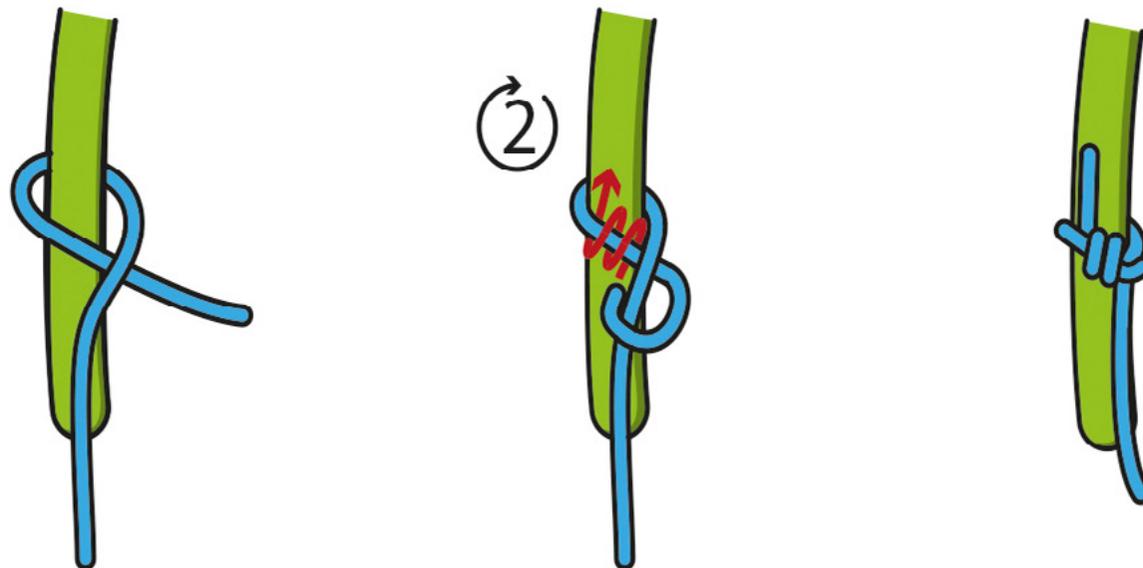


Fastening Knots

Fastening knots and hitches are used when you want to attach tools to a line, or during rigging. The following knots and hitches are effective and fast to tie and easy to undo.

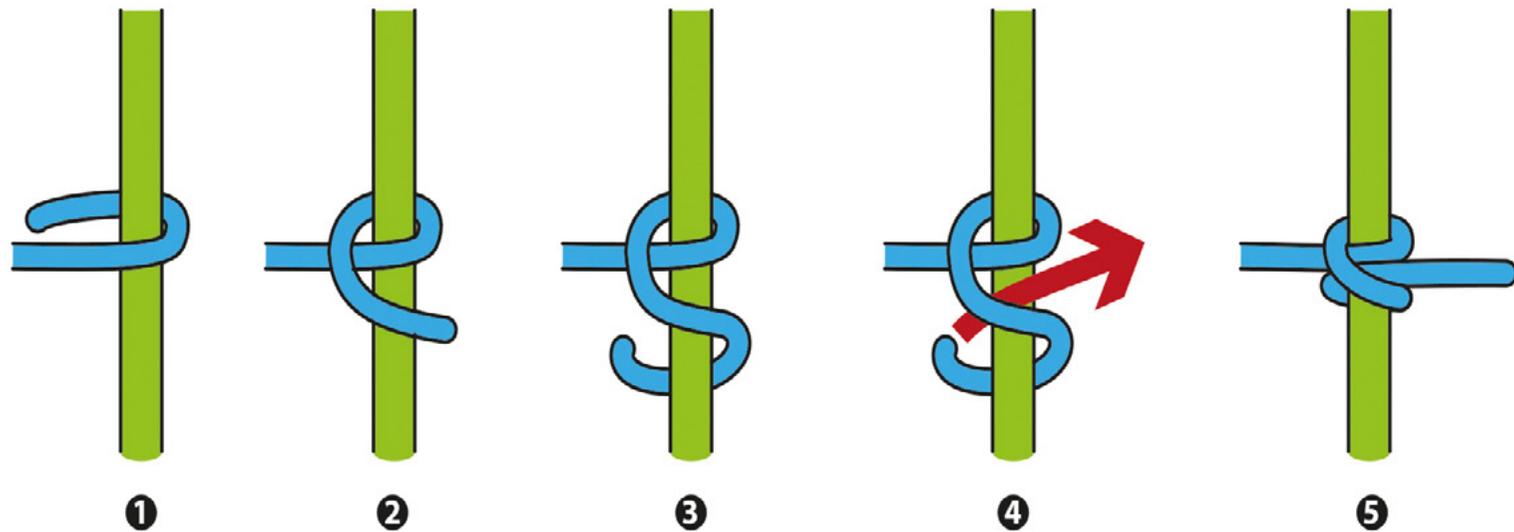
Timber Hitch

The Timber Hitch is a knot used to attach a single length of rope to a tool or a piece of wood for hauling or hoisting. Known as the Bowyer's Knot, it is used to attach the lower end of the bowstring to the bottom limb on an English longbow. An additional use is for attaching strings to the bridge of ukuleles and classical acoustic guitars (!). The knot must be made with a minimum of 3 turns, while more can be used when convenient.



Clove Hitch

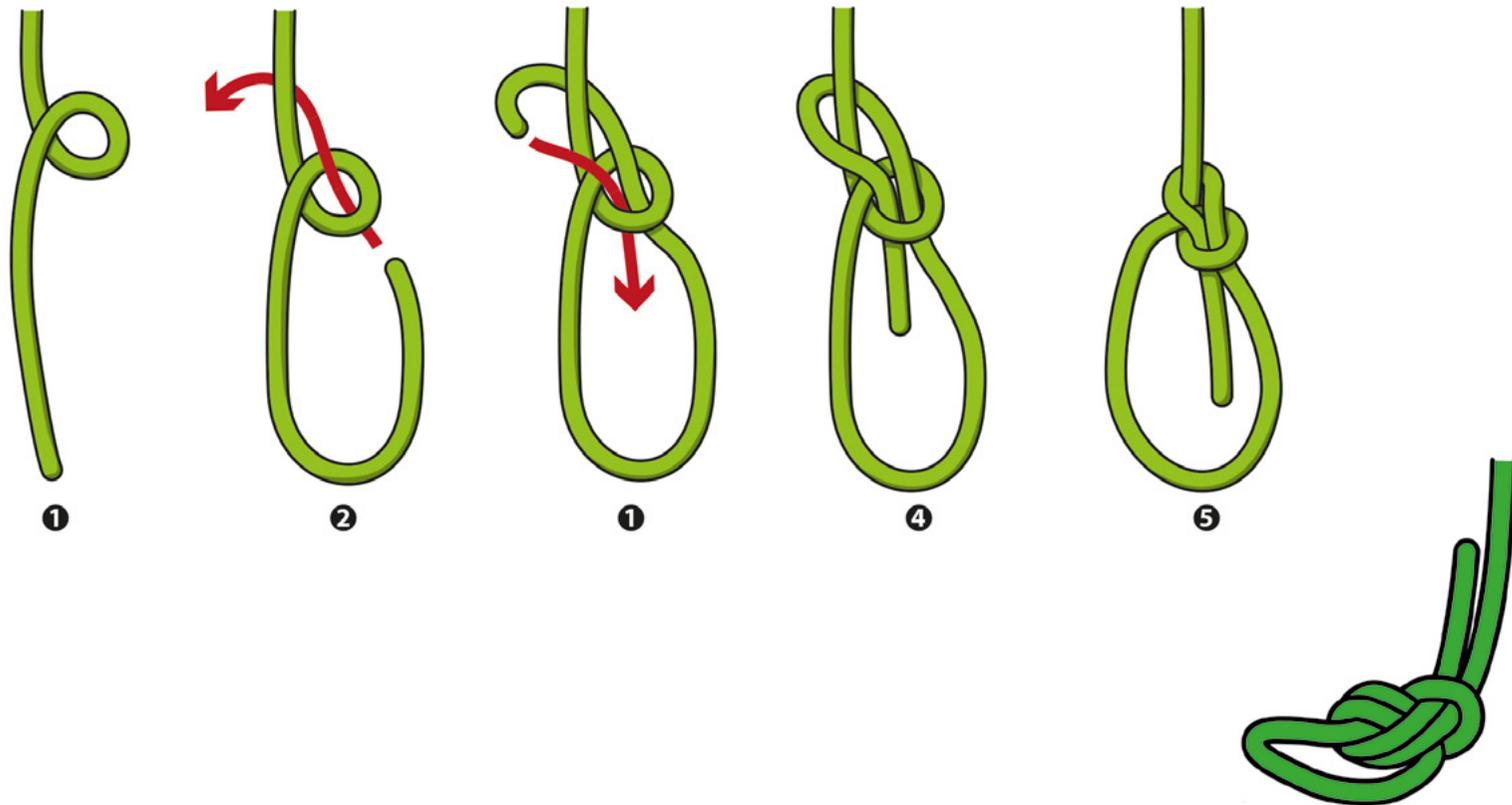
The Clove Hitch is used to begin the Distel. It is considered by many to be "an essential knot", and it is very secure when both ends of the rope is under tension. However, when loading only one end, the knot is prone to slip by rolling. Can be used as a part of the knots when attaching the throwline to the climbing line. The Clove Hitch should never be used alone if safety is at stake.



Bowline

The Bowline is used to make a solid, fixed loop in the end of a line, especially if the tension is permanent. Under cyclic tension the Bowline has a tendency to become undone. Even after extreme tension the bowline is easy to undo, except when it has been used on UHMWPE¹ where the knot can weld itself together due to the low melting point of the rope.

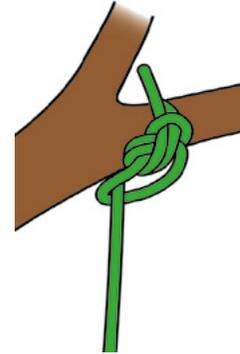
The Bowline can be made with a *Yosemite Tie-off* as a safety termination, this increased the safety of the knot remarkably. Pay attention to the tail, this should be inside the loop. Not to be used as termination knot on climbing rope, even with Yosemite Tie-off



¹ Ultra-high-molecular-weight polyethylene. Extremely strong artificial fibre, with a melting point at 130°C.

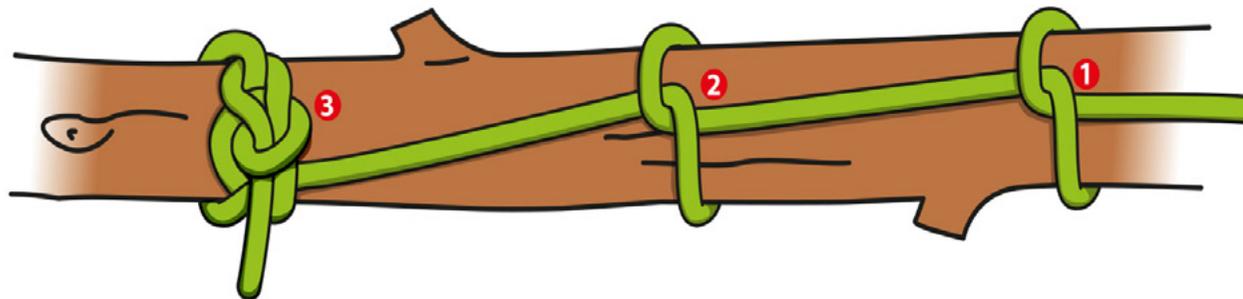
Running Bowline:

The Running Bowline is a type of noose (running knot), related in structure to the standard Bowline. As with most running knots, the Running Bowline will automatically tighten up under strain, but will release once the strain is removed. It slides easily and, as with the standard Bowline, unties easily even after heavy use. Often used as tie-in at rigging. With Yosemite Tie-off the Running Bowline can be used as a final anchorpoint in connection with SRT¹.



Running Bowline w/ half hitches:

Used in rigging operations to secure the load and distribute the weight. One or more half hitches are added to secure the load.

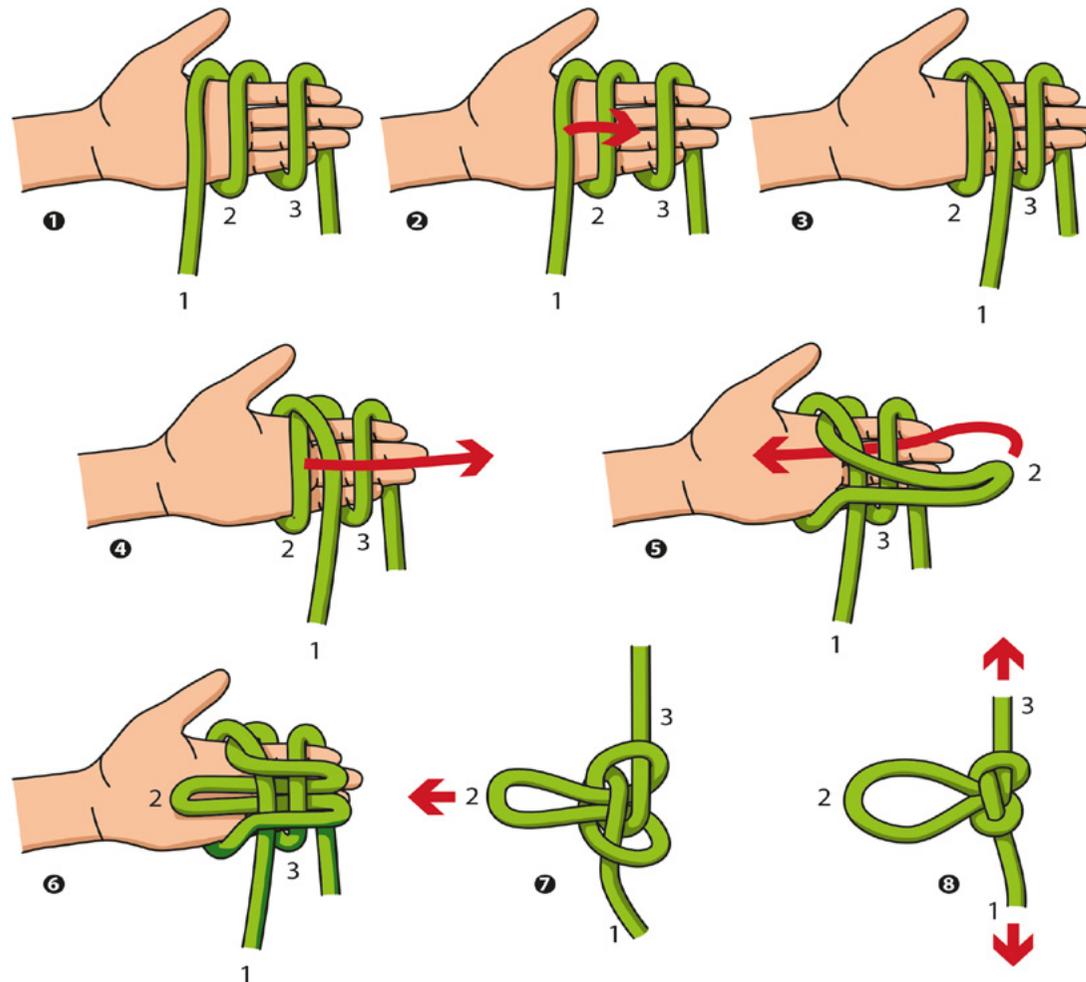


1 Single Rope Technique.

Loops:

Alpine Butterfly:

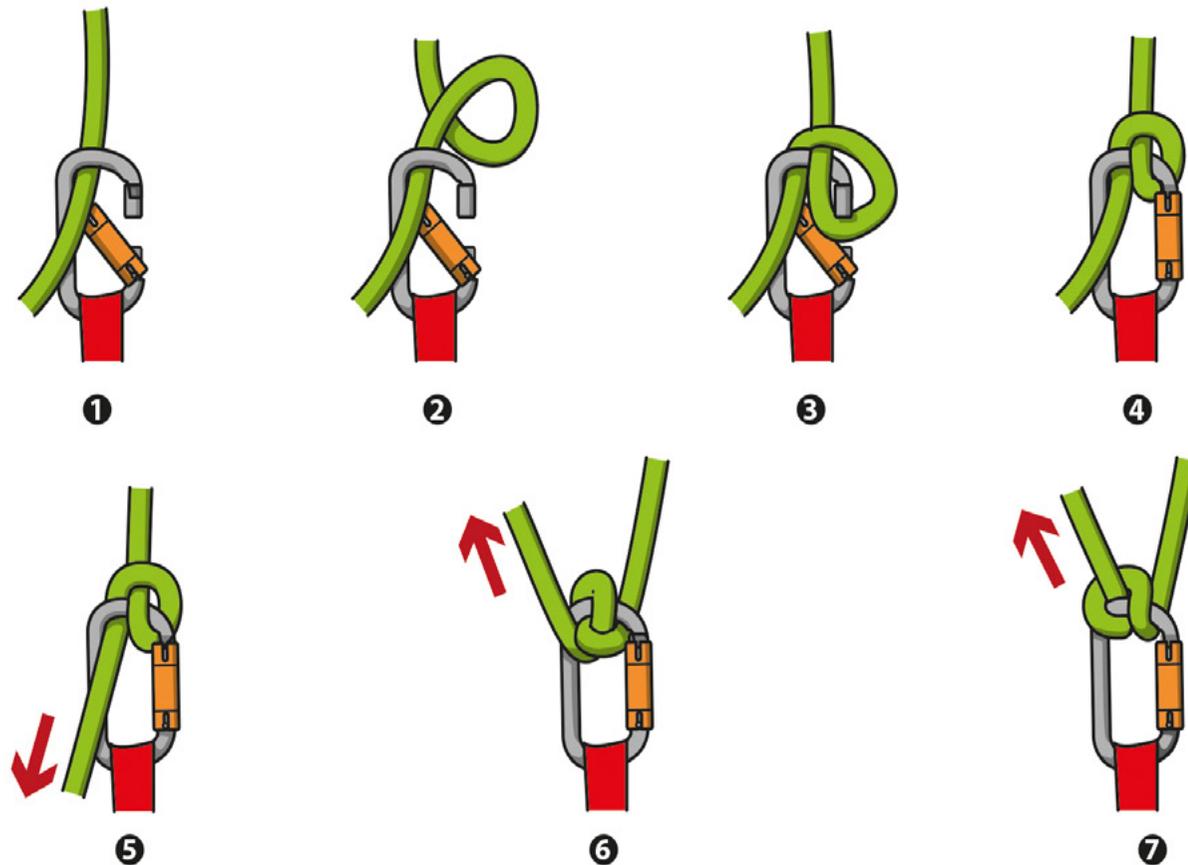
The Alpine Butterfly Knot is used to form a fixed loop in the middle of a rope. Tied in the bight, it can be made in a rope without access to either of the ends; this is a distinct advantage when working with long climbing ropes. An excellent mid-line rigging knot, the Alpine Butterfly is easy to inspect for correctness, can be loaded in any direction, and can be tied with gloves on. In a climbing context it is also useful for anchors, shortening rope slings, and for isolating damaged sections of rope. The knot can typically be used anywhere a fixed loop is called for and is often used as a component of the Trucker's Hitch.



Munter Hitch.

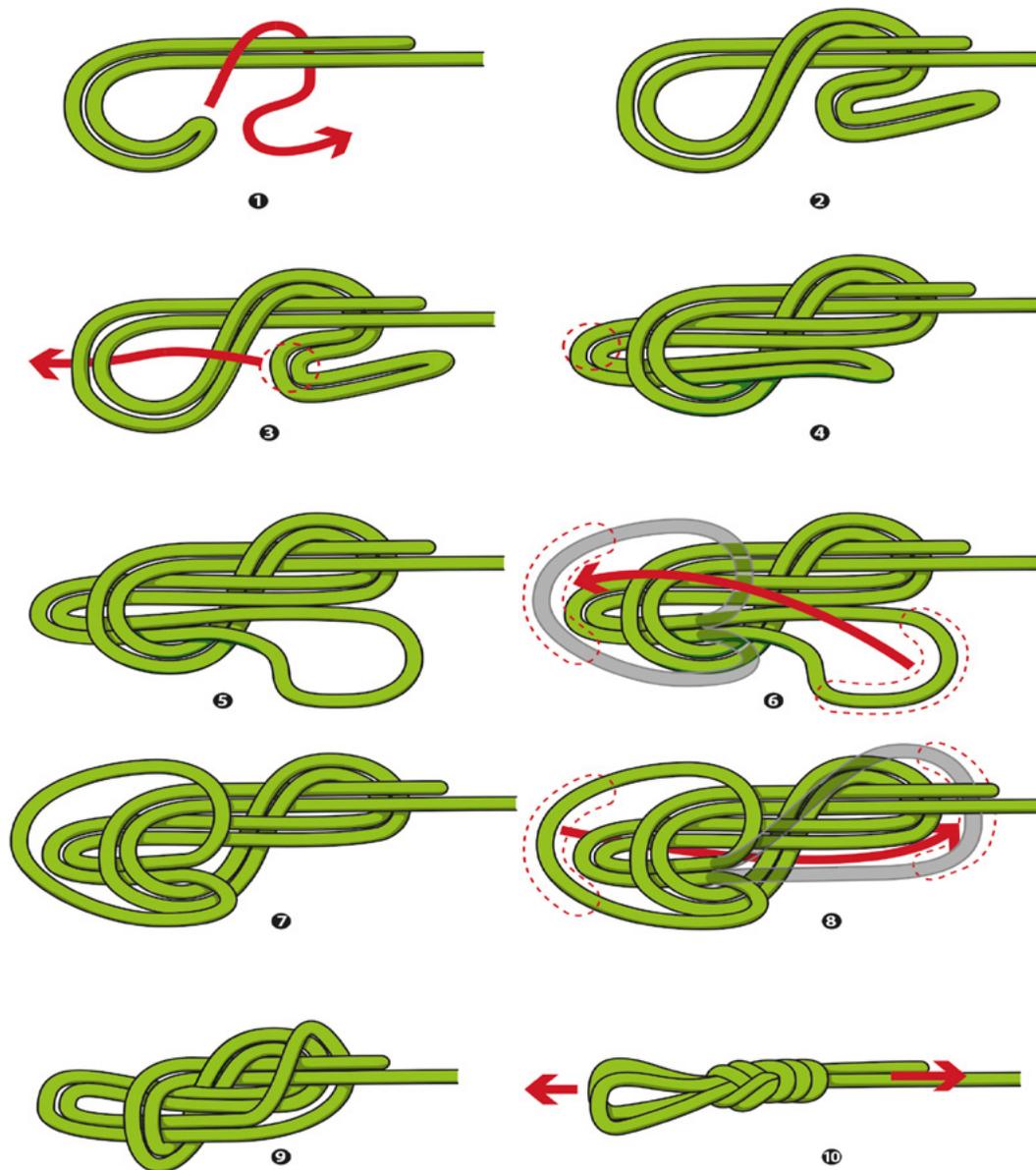
The Munter Hitch is a simple knot, commonly used by climbers and cavers as part of a life-lining or belay system. This technique can be used with any locking carabiner wide enough to take two turns of the rope. The Munter hitch creates friction by having the rope rub on itself and on the object it has been wrapped around. There is no static friction on any part of the rope as it is a continuously moving knot. One very useful aspect of the Munter is its reversibility; it can be pulled from either side of the rope and it still works just as effectively. Must always be used with additional back-up when descending.

The 'Munter Hitch' is named after a Swiss mountain guide, Werner Munter, who popularized its use in mountaineering. This knot is also known as HMS, the abbreviation for the German term Halbmastwurfsicherung, meaning half clove hitch belay.



Double Bight Figure Eight

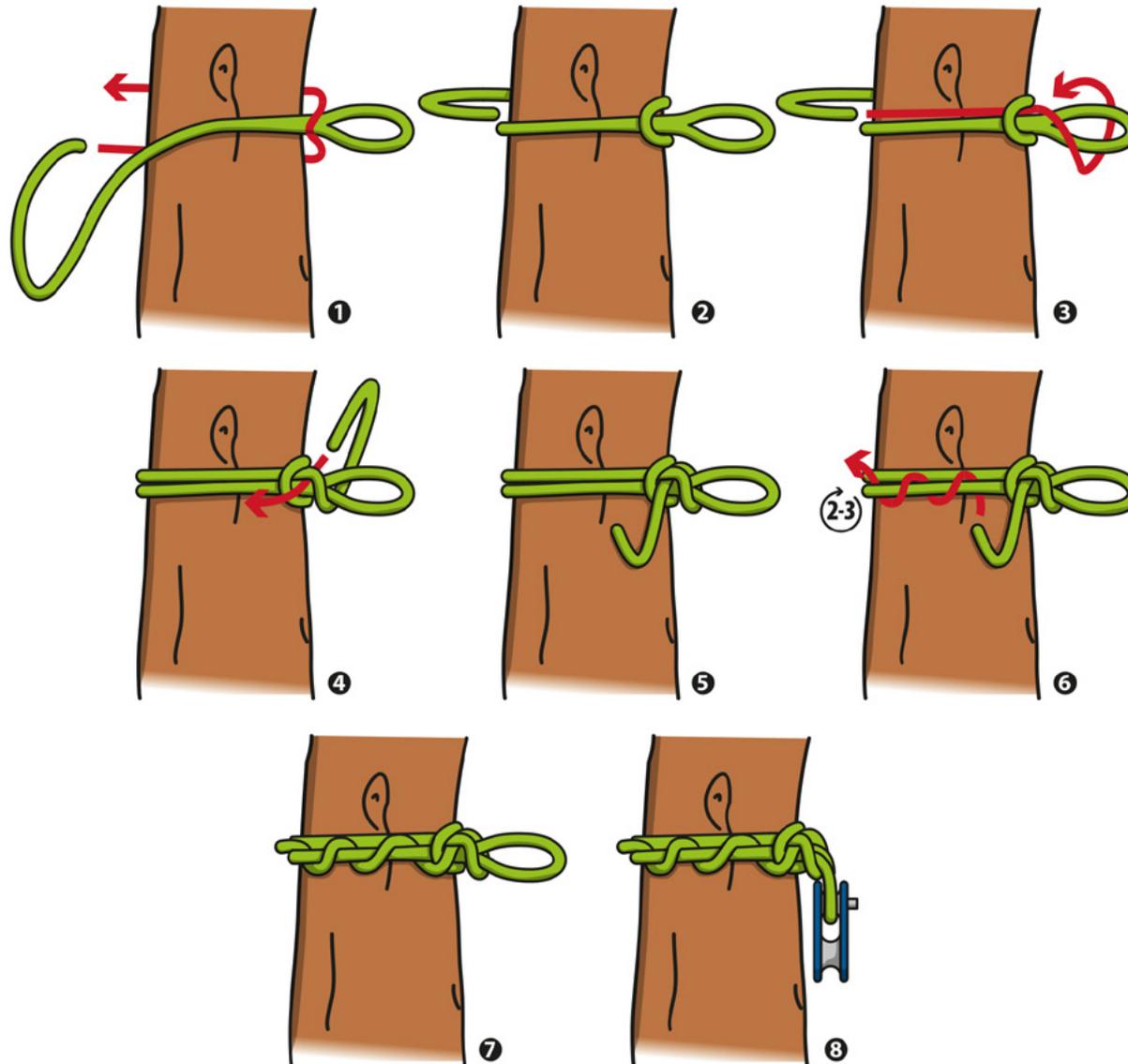
The Double Bight Figure Eight, also known as the "Bunny Ears", is useful for equalizing two anchors and providing redundancy.



Compared to many other double loop knots, the Double Bight Figure Eight is considered to be strong and secure, and it is fairly easy to adjust the size of the 'ears' or loops by moving rope from one of the loops to the other. Each loop shares a portion - roughly 50% - of the load. If either loop, either anchor, or either carabiner fails, the remaining anchor assembly should not be compromised.

Secured Cow Hitch:

The Secured Cow Hitch is used where a solid eye is needed close to the stem, often in rigging operations, where it is used for attaching a rigging block. The turns at drawing #6 are partly for safety, partly for stowage of excess line.

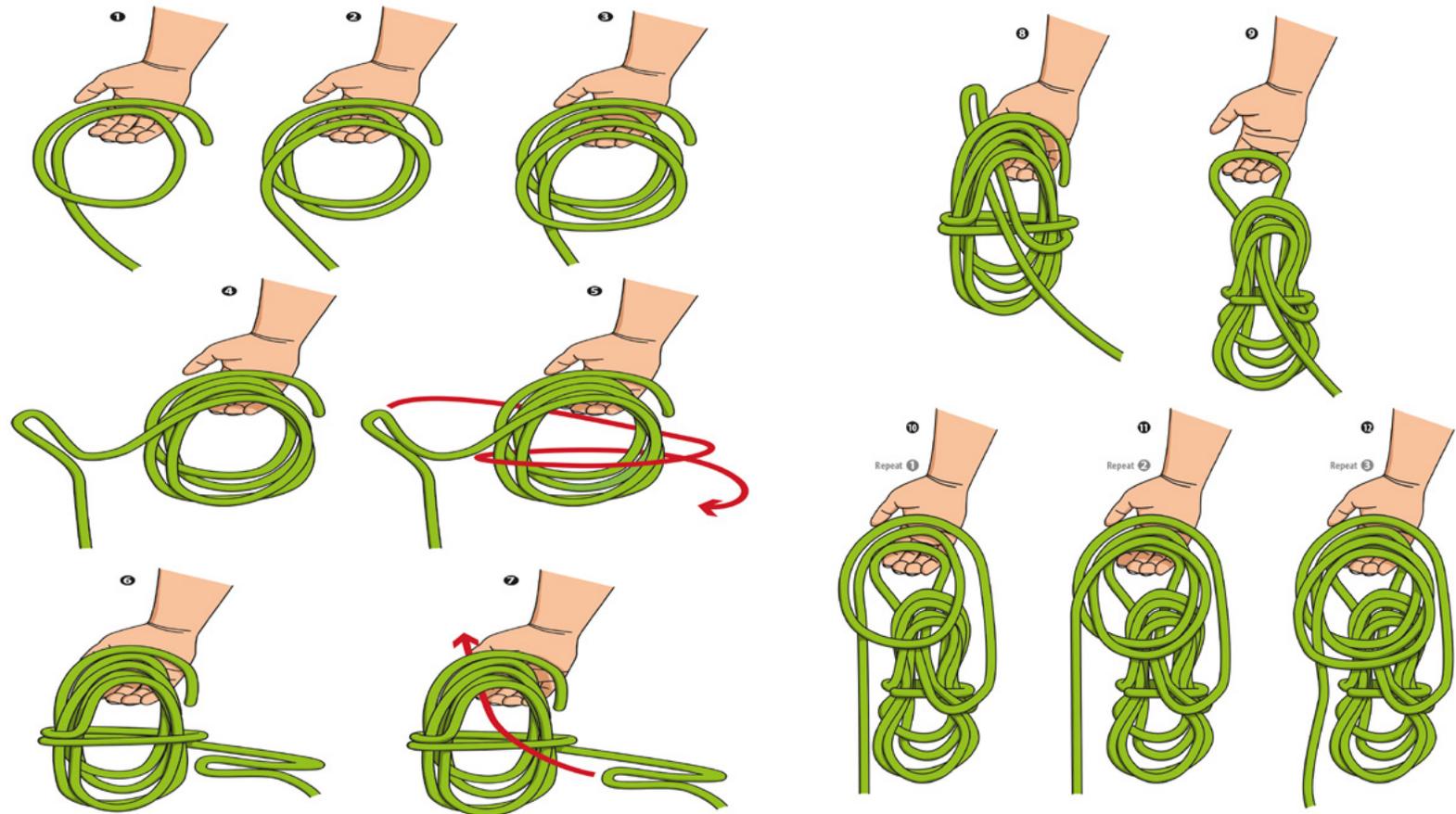


Throw Bundle 1

The Throw Bundle is a way to forward your climbing rope further up when ascending the crown. Train on the ground before approaching the tree. Especially the half hitches can be tricky to master.

Tying:

Estimate the distance from the temporary anchorpoint and back to you. Make a series of coils equivalent to this distance (Typically one coil per meter). The coils are made of round turns and half hitches in shifts (Important, since this takes the small kinks out of the rope). Make one or two tight turns around the coils and pass a bight through the upper part of the coils. You will now have a weight that will release itself when it passes over the branch. Making the bight as little as possible, collect the same amount of coils in the same way, round turns and half hitches. Your throw bundle is now ready.



Throw Bundle 2.

