CLOTHING • FABRICS • LAYERING • CLOTHING CARE • FOOTWEAR • PACKS • ESSENTIAL EQUIPMENT • PREPARING FOR THE FREEDOM OF THE HILLS

CHAPTER 2

CLOTHING AND EQUIPMENT

Packing everything you might need to keep you safe, dry, and comfortable on a wilderness trip can paradoxically lead to danger, chill, and misery. The challenge is to limit the load enough to allow for fast and light travel while still having the gear essential for success and survival. Each onerous ounce limits how far, fast, or high you can climb and how speedily you can retreat to safety.

To strike a balance between too much and too little, monitor what you take on a trip. After each trip, determine what was used, what was genuinely needed to achieve a reasonable margin of safety, and what items were unnecessary. When buying equipment, go for lightweight, low-bulk alternatives that offer sufficient performance and durability.

If you are new to mountaineering, wait until you have experience before spending too much money on clothes, boots, or packs. Rent, borrow, or improvise during early outings, gaining hands-on experience before you invest. Get advice from seasoned climbers, window-shop at outdoor stores, and scout mountaineering magazines and online sources. The latest and greatest products or most expensive items are not always best overall. Neither

is the cheapest gear necessarily the most economical since certain gear features justify a higher cost.

This chapter provides information on basic and essential wilderness gear, including guidelines on what constitutes good equipment, and though it does not recommend brands, it will help you select high-quality items that work flexibly together. Additional gear for eating and sleeping in the great outdoors is covered in Chapter 3, Camping, Food, and Water.

CLOTHING

Clothing helps a person stay comfortable by creating a thin insulating layer of air next to the skin. The enemies of comfort—precipitation, wind, heat, and cold—work against this protective air layer. The right clothes protect that layer. "Comfort" is a relative term for mountaineers. Inclement weather often forces climbers to endure conditions that deteriorate far below most people's definition of comfort. Still, in climbing, the key to maintaining relative comfort is to stay dry—or, after getting wet, to stay warm and dry out quickly. Safety is the primary concern. When venturing into remote territory, climbers need layers of clothes and a layering system that helps them deal with difficult conditions for however long those conditions last.

Prolonged periods of dampness, even in moderately cool temperatures, can cause your body's core temperature to fall, possibly triggering hypothermia, a frequent cause of death in the mountains. Failure to protect yourself from wind exposes you to windchill and can contribute to hypothermia or lead to frostnip or frostbite. (See "Cold-Related Conditions" in Chapter 24, First Aid.) Carefully select the clothes you will layer to ensure that you can survive sustained exposure to cold and wet conditions.

CHOOSING A STARTER ENSEMBLE

Get started by purchasing a few high-quality, well-fitting pieces to serve as the core of your layering system for most trips:

- Boots and socks
- Light- or medium-weight base layer—two tops and one bottom
- One or two synthetic or wool (knit) tops of varying weights—one with a zip collar or full-length zip and one with a lightweight hood
- Synthetic pants and shorts
- Insulated ("puffy") coat

- Hardshell jacket and pants
- Warm hat and gloves
- Sunglasses

Outdoor clothing must also protect climbers from overheating on hot days and prevent excessive sweating, which can dampen clothes from within and lead to severe dehydration. Ventilation, breathability, and sun protection are additional key considerations. Because an overwhelming variety of garments, high-tech fabrics, features, and brands all proclaim superior performance, assembling a layering system for the first time can be daunting. When shopping, ask questions and read tags. Evaluate garments for their functionality and versatility: Will this work when wet? Does it have a wide comfort range? Be skeptical; clothing is an area of strong marketing claims and weak data. In addition to cost, consider durability, fit, and versatility. Clothes designed for other sports may also be suitable for climbing.

Keep in mind that one climber may select a clothing system markedly different from that chosen by another with a different body structure, metabolism, or preference. A solid core of garments lets you adapt to season and activity to meet the demands of many conditions. (See "Layering," below.) Thoughtful additions can expand your clothing quiver to meet the challenge of upcoming adventures. Eventually, you will pare down your packed layers, but if you are new to wilderness travel, start out carrying more than enough to stay warm and dry. Leave items at home only when you are certain that it is possible to survive and thrive without them. Try to minimize the weight of your clothes but not at the expense of safety. Before heading out, get a weather forecast and think ahead about the temperature and weather extremes you may encounter, and then pack accordingly.

FABRICS

Clothing suitable for the outdoors is made from a great variety of fabrics, each with its particular advantages and drawbacks.

SYNTHETIC FABRICS

Synthetic fibers—polyester, nylon, spandex, and acrylic—have largely replaced natural fibers in mountaineering fabrics. Synthetic fibers are

hydrophobic, meaning they tend not to absorb moisture. Synthetic fabric garments will absorb some moisture but only in the spaces between the fibers and between the filaments making up each thread. (Bacteria thrive in these spaces, setting up a factory of funk, turning your sweat into stink. See "Clothing Care" below for solutions.) Most of the moisture in a wet synthetic garment can be wrung out; the rest evaporates quickly. Synthetic fabrics are slicker than natural fibers, a disadvantage to the climber in a fall on steep snow or ice. Table 2-1 compares wind resistance, breathability, waterproofness, and stretchiness of outdoor clothing fabrics.

Polyester. High-quality polyester threads can each contain more than 100 filaments, giving the final fabric a soft, cotton-like feel. Fabrics made of them are often chemically treated or shaped to help wick away moisture. In today's garments, polyester has largely replaced polypropylene, offering a softer feel against the skin and somewhat less odor retention.

Nylon. Fabrics made of nylon, technically known as "polyamide," are very strong, resulting in somewhat better abrasion resistance than polyester. These characteristics lead to nylon's use in ropes and in outerwear, including the outer layer of waterproof-breathable laminated fabric. Nylon fabrics also have a soft "hand," leading to their use in many garments. Nylon retains twice as much water as polyester but still only one-fourth as much as cotton or wool. Water-repellent finishes reduce this further.

Spandex. This stretchy fiber, also known as Lycra or elastane, is added to fabrics to give a tight fit yet allow freedom of movement. Base layers stay close to the skin to help the body's heat move moisture to the next layer (although some non-spandex knit fabrics can do this too). In other layers, spandex can keep the fabric close to the body to minimize the "bellows effect" that blows away some of your hard-earned warm air layer as you move. Spandex adds significantly to the weight of a garment and increases drying time. Look for blends containing 10 percent or less spandex to optimize the benefits of fit, stretch, and warmth with minimal additional weight and drying time.

WARM WHEN WET?

Wool used to carry the banner of "warm when wet," a badge now heralded by synthetic fabrics and fills. But a wet fabric is a cold fabric, and there's no getting past the physics: it takes a lot of energy (warmth)

to convert the liquid sweat in damp clothes into vapor. If you want to stay warm, *stay dry*.

TABLE 2-1. FABRIC FEATURES

FABRIC	WIND RESISTANCE	BREATHABILITY	WATERPROOFNESS	STRETCHINESS
Fleece	Poor	Excellent	Poor	Excellent
Double-weave softshell	Fair	Excellent	Poor	Excellent
Laminated softshell	Good	Good	Fair	Good
Waterproof-breathable laminated softshell	Excellent	Fair	Good to excellent	Fair
Waterproof-breathable hardshell	Excellent	Fair	Excellent	Poor

Synthetic fleece. Also known as "polar fleece," "fleece," or "pile," this warm and lightweight polyester fabric replaced most wool in garments for climbing starting in the 1980s. Clothes made of it absorb little moisture and retain loft and reasonable insulating properties when wet. Fleece has a good warmth-to-weight ratio but very little ability to block the wind, and it can be bulky.

Dyneema (or Spectra). These lightweight fibers, the strongest in the world, are commonly used in climbing runners and utility cord. More recently, Dyneema is being woven into extremely lightweight abrasion-resistant fabrics for backpacks and sandwiched into ultralightweight, waterproof-nonbreathable Dyneema Composite fabric (formerly Cuben Fiber) for tents and raingear.

Softshell fabrics. Made up of a dense flexible cloth woven with two interconnected layers, softshells typically have a fleecy interior for warmth and a smooth exterior treated with durable water repellent (DWR) that sheds and deflects some snow and wind. Newer softshell materials are laminated with an abrasion-resistant, stretchable nylon face. Some types include a full or perforated waterproof-breathable membrane for additional wind and weather resistance. Softshell materials generally fall into three categories:

1. **Double-weave softshell.** The original "ski pant" material, this softshell fabric is ideal for high levels of activity and modestly cold conditions. Its stretch allows freedom of movement, and a relatively hard finish resists wind, snow, and abrasion.
2. **Laminated softshell.** A stretchy woven nylon fabric added ("laminated") to the exterior of this fabric significantly blocks wind,

sheds snow, and adds some rain protection.

3. **Waterproof-breathable laminated softshell.** This material sandwiches a waterproof-breathable membrane between a layer of fleece on the inside and woven nylon on the outside. The result is a soft-to-the-touch, slightly stretchy fabric with most of the weather resistance of a waterproof-breathable (hardshell) fabric, described below.

WATERPROOF FABRICS

Hardshells—rain parkas and rain pants—are generally made of nylon or nylon blends. Since nylon itself is not waterproof, rain garments derive their waterproofing from either different fabrication methods and/or fabric treatments.

Waterproof-nonbreathable. The simplest way to create a waterproof fabric is to coat or impregnate nylon with waterproof but nonbreathable polyurethane or silicone (silnylon). Such coatings are lightweight and relatively inexpensive, but they often are not very resistant to abrasion or mildew. Although such coatings keep rain out, they also seal sweat and water vapor in. If your sweat does not have a way to escape through your clothes, you will get wet.

Waterproof-breathable (hardshell) fabrics. Created to repel rain and snow while allowing some liquid in vapor form—perspiration—to escape, these fabrics have billions of microscopic pores per square inch. Because moisture vapor from the skin is emitted as individual water molecules (much smaller than droplets of rain), the holes in the waterproof-breathable coating are large enough to let vapor escape but too small for raindrops to get in.

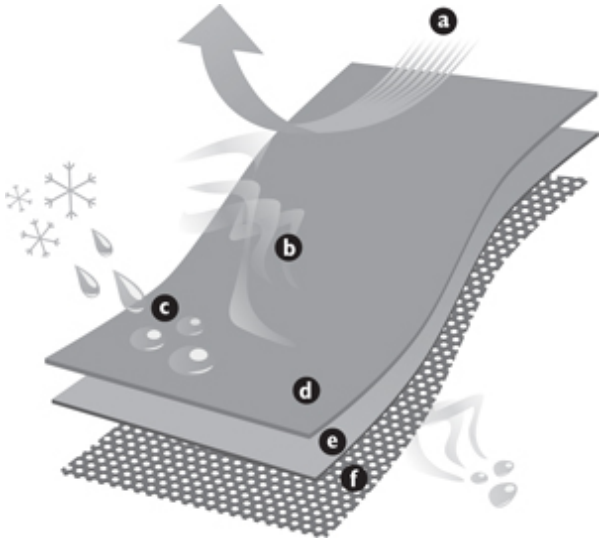

Fig. 2-1. Waterproof-breathable fabric system: a, wind is repelled; b, sweat as water vapor transpires through fabric; c, snow and water bead up due to thin molecular coating of a durable water repellent (DWR) finish; d, outer nylon fabric; e, waterproof-breathable film or coating; f, inner liner (optional).

Coatings or lamination provide the waterproofing and breathability of waterproof-breathable fabrics (fig. 2-1). Coated fabrics are less expensive and less durable than laminated fabrics. Waterproof-breathable laminated fabric—Gore-Tex is the best known—is more expensive to make; it consists of an interior fabric, or membrane-protective coating (to help spread out any condensed perspiration), an inner membrane, and an outer nylon shell that protects the membrane. These laminated fabrics tend to last longer since the waterproof-breathable membrane is protected between two other layers of fabric.

Waterproof-breathable fabrics are a marked improvement over nonbreathable coated nylons, but they are not perfect. A person who is working hard will exceed the garment's ability to pass water vapor, and sweat will condense inside the shell. In liquid form, sweat can no longer escape and the original problem is back again. All waterproof-breathable fabrics have a factory-applied DWR finish added to make rainwater bead up on the surface. DWR treatments are not permanent but are critical to these fabrics' functioning. If rain does not bead up, it coats the exterior, physically blocking the micropores and greatly reducing the fabric's ability to breathe. In cool weather, the "wetted out" shell fabric becomes cold, increasing condensation inside the garment. (See the "Care and Feeding of Waterproof-Breathable Fabrics" sidebar, below.)

Construction techniques and features such as zippered vents under the arms or along the torso can significantly improve a garment's ventilation, but extra ventilation features often command a higher purchase price. Plus zippers and extra material add to the garment's weight. A base layer can help, too, by absorbing liquid sweat, spreading it out, and allowing it to vaporize from body heat and then escape directly through the fabric or via a vent. Minimize perspiration by wearing the smallest amount of clothing possible on top of the base layer—start out a bit cold and assume you'll warm up as you climb.

NATURAL FIBERS

In the early days of mountaineering, natural-fiber clothes were all that was available. Cotton, with the possible exception of a t-shirt on a hot day or in base camp, now has no place in the climber's pack. The rise of synthetic fleece has allowed climbers to dismiss "ragg wool" as a coarse and itchy fabric, but base layers, knit shirts, and socks made from merino wool and blends have had a resurgence in popularity.

Cotton. Comfortable to wear when dry, cotton loses its insulating qualities when wet, absorbs many times its weight in water, and generally takes a long time to dry—it is dangerous to rely on cotton for warmth. Cotton plays a common role in many hypothermia tragedies, leading to the adage "cotton kills." Wet cotton also chafes the skin, a particularly annoying characteristic in underwear and socks or in sweat-soaked shoulder areas under pack straps. Yet in hot, dry weather, cotton can provide good sun protection and ventilates well. The sweat evaporating from a wet cotton t-shirt on a hot day will cool you off.

Modal, rayon, and viscose. These yarns are essentially "synthetic" cotton fibers chemically extruded from wood pulp. They exhibit all the downsides of cotton. Avoid them in the outdoors.

Merino wool. Under such brands as SmartWool, Ibex, and Icebreaker, modern wool fabrics use small-diameter silky fleece, primarily of merino sheep. Chemical descaling removes most of the fabric's itchiness and tendency to shrink. The downsides are that this luxurious fabric is expensive and delicate, and lightweight versions are especially prone to holes. Wool, in general, can become heavy with absorbed moisture and is slower to dry than synthetics.

Nevertheless, merino wool gets high marks for comfort and warmth next to the skin. One hundred percent wool has amazing natural anti-stink qualities

currently unrivaled by synthetics and especially appreciated by tent mates on longer trips.

INSULATING FILLS

Insulation for outdoor clothing and gear, such as sleeping bags, is made of either down or synthetic materials.

Down. High-quality goose or duck down is the warmest, lightest, most compressible insulating fill available. Down compresses well yet quickly regains its loft—and therefore its warmth—when unpacked. High-quality goose down has 650 to 900-plus fill power, which means that each ounce, uncompressed, expands to fill 650 to 900-plus cubic inches (or 376 to 520-plus cubic centimeters per gram). Down's low weight-to-warmth ratio makes it popular for cold-weather jackets and especially for sleeping bags. Good down is expensive yet has a much longer useful life than other insulating fills. Unfortunately, down loses all its insulating value when wet and is almost impossible to dry in damp conditions. DWR-treated down ("water-resistant" down) can give a false sense of security, providing only a brief delay until a down coat becomes sodden (although such treatment may shorten the drying time).

Synthetic fill. Unlike down, synthetic fills do not collapse when wet, providing more reliable insulation in damp climates. Heavier and less compressible than down, they are also less expensive and easier to clean. Compared with down, synthetic fills may not withstand as many compression cycles (stuffing and unstuffing), which means they lose their loft and insulation properties more quickly.

Typically, the fabrics needed to hold down or synthetic fill in place need to be robust, so puffies tend not to be very breathable. Some newer insulation can be stabilized by thinner fabric allowing for better breathability, packability, and stretch. Garments using Polartec Alpha or Patagonia's FullRange insulation fall into this category of "active insulation."

LAYERING

Dressing in layers makes it easier to adapt to fluctuating temperatures and conditions in the mountains. The goal is to minimize clothing weight and bulk while efficiently maintaining a comfortable body temperature by removing or adding layers as needed. Experienced mountaineers develop a basic strategy

of layering consisting of a few select garments of high functionality, which they use in combination—depending on conditions and personal preference—for most of their activities. They may swap in a new base layer, carry more or fewer midlayers or a different outer garment, or try something new—but the layering system has withstood the test of time and the elements. An outdoor clothing layering system consists of four types of layers:

1. **Base layer.** The base layer, immediately next to your skin, allows perspiration to evaporate, keeping your skin warm and dry.
2. **Midlayer.** Midlayers trap warm air close to your body. The thicker the layer of trapped air, the warmer you will be. Although less efficient than a single, monolithic block of "dead" air (as in a down parka, for example), several light, loosely fitting layers can trap a lot of insulating air, and such an arrangement is very adjustable.
3. **Shell layer.** Shells protect midlayers from wind and precipitation. These could be waterproof-breathable hardshells, softshells, or wind shells, depending on conditions.
4. **Belay jacket.** Donned quickly when you stop moving in cold conditions, an insulated jacket sized to fit over everything can preserve hard-won warmth.

Think of layers as a system intended to maintain comfort in a wide variety of mountain weather, or worn all at once to survive an unplanned bivouac. Try the layers on together before you commit to the complete system for a climb to make sure the shell layer fits comfortably over all the midlayers without compressing insulation or restricting movement.

PUTTING TOGETHER A LAYERING SYSTEM—FROM THE SKIN-SIDE OUT

Armed with knowledge of outdoor fabric characteristics and the strategy of layering, you can assemble an effective mountaineering clothing layering system. Figure 2-2 shows how various articles in a complete clothing system are mixed and matched to function throughout a spectrum of weather conditions and different levels of physical exertion. The exact garments chosen will vary significantly from climber to climber. The goal is to create a flexible system that keeps you safe. Following are some specific guidelines for particular mountaineering conditions.

Cool conditions with rain or wet snow are the most difficult to prepare for. Waterproof-breathable garments are the best available, but condensation will

still form under them during exertion. Dress minimally underneath to avoid overheating, vent as much as possible, and assume the clothes you are wearing underneath are going to get wet. Wear gaiters under rain pants. A rain kilt or poncho is an option for the approach hike. Colder conditions and precipitation in the form of snow is a bit simpler to dress for than rain. Cold snow will sluff off garments before it has a chance to melt. Waterproof-breathable garments do not breathe as well as other outer layers; more-breathable softshells (either laminated or waterproof-breathable laminated) may be sufficient.

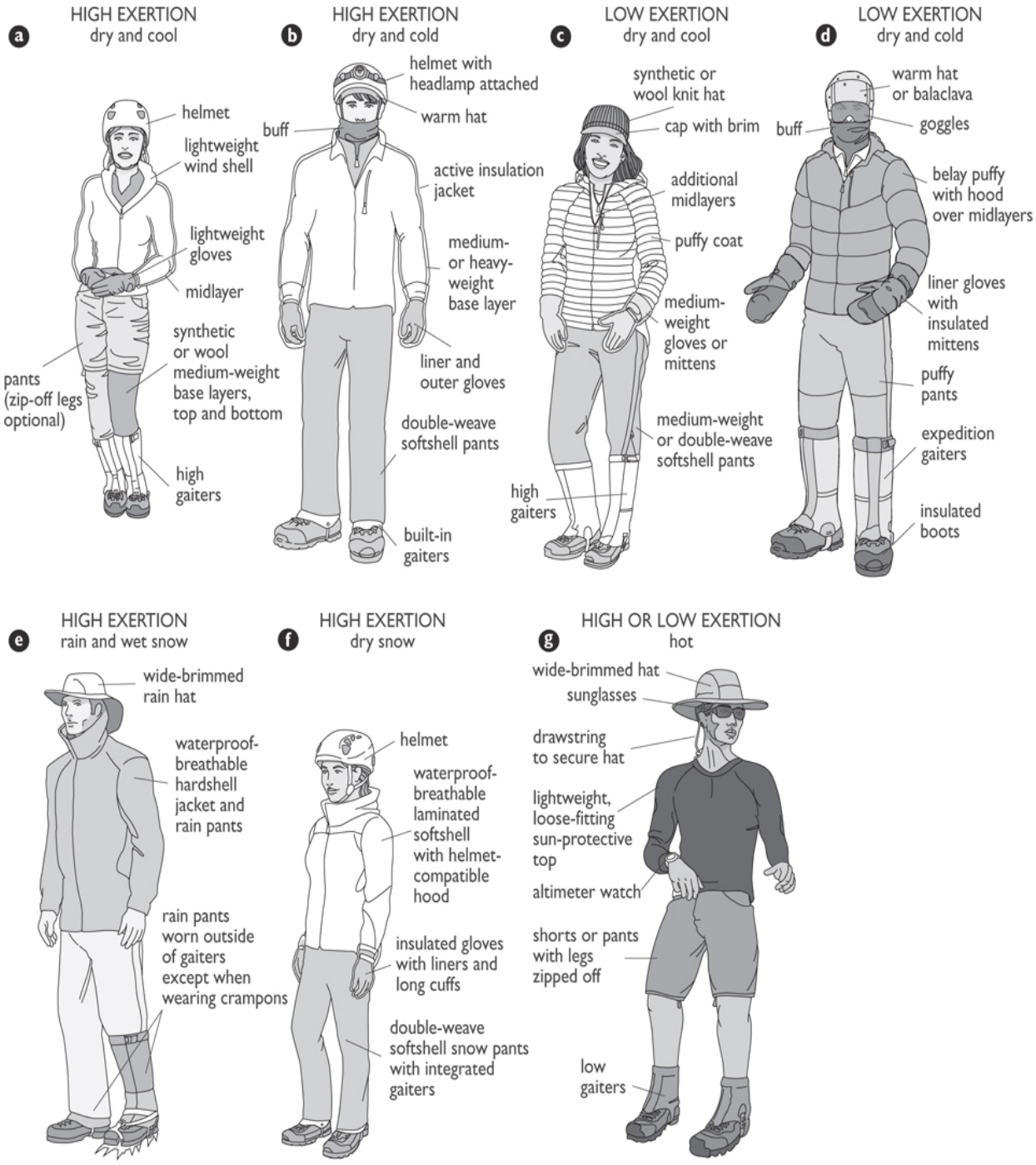

Fig. 2-2. Layering for a variety of conditions

Closely monitor your personal temperature levels. To avoid overheating, vent as much as possible and adjust layers as needed. Try to start off feeling a bit cool to avoid overheating as you exert more energy and warm up. Remove waterproof-breathable garments as soon as possible. For resting, belaying, or in camp, waterproof-breathable garments are at their best, when both exertion

and perspiration are low. Increase midlayers under the shell layer while at rest.

MANAGING MOISTURE: THE KEY TO STAYING WARM

To protect your midlayers from precipitation and perspiration and keep your clothing system functioning at its best:

- Start up the trail feeling a bit cool. Readjust layers 10 to 20 minutes after starting and whenever needed and practical during the day.
- Avoid waterproof-breathable fabrics until necessary—and then wear minimal clothes underneath.
- Use zippers and vents to shed excess heat.
- Dry damp clothes when possible.
- Just say "no" to cotton.

BASE LAYER

Protection from cold begins with an appropriate base layer, formerly known as long johns or thermal long underwear. Wicking fabrics made of polyester (and perhaps a bit of spandex) or merino wool are very popular for this purpose. A good base layer will also sop up liquid sweat, disperse it, and allow the body's heat to vaporize it. Dark-colored base layers dry quicker in sunlight than light-colored layers do, but light colors absorb less heat in the sun and are better on hot days, when a base layer may be worn alone as protection from sunburn or insects.

For rock climbing, spandex-blended polyester tights are sometimes worn as a base layer that allows a full range of motion. Versatile lightweight nylon or double-weave softshell pants can be worn alone against the skin.

T-shirts and shorts. In hot weather, a cotton t-shirt or tank top may suffice as a base layer, although long sleeves provide more sun and insect protection. But even on a moderately cool day, a cotton t-shirt can become soaked with sweat during a steep ascent, and you can get a deep chill when stopping for a break. Non-cotton fabrics are nearly always the better choice. Warm-weather shirts should be light-colored for coolness and moderately baggy for good ventilation. Clothes offer more sun protection than sunscreen (see "Sun Protection" in the Ten Essentials, later in this chapter). Ventilation and

durability are key requirements for shorts. A loose-fitting pair of nylon shorts, perhaps with an integral mesh brief, can work well. A popular combination for mild conditions is a lightweight base layer under a pair of synthetic shorts (fig. 2-2a). Lightweight nylon pants with zip-off legs that convert to shorts are also very popular and versatile.

Underwear and sports bras. Although underwear and sports bras do not constitute an adjustable "layer" (they are inconvenient to put on and take off), they add additional warmth and insulation and need to perform as part of the total system. Cotton chafes when damp and so is a poor choice for tight-fitting garments like underwear and socks. Sports bras, of course, can do double duty as a top.

MIDLAYERS

The workhorse of any layering system, the midlayer slows the inevitable escape of warmth and allows perspiration to evaporate while providing light protection from the elements. Climbers carry and wear a variety of midlayers, mixing and matching fleece, down or synthetic jackets or sweaters (puffies), and double-weave softshell depending on the challenge (see Table 2-2).

Synthetic shirt and pants. Simple nylon or polyester shirts and pants are lightweight pieces that provide sun and insect protection while being adaptable to cold weather. Shirts and fleece tops should be long in the torso so they can be tucked into or pulled below the hips to prevent gaps that let valuable heat escape.

Synthetic fleece. Core elements of the midlayer are synthetic fleeces and non-cotton hoodies. Climbers usually combine thin to medium fleece shirts with other midlayer options. Having one fleece layer with a hood and one or two with zip-up collars can provide significant warmth or sun protection with little added weight. For pants, fleece is a virtual snow magnet and so has mostly been replaced by more formfitting, smooth-finished, double-weave softshell pants. The venting allowed by full-length zippers increases the temperature range and flexibility of such pieces.

TABLE 2-2. MIDLAYER OPTIONS

TYPE OF MIDLAYER	WARMTH-TO-WEIGHT RATIO	BREATHABILITY

Synthetic shirts and pants	Good	Good
Synthetic fleece	Good	Excellent
Wool knit shirts	Fair	Good
Synthetic puffy	Good	Fair
Down puffy	Excellent	Fair
"Active insulation" puffy	Good	Excellent
Double-weave softshell	Good	Excellent

CHOOSING A COLD-WEATHER STRATEGY

In addition to layering, these tactics can also help with your cold-weather defense:

- Manage moisture carefully.
- Add additional midlayers that can function with the rest of the system.
- Add a belay jacket and puffy pants.
- Eat more, starting with a big breakfast. Fat and calories correlate directly with warmth, so keep high-calorie snacks at the ready in a pocket where they won't freeze and can be eaten gradually.
- Drink more water, even when urinating may be inconvenient. Dehydration results in low blood volume that will make you extra cold.
- Manage cold feet and hands. Rotate wet gloves or mittens and socks with dry ones as needed. Try chemical hand and foot warmers, but to prevent burns, avoid direct skin contact especially while asleep. Monitor for frostbite and have a contingency plan.
- On a day trip bring hot water and a stove.
- From base layers to one-piece climbing suits, consider one-piece options for extreme cold.

- Accept being a little cold, but be vigilant of the line between discomfort and injury.

Merino wool knit shirt. The allure of this luxurious fabric comes from its warm-to-the-touch feel and organic renewable source—a welcome contrast to a pack full of petroleum-derived yardage.

Puffy jacket. Modern insulated jackets (typically referred to as a "puffy") —compressible, lightweight, trim-cut garments insulated with down or synthetic fiber—have largely replaced bulky and heavy synthetic fleece jackets. Down is ideal for cool, dry conditions or where the climber can protect the garment from precipitation with a hardshell. Synthetic-filled puffies are better in damp conditions. Puffies have become the indispensable pillar of most layering systems—light enough to wear during activity, thin and trim enough to work well with other layers. For most trips in cool to cold weather, a thinner, highly breathable synthetic fabric that is less affected by sweat absorption is best while on the move. Keep a second, heavier insulating layer, such as a puffy, ready to put on as soon as your activity level drops when resting, belaying, or camping.

Double-weave softshell. A garment made of this fabric is a good outer midlayer to provide reasonable wind and weather resistance for most conditions. The spandex content makes for trim-fitting garments, and the fabric works particularly well as warm, flexible pants for skiing or climbing in cool or snowy conditions. (Softshell laminates offer even more waterproofing and are used in outer shells; see "Shell Strategies," below.)

Puffy pants or skirt. For colder conditions, insulated ("puffy") pants, typically filled with synthetic insulation, help your legs retain heat. Look for full-length side zippers that make it possible to put the pants on while you are wearing boots, crampons, or snowshoes. While less useful, a puffy skirt can help you avoid deeply chilled thighs.

SHELL STRATEGIES

The ideal shell would be fully waterproof, windproof, and breathable. No single garment achieves all these objectives, but various strategies come close. Many mountaineers carry two shell layers: a lighter, wind-resistant, breathable jacket and a somewhat heavier, waterproof-breathable set of jacket and pants. They wear the more breathable wind-resistant gear in cool, windy,

and even lightly drizzling conditions and for periods of heavy exertion and reserve the more weatherproof hardshell for periods of lighter exertion or heavier rain.

Wind shells. Compressible to the size of an apple and as light as 2 ounces (60 grams), a wind shell helps the body retain the warmth captured by the midlayers. It packs more warmth per gram than any other garment. Wind shells are highly breathable, yet their DWR coating can shed light precipitation.

Softshells. Laminated softshells feature an outer layer that is stretchy and more breathable than a hardshell while still offering some resistance to wind and dry snow. Waterproof-breathable laminated softshells are another step up, offering about the same breathability of a hardshell, but with a bit of stretch and good to very good weatherproofness. Yet when there is a risk of extended exposure to precipitation, skip this category entirely and pair the midlayers of your choice with a hardshell.

Hardshells. Stormy weather requires serious protection in the form of a hardshell. Made of either two- or three-layer waterproof-breathable fabric, hardshells sacrifice breathability for complete weatherproofness. A quality hardshell jacket may be the most expensive garment in your arsenal. For ventilation, hardshells have full front zippers plus a variety of tricks to improve their mediocre breathability, including adjustable openings at the front, waist, underarms, sides, and cuffs. Hardshell pants (rain pants) should have full-length zippers so you can don or remove them over boots, crampons, or snowshoes. Because rain pants tend to be worn less often than parkas—and because they can be ruined by bushwhacking or glissading—choosing a nonbreathable pair can save money. In cold conditions, as a lower-body shell layer, some climbers use waterproof-breathable bib pants held up by suspenders.

Insulated bibs are considerably warmer than rain pants because they cover much of the torso and keep snow from entering around your waistline. They are a good option for backcountry skiing, waterfall ice, and mixed climbing. Some climbers use one-piece (“8,000 meter”) suits, the warmest, but least versatile, option.

BELAY JACKET

In cold weather one final layer, a thickly insulated jacket commonly referred to as a belay parka or belay puffy, helps keep the stationary belayer warm and therefore attentive. Good features include an integral hood, thick but very

compressible insulation, and lightweight, water-resistant shell material. If large enough to fit either member of the rope team (on top of all their other layers), one belay jacket could suffice. But one jacket for each climber can be a lifesaver.

HEADWEAR

The adage says, "If your feet are cold, put on a hat." Your body, when cold, reduces blood flow to the arms and legs to warm other more vital areas. Putting on a hat helps to reduce heat loss. Climbers often carry several different types of hats to quickly adapt to changing temperatures. To prevent the misfortune of having a hat blow off and sail over a cliff, some choose headgear with a strap or leash. Consider carrying two insulating hats: an extra hat provides almost as much warmth as an extra sweater while weighing much less. Thin hats can be worn beneath a climbing helmet in cold weather.

Insulating caps come in wool, acrylic, or polyester fleece. Balaclavas are versatile insulators because they can cover both your face and neck or can be rolled up to allow ventilation of the collar area. Stretchy knitted cylinders known as Buffs (also called neck tubes or neck gaiters), worn around the neck, help seal the jacket neck opening that continually bellows warm air. Buffs can be used as a hat to cover the head and ears and are thin enough to wear under a helmet. On a very cold day, they can be pulled up from the neck to cover the mouth, helping with conditions such as the trek to Everest Base Camp where yak-dung dust can bring on the "Khumbu cough."

CHOOSING A SHELL JACKET

Fabric makes a difference:

- Uninsulated shells are lighter and more versatile.
- Two-layer waterproof-breathable fabric costs less and weighs less than three-layer, and two-layer shells are good for moderate weather.
- Three-layer waterproof-breathable fabric creates a shell that performs better in severe weather.
- Laminated or waterproof-breathable laminated softshell fabric is a good alternative for cold, dry conditions where precipitation would likely be dry snow.

Features are important:

- Large enough to fit over all midlayers and a climbing harness

- A hood with a brim that fits over a helmet
- Neck construction that covers the chin comfortably and allows the head to move freely
- Good ventilation
- Waterproof zippers
- Pockets that are easily accessible even while wearing gloves and carrying a pack
- A length sufficient to seal the waistline and sleeves that cover the wrists

A rain hat made of waterproof-breathable fabric is useful because it provides more ventilation (for exertion) and frequently is more comfortable than a hood. Sun-protective hats, with wide brims or protective shades that drape over your neck and ears, are popular for glacier climbs, as is a baseball cap with a bandanna pinned on or worn under it. A brim shades your eyes and keeps rain and snow off glasses. Remember to confirm each hat's helmet compatibility.

HANDWEAR

Fingers are perhaps the most difficult part of the body to keep warm because of the body's tendency to sacrifice blood flow to the extremities when cold. Unfortunately, this altered blood flow can inhibit tasks that require dexterity—such as pulling zippers and tying knots—which may slow a climbing party's progress at the very time when they need to move fast to find shelter from the cold.

Mitten and glove selection usually entails a compromise between dexterity and warmth. In general, bulk means increased warmth and reduced dexterity. The more technical a climb, the more significant the compromise. As with other insulating garments, mittens and gloves must be made of fabrics that retain some warmth when wet and then dry quickly. Suitable gloves and mittens come in synthetics, wool-synthetic blends, or sometimes wool. Double-weave softshell fabric is common in alpine gloves. The layering concept for clothing also applies to hands. The first layer may be a light pair of gloves; additional layers are usually heavier gloves or mittens. Mittens are warmer as a layer because they allow fingers to share warmth.

Climbers need hand protection from cracks, ropes, and cold. Some handwear allows inner gloves or mittens to be removed to add versatility and speed drying. Some provide a nonslip coating on the palm to improve grip for snow and ice tools. To combat cold, handwear cuffs should overlap the parka sleeve about 4 to 6 inches (10 to 15 centimeters), and Velcro closures should cinch around the forearm. Security cords can prevent loss when mittens must be removed to climb rock or apply sunscreen. Heated gloves aid ice climbers. Touch screen compatibility helps navigators in cold weather.

In camp, wearing glove liners or fingerless gloves inside mittens can permit good dexterity for delicate chores without exposing bare skin. Be aware that many synthetics can melt in high heat (from a stove, for instance). Even so, in freezing temperatures it is important to keep fingers from freezing to metal: glove liners are better for this than fingerless gloves. But when you are rock climbing in cold weather, fingerless gloves are often best. Handling wet rope or scrambling over wet rock can saturate gloves or mittens, even in dry weather. Some climbers carry several pairs of gloves or liners, rotating them to inside pockets when they become wet and cold to start each pitch with dry gloves and warm hands.

Often worn for rope handling such as rappelling or belaying, leather gloves provide a better grip and prevent rope burns. While most leather gloves do not insulate when wet, and dry slowly, some climbing versions have waterproof-breathable liners and water-resistant leather. Mechanics' work gloves with leather palms can be an inexpensive alternative for scrambling, belaying, and rappelling.

SLEEPWEAR

Many climbers carry a dry set of base layers and socks for camp and sleeping. Changing into this dry set at the end of the day helps thwart the chill of long shadows from a setting sun. At times, however, a climber may have to dry out damp clothes by spreading them out within the sleeping bag or wearing them to bed.

CLOTHING CARE

The key to laundering most outdoor fabrics is simply to follow the garment's washing instructions. For outdoor clothing: close all zippers and fasteners; wash in cold or warm water with a liquid sports wash or mild, powdered

laundry soap; and then line dry or tumble dry on a low setting. Avoid fabric softeners (ruins water repellency), scented detergent (attracts bears and bugs), chlorine bleach (ruins colors, except polyester), hot irons (synthetics have low melting points), and dry cleaning down garments (strips essential oils). Launder double-weave softshell fabric like most garments, but pay attention to their DWR treatment (see more about DWR and hardshells, below). Launder both laminated and waterproof-breathable laminated softshells the same as waterproof-breathable hardshells. Clean gently, rinse thoroughly, dry carefully, and touch up or reapply the DWR coatings to help your gear live long and prosper.

Funk. Bacteria thrive in the interstitial spaces of synthetic thread and even survive the gentle laundering recommended above. On each outing this microbiome generates its factory of funk, turning your sweat into stink. Fabric labels to the contrary, most polyester fabrics (but not nylon or other synthetics) can be safely laundered with chlorine bleach. For other stinky souvenirs, try a presoak using a nonchlorine bleach followed by normal cleaning.

Waterproof-breathable garments. Whether they have a coating or a laminated membrane, waterproof-breathable shells depend on relatively delicate components to function. Dirt and oils, such as sunscreen or insect repellent, can clog and contaminate fabric pores, reducing breathability. Keeping waterproof-breathable fabric clean helps keep it in optimal working condition. It's best to use a sports wash detergent. Do not use fabric softener. Understand that detergent is hydrophilic; it is critical to rinse the garment a second time. Then dry it on a line or in a tumble dryer on medium (140 degrees Fahrenheit or 60 degrees Celsius), and then test the DWR as explained below.

DWR on hardshells and softshells. The durable water-repellent finish on waterproof-breathable fabric is a critical component. DWR may be "durable," but it will not last the life of a garment. Eventually rainwater "wets out" the outer shell surface, making the fabric appear dark; water vapor is blocked and can no longer pass through the fabric. The fabric also becomes heavy and the surface, cold, compounding the issue by causing vaporized sweat to condense on the inside.

At home, test the garment with a spray bottle. When water no longer beads up on the surface, the DWR can be restored somewhat by heat. The chemistry of DWR works like a microscopic version of the fine hairs found on plant

leaves that repel water. Abrasion tends to bend these molecular structures, but heat helps straighten them out and somewhat restores water repellency. To revive the DWR finish, after your shell is clean and completely dry, tumble it dry for an additional 20 minutes on medium heat. If you are unable to tumble dry, you can try ironing the dry garment on a gentle setting (warm, no steam), placing a towel or cloth between the garment and the iron.

CARE AND FEEDING OF WATERPROOF-BREATHABLE FABRICS

The DWR feature of waterproof-breathable fabrics fails over time. Following these steps will help keep these fabrics functioning well for as long as possible.

- **Keep it clean.** Wash the garment regularly using a liquid sports wash and do not use fabric softener.
- **Rinse it well.** After washing, put the garment through a second rinse.
- **Dry it.** Drip-dry or use a dryer set on medium (140°F or 60°C).
- **Revive it.** Once the garment is completely dry, tumble dry for an additional 20 minutes on medium heat to revive the DWR.
- **Conduct a spray test.** Water should bead up.
- **Reapply DWR.** If the garment fails the test, reapply the DWR coating.

When the fabric no longer responds to this method, try applying a spray-on or wash-in DWR. Always treat clean garments, following the manufacturer's instructions. These procedures may or may not work to revive an expensive hardshell or softshell—but it's your only chance.

Home-applied products are either fluorinated or not. Nonfluorinated DWRs repel water but are currently more susceptible to contamination from oils—sunscreens, insect repellents, and body oils. Fluorinated DWRs, while environmentally dubious, are currently the most effective and durable at repelling both oil and water. Unfortunately, labels can be vague. Products with labels that say "PFC-free," "contains no fluorocarbons," or simply "fluorine-free" do not contain fluorine. Products with labels that say "PFOA & PFOS free" are likely fluorinated.

Spray-applying these textile home remedies to clean, wet garments allows the DWR to penetrate the surface of the fabric slightly better, displacing the water as it evaporates. For a more uniform application, you can also use a

wash-in DWR product. Wash-ins are particularly helpful to softshells. Hand washing can ensure that more of the chemistry ends up on the garment. Read the instructions carefully as there are some incompatibilities when using wash-in DWR on coated (nonlaminated) waterproof-breathable fabrics.

After applying the DWR, dry the garment according to the reviving directions noted above. Some newer home-applied fluorinated chemistries do not require the second drying step, though doing so may help revive the garment's original factory DWR. Reapply the DWR coating when you start to see signs of "wetting out" on the surface of the garment. Or simply touch up high abrasion areas after every trip or two. It is quite satisfying after spray-testing to see the water bead up on the surface like it would on a well-waxed car.

DWR is factory-applied to many other garments such as fleece jackets, wind shells, pants, hats, and gloves. These treatments are also not permanent and can be revived and reapplied, although they are less critical to these garments' functionality.

FOOTWEAR

A climber's feet are the means for reaching the objective, so they need especially good gear including boots, socks, gaiters, and sometimes specialized footwear.

CHOOSING SPECIALIZED FOOTWEAR

Depending on the trip, a climber may wear one kind of boot for the approach hike, another type of footwear in camp, and yet another when climbing. If foot-wear other than boots is desired and you are willing to carry the extra weight, consider these options:

- **Lightweight, sticky rubber approach shoes** are less likely to cause blisters and less fatiguing to wear than climbing boots on some easy approaches; however, they may not provide the support needed for carrying a heavy pack, especially on rough ground or descents.
- **Lightweight athletic shoes, sandals, or neoprene socks or booties** offer comfort in camp, give boots and feet a chance to dry, and can be used for stream crossings.
- **Insulated booties or fleece socks** provide warmer lounging and sleeping.

- **Rock shoes,** for climbing technical rock, are Lightweight and compact.

BOOTS

A good alpine climbing boot is a compromise between performance and suitability for the likely range of conditions. No single boot type or design will do everything well. The rigidity of the boot's sole, the stiffness and support provided by the upper, and how the sole and upper interact in use are the key design features, while proper fit is key to happy feet. A full mountaineering boot (fig. 2-3) must strike a balance between being tough enough to withstand being scraped on rocks and rigid enough for kicking steps in hard snow and wearing crampons, yet comfortable enough for the approach hike. In a single day of climbing, boots may have to contend with trails, mud, streams, gravel, brush, scree, steep rock, hard snow, and ice.

The "classic" all-leather-upper boot, while respected for its versatility, has been supplanted by new designs: boots with plastic-composite shells, pieces of leather, fabric panels, synthetic leather, waterproof linings, integrated gaiters, and overall lighter construction. Boot designs are evolving, but the many jobs they need to do are not.

Lightweight Mountaineering or Scrambling Boots

Some boots that incorporate synthetic fabric panels to reduce weight and increase breathability are suitable for climbing. These lightweight mountaineering or scrambling boots (fig. 2-4) are basically a rigid hiking boot and provide several advantages over more robust boots:

- Reduced weight
- Improved comfort hiking long approaches; shorter break-in time
- More flexible sole allows for better friction climbing
- Faster drying time
- Lower cost

Fig. 2-3. Full mountaineering boot.

However, lightweight boots may have significant drawbacks from full mountaineering boots:

- Less stability when edging and toe holding
- Less waterproofness and durability
- Insufficient weight or stiffness for step-kicking in firm snow or for wearing crampons

If you are considering lightweight mountaineering or scrambling boots for climbing, check that the uppers are high and rigid enough for good ankle support, that stiff counters wrap the heel and toe, and that abrasion areas are reinforced. If the boot is too flexible, your body will waste energy when moving across difficult ground as your feet flex unnecessarily with each step. The boot may not edge well or be suitable for some crampons. A more rigid boot acts as a tiny platform wherever you step so that bigger muscle groups perform simpler movements and save energy.

Full Mountaineering Boots

Full mountaineering boots include fabrics and features making them more robust, durable, and expensive than lightweight climbing boots. Typically lined with neoprene-like padding, they are also warmer and more waterproof. The best choice for a full mountaineering boot depends on how it will be used and is generally a compromise between the boot's walking comfort and its technical capability. For trails and easy snow or rock routes, boots with moderately stiff soles and uppers provide enough support while being acceptably flexible and comfortable.

For technical alpine rock climbing, a more rigid boot is desirable for its edging capabilities. Flexible boots (fig. 2-5a, c, e, and g), while sometimes used on technical rock, are usually a poor substitute for rock shoes. (To learn

more about rock shoes, see Chapter 12, Alpine Rock Climbing.) Stiffer boots can make walking less comfortable, but they greatly reduce leg fatigue when a climber is standing on small rock nubbins. Look for boots stiff enough to permit edging on narrow rock ledges with either side of the boot (fig. 2-5b) or with the toe (fig. 2-5d).

Fig. 2-4. Lightweight mountaineering or scrambling boot.

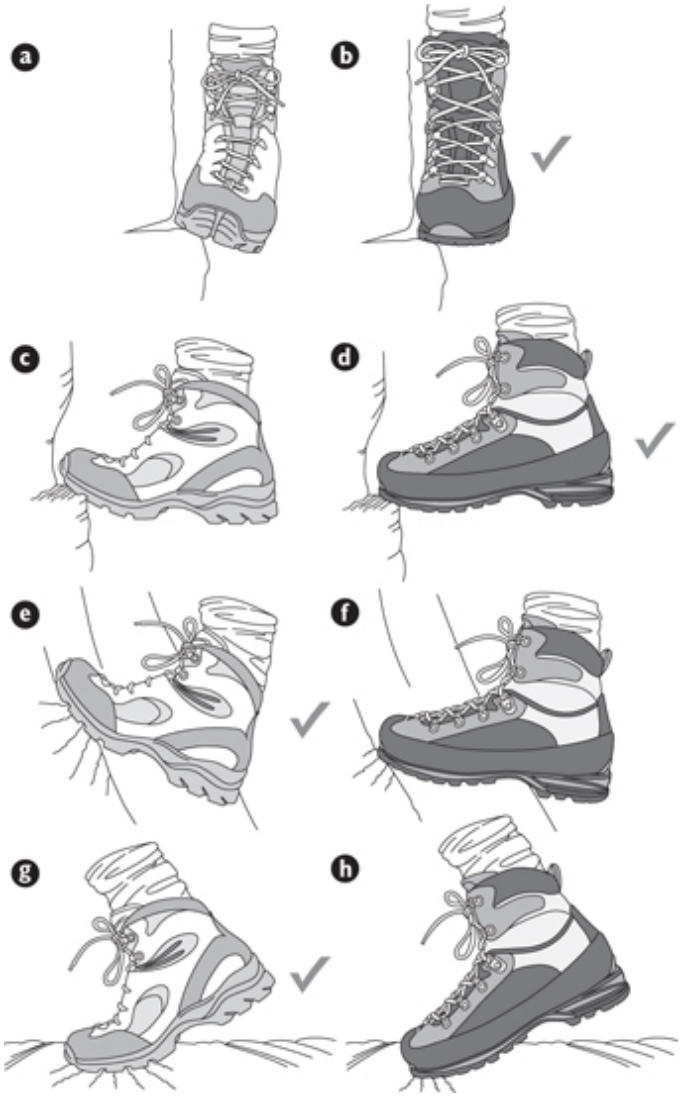

Fig. 2-5. Performance of flexible boots versus stiffer boots in various situations: a and b, edging; c and d, toe holding; e and f, friction climbing or smearing; g and h, hiking.

For traveling on hard snow, a highly flexible boot is a disadvantage. It takes a stout boot to kick good steps or plunge-step with confidence. Snowshoes and (especially) crampons may not stay on if boots are too flexible for the bindings.

Ice climbing demands an even higher level of boot support and very stiff soles and uppers. Plastic-composite boots or extremely stiff leather boots are generally best (see Chapter 19, Alpine Ice Climbing).

Plastic Mountaineering Boots

Plastic mountaineering boots consist of hard synthetic outer shells with inner insulating boots. The synthetic shells of these boots are usually quite stiff, which makes them good for use with crampons or snowshoes. They permit straps and bindings to be cinched tightly without impairing circulation in the feet. They provide solid support for edging and kicking steps. Being truly waterproof, plastic mountaineering boots are great in wet conditions. The inner insulating boot remains free of snowmelt and keeps feet warm. In camp, the inner boot can be removed and warmed, which helps in drying out perspiration. Unfortunately, the factors that make plastic boots ideal for snow and ice (rigidity, waterproofness, and warmth) make them a poor choice for general trail use.

BOOT CARE

With proper care, well-made boots can last many years. Keep them clean and dry when not in use. With plastic composite boots, remove the inner boots after use and allow them to dry. Shake or wipe out any debris in the shells to prevent abrasion and excessive wear. Avoid exposing boots to high temperatures, because heat can damage leather, linings, and adhesives. During an outing, water can seep into boots through the uppers and seams. Waterproofing agents help limit the entry of water. Waterproofing needs to be repeated regularly.

Before waterproofing, clean boots with a mild or special purpose soap and a stiff brush. Apply waterproofing appropriate to the boots' construction according to product instructions. Most mountaineering boots feature a Gore-Tex seam-sealed waterproof bootie, which keeps feet drier in wet conditions. Functioning like DWR on a hardshell, a Gore-Tex-approved waterproofing should be applied a year after purchase and then once or twice a year after that. Waterproofing should be applied to boots that have been cleaned and are still very damp. Gore-Tex is no panacea; boots that include a Gore-Tex bootie are usually more expensive, they may make feet uncomfortable during hot weather, and the membrane can degrade from dirt and sweat.

PROPER FOOTWEAR FIT

The key to happy feet is proper fit, and the key to proper fit is to consider boots, socks, and insoles as the three pieces of a footwear system. Purchase insoles and socks at the same time as your boots; try on not only different boot types and sizes but a variety of insoles and socks.

Boots

No matter what the boot's design or materials, fit is critical. The shape of a boot is defined by the unique "last" on which it is built. The complex dimensions of the boot are not completely captured by length and width, so try on several makes and styles. Some brands are available in multiple widths; others offer both men's and women's models. Some men do better in women's models and vice versa.

After lacing up the boots firmly, stand on a narrow edge or rock side to side to test their stability. Walk in the boots, with a heavy pack on if possible, to allow the boots and your feet to get used to each other. Note whether the boots have any uncomfortable seams or creases or whether they pinch anywhere. In boots that fit properly, the back two-thirds of your foot will feel firmly anchored in place while your toes will have plenty of room to wiggle. Try standing on a downward incline for a critical test of toe space. Kick something solid—your toes should not jam against the toe box.

Boots that are too tight will constrict circulation, leading to cold feet and increasing the chance of frostbite. Overly tight or excessively loose boots can cause blisters. Be especially careful that boots intended for use in extreme cold and/or at high altitudes do not constrict your feet and impede circulation. Because fit is critical for comfort and performance, climbers with impossible-to-fit feet may need custom-made leather boots.

Socks

Socks cushion and insulate the feet and reduce friction between the boot and the foot. Socks made of nylon or merino wool help reduce friction; those made of cotton do not. Cotton socks become abrasive when wet, leading to blisters. Socks need to fit closely; too-large socks lead to wrinkled fabric and irritated skin. Discard old socks: threadbare, worn sections can cause blisters. Because boots do not breathe appreciably, sweat generated by the feet collects and builds up until the boots are removed. In dry conditions, some climbers will change their socks once or twice per day, donning a dry pair while drying out the other. Synthetic socks dry faster than wool.

Many climbers wear two pairs of socks. Next to the skin, thin, smooth liner socks help resist blisters by transporting perspiration away from the foot while staying somewhat dry in the process. Liner socks also allow a climber to fine-tune the fit of the footwear system. The outer sock is thicker to absorb the moisture passing through the inner sock and to cushion against the boot

lining. Others prefer a single medium- or heavy-weight blended sock. There are exceptions. Rock climbers want flexible rock shoes to fit like skin, and so they wear no socks or one thin pair. Hikers using trail shoes on a warm day may wear a single pair of socks; winter climbers on very cold days may wear three pairs of socks inside oversized boots. Whatever the strategy, keep your toes free enough to wiggle; an additional pair of socks will not improve warmth if they constrict circulation.

Before donning socks, consider protecting your feet at places prone to blisters, especially the back of the heel, with specialized tape or Moleskin. For more information, see "Blisters" in Chapter 24, First Aid. Foot powder and lubricants, such as petroleum jelly, are commonly recommended blister fighters; yet studies show no benefit and perhaps even a detrimental effect.

Waterproof-breathable Gore-Tex socks can improve comfort in wet conditions. Worn over an inner pair of standard socks, these socks function much like Gore-Tex liners in boots, while providing a higher, snugger cuff. In extremely cold weather, a vapor-barrier sock worn between the two main sock layers can reduce the danger of frostbite. Because vapor-barrier socks do not breathe, your feet get damp; but they retain more heat and so your feet stay warmer. However, if feet stay moist for too long, you risk developing the serious condition of immersion foot (see Chapter 24, First Aid). Dry your feet thoroughly at least once each day if you use vapor-barrier socks.

Insoles

Most climbers toss out the cheap, stock insoles that come with boots. Aftermarket insoles come in an array of arch sizes and thicknesses ("high volume" means very thick). They provide additional comfort, insulation, and support—and affect the final fit considerably.

GAITERS

During an outing, water, snow, and debris can get into boots over the cuff. Gaiters seal the boundary between pant legs and boot tops. Climbers often carry gaiters in both summer and winter, because rain, dew, mud, and snow provide year-round opportunities to saturate pant legs, socks, and boots. Wet socks and boots can, in turn, prove very uncomfortable and even lead to serious foot problems.

Short trail gaiters (fig. 2-6a), extending a bit above the tops of the boots, are adequate for keeping corn snow and debris out of boots in summer. The

deep snows of winter, however, usually call for standard alpine gaiters (fig. 2-6b) that extend up to the knee. Expedition gaiters (fig. 2-6c) are made from beefier material and sized to accommodate large-sized plastic boots; insulation built into some expedition gaiters covers the boots for added warmth. Boots with nonremovable (integrated) gaiters are a growing trend in winter mountaineering boots (fig. 2-6d). Snow pants often have built-in gaiters, eliminating the need for a separate piece in some conditions.

Fig. 2-6. Gaiters: a, trail; b, alpine; c, expedition; d, integrated.

Gaiters are usually held closed with snaps, zippers, or Velcro; Velcro offers the easiest fastening in cold weather. If you select gaiters with zippers, be sure the teeth are heavy-duty. A flap that closes over the zipper with snaps or Velcro protects it from damage and can keep the gaiter closed and functional even if the zipper fails. Elastic or a strap at the top of the gaiter keeps it from sliding down. A snug fit around the calf helps prevent crampon points from catching on the gaiters, leading to a fall.

A close fit all around the boot is essential to prevent snow from entering under the gaiter, especially when you are plunge-stepping during descents. A cord, lace, strap, or shock cord runs under the foot to help the gaiter hug the boot. The parts underfoot will wear out during the life of the gaiter, so look for designs allowing easy replacement. Neoprene straps work well in snow

but wear quickly on rock, whereas cord survives rock better but can ball up with snow. Women's gaiters are typically shorter in height and a bit wider at the top.

PACKS

Climbers usually own at least two packs: a day pack to hold enough for a single-day climb, and a full-size backpack to carry gear for camping in the backcountry. All packs should allow climbers to carry the weight close to their body and centered over their hips and legs (see Figure 2-9).

BUYING AN OVERNIGHT OR EXPEDITION BACKPACK

First, determine the needed pack capacity depending on the demands of the climb (see Table 2-3). Then, find a pack that fits your body. The backpack's adjustment range must be compatible with the length of your back. Some backpacks adjust to a wide range of body sizes; others do not. Try on various packs and make your own decision (see "Choosing a Pack" sidebar). Figure 2-7 shows a typical 50-liter climbing pack with a streamlined design.

Don't be in a hurry when fitting a backpack. Load it up, as you would on an actual climb; bring personal gear to the store. Without a typical load, you cannot tell how the pack rides or if the adjustments provide a good fit. To test for fit, first follow the steps in the next section "Properly Fitting and Adjusting a Backpack." Check the fit in a mirror to see if the frame follows the curve of your back. If it does not, check whether the stays or frame can be bent to improve the fit; some frames of composite materials cannot. The shoulder straps should attach to the backpack between your shoulder blades and leave little or no gap behind your back.

TABLE 2-3. TYPES OF PACKS

TYPE	CAPACITY	NOTES
Day pack	30–50 liters; 20–30 lb (9–14 kg)	Best for single-day climbs. Efficient packers facing good weather can overnight with a pack this size.

Overnight pack	50–80 liters; 30–55 lb (14–25 kg)	Most popular size for overnight trips, winter day trips, or backcountry skiing. Compression straps minimize size for day trips. Careful packing may accommodate longer trips.
Expedition or winter pack	70-plus liters	Extended trips of 5 days or more or winter treks usually call for packs of 70 liters or larger to accommodate extra food and clothes, warmer sleeping bag, and four-season tent.

Once the backpack is adjusted, check your head clearance while wearing a helmet. Is it possible to look up without hitting the back of your head? Next, check for adequate padding wherever the pack touches your body. Pay particular attention to the comfort of the shoulder straps and hip belt; note the quality of the padding while realizing that thicker and softer is not necessarily more comfortable. The hip belt should be substantial; its padding should cover your hip bones by good margins. For proper load transfer to your hips, ensure that the hip belt wraps directly onto the top, not the sides, of your hips and not around your waist.

Women's backpacks. Most women prefer a women's-specific design with shorter back length, narrower shoulder width, shorter, narrower shoulder straps, and a slightly larger belt flare angle at the hips. Although a larger hip belt flare angle can be somewhat accommodated by adjusting the angle of the belt's webbing, a women's-specific hip belt is often best. Women's hip belts are also generally narrower and more padded than men's to avoid the possibility of putting pressure on the lower ribcage. Some women find that men's or unisex packs fit better.

PROPERLY FITTING AND ADJUSTING A BACKPACK

First, loosen all the straps. Then shoulder a full pack and follow these steps (fig. 2-8).

Step 1. Position the middle of the hip belt over the top of the iliac crest (hip bones). Raise your shoulders and *firmly tighten* the waist belt. Virtually all the weight should be on the hips since the shoulder straps are slack at this point.

Step 2. Tighten the shoulder straps—but not too tight—so they form a smooth arc over your shoulders. Note that the shoulder stabilizer straps are slack at this point. The main weight should be on the hip belt, with minimal load carried by the shoulders.

Step 3. Gently tension the shoulder stabilizer straps (day packs generally don't have these) to bring the pack close to the body. Ideally, they should end up at around a 45-degree angle. Excess tension interferes with the smooth arc of the shoulder pad over the shoulder. Tension any hip belt stabilizers and (optionally) any sternum straps.

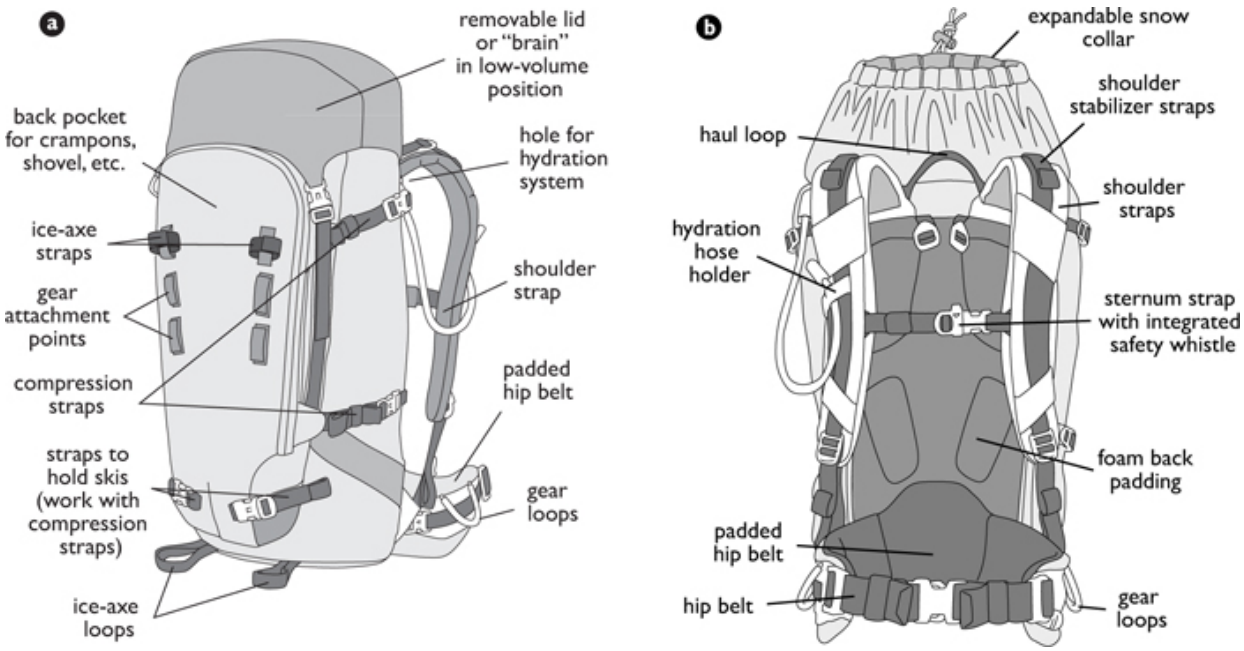

Fig. 2-7. Typical climbing pack: a, view of back and side; b, view of back pad and straps, with lid removed

Fig. 2-8. Fitting and adjusting a backpack.

Each time you put on your backpack, adjust the straps in the same sequence, from bottom to top: position the waist belt and firmly tighten while raising the shoulders, tighten the shoulder straps, and then tension the stabilizer straps.

BUYING A DAY PACK

Day packs for climbing usually have volumes of between 30 and 50 liters, enough to carry 20 to 30 pounds (9 to 14 kilograms). The large selection of day packs on the market covers a wide spectrum of sturdiness. Some are designed without rigid frames or padded hip belts and may be too flimsy for carrying the heavy tools of climbing: rope, rack, crampons, and ice axe. Seek a pack with a sturdy internal frame and a hip belt that is at least 2 inches (5 centimeters) wide at the buckle and 4 inches (10 centimeters) wide where it covers the hips. Insist on ice-axe loops, a haul loop, and compression straps. Most of the features you would consider in choosing a full-size pack apply to day packs. Try on and compare day packs as thoroughly as you would a full-size backpack.

TIPS ON PACKING

Strategically loading items in a pack can dramatically influence a climber's speed, endurance, and enjoyment of an outing. Generally, climbers will feel best if they can concentrate the load on their hips. Pack heavy items as close to your back as possible to bring in and lower your center of gravity; center them in the pack to allow you to more easily keep your balance (fig. 2-9). Heavy items such as ropes placed high in the pack create top-heavy instability.

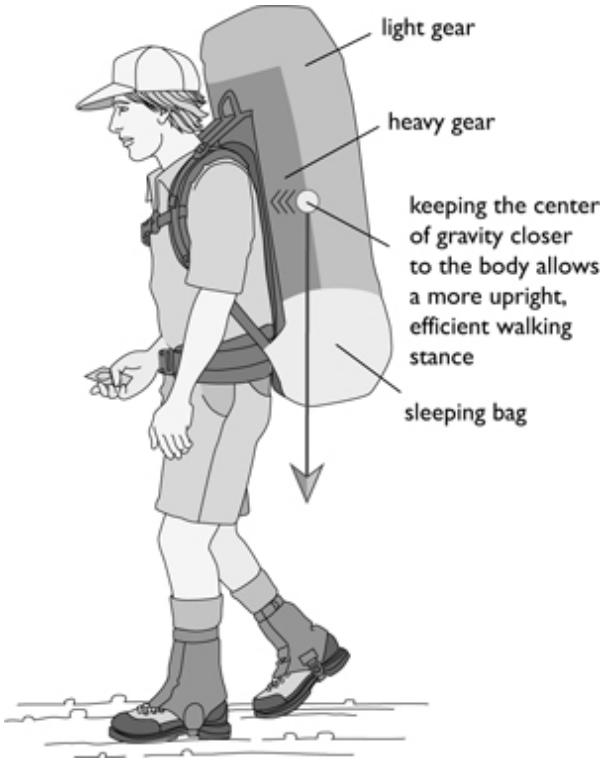

Fig. 2-9. Loading heavier items closer to the center of the back improves balance, efficiency, and endurance.

CHOOSING A PACK

First, you must decide on capacity: day, overnight, or expedition. Consider the weight and volume of what you will need to carry, and then factor in the length of your trip. Your back length matters more than your height. Beyond those factors, consider each pack's features and details:

- Does the pack have a smooth profile, or will it get tangled up in heavy brush or when hauled up a steep rock face?
- How sturdy and durable are the suspension system, stitching, and zippers?

- How convenient is it to store, arrange, and access gear?
- Can it carry special items such as crampons, skis, snowshoes, and a snow shovel?
- Does the pack have a haul loop, ice-axe loops, and compression straps (to reduce volume and prevent the load from shifting)?
- Can the pack's capacity be increased for extended trips (for example, expandable snow collar, side-pocket accessories)?

Along with arranging items for optimum weight distribution, organize them for quick access. Carry the gear that you will need most often close at hand. Articles such as gloves, hats, sunglasses, maps, and insect repellent are often most convenient in side and top pockets, jacket pockets, or a fanny pack worn in combination with the main pack. Keep snacks and water close at hand for easy and frequent refueling. In cool weather, keep a puffy coat at the ready. Readjusting the backpack during use will help reduce soreness and fatigue.

Determine a strategy to keep pack contents dry in rainy weather. Even packs constructed from waterproof materials are rarely waterproof; water can leak through seams, zippers, pockets, the top opening, and places where waterproofing has worn off. Individual plastic bags or waterproof stuff sacks can help protect pack contents, while a waterproof pack cover can keep the entire pack dry. Some climbers prefer to line their pack with a large plastic trash bag.

ESSENTIAL EQUIPMENT

Certain equipment deserves space in every pack. A climber will not need every item on every trip, but essential equipment can be a lifesaver in an emergency. Exactly how much equipment "insurance" should be carried is a matter of healthy debate (see the "Ultralight Travel" sidebar). Some respected minimalists argue that weighing down a pack causes people to climb slower, making it more likely they will get caught by a storm or nightfall. "Go fast and light. Carry bivy gear, and you will bivy," they argue. The other side of this debate is that, even without the extra weight of bivy gear, climbers still may be forced to bivouac. Each party must determine what will keep them safe.

Most climbers take along carefully selected items to survive the unexpected. Whatever your approach to equipment, a checklist (Table 2-5) will help you remember what to bring in the rush to get ready for a trip. Adapt

this list to suit your needs, and get in the habit of checking it before each trip. The best-known list, first developed by The Mountaineers in the 1930s, has become known as the "Ten Essentials."

THE MOUNTAINEERS' TEN ESSENTIALS

The point of the Ten Essentials (Table 2-4) has always been to help answer two basic questions: First, can you prevent emergencies and respond positively should one occur? Second, can you safely spend a night—or more—outside? The Ten Essentials is a guide that should be tailored to the nature of the climb. Weather, remoteness from help, and complexity should be factored into the selected essentials. The first seven essentials tend to be compact and vary little from climb to climb, and so they can be grouped together to facilitate packing. Add the proper extra food, water, and clothes, and you're ready to go. This brief list is intended to be easy to remember and serve as a mental pretrip checklist. Each essential is discussed in more detail below.

1. Navigation

Modern tools have revolutionized backcountry navigation. Today's mountaineer carries five essential tools while navigating the backcountry: map, altimeter, compass, Global Positioning System (GPS) device, and a personal locator beacon ("PLB") or other device to contact emergency first responders. Wilderness navigators need to carry these tools and know how to use them—if life is threatened, they need to be able to communicate with emergency responders. Using multiple tools increases confidence in location and route, provides backup when tools fail, and increases situational awareness. Refer to Chapter 5, Navigation, for in-depth information on navigation tools and techniques.

ULTRALIGHT TRAVEL

The ultralight concept is as much a philosophy of mountain travel as it is a specific set of gear recommendations. It is the antithesis of the style used by the huge Himalayan expeditions of the mid-twentieth century, which typically involved hundreds of porters and tons of equipment.

In contrast, the ultralight concept espouses two principal considerations: first, consider each item of gear and select the lightest

version, and second, take the minimum amount of gear consistent with your chosen degree of commitment. Circumstances may limit what can be accomplished, and ultralighters, with their minimal gear, have less margin for error.

There have been ultralight devotees for as long as there have been mountaineers. But the modern movement toward ultralight was first popularized by Yosemite climber Ray Jardine in the 1990s. The idea is to use multipurpose, lightweight gear and clothes in place of technically sophisticated equipment.

For mountain travel, less weight may mean a more enjoyable trip. For many technical routes, climbing light means climbing faster and, consequently, more safely (see Chapter 12, Alpine Rock Climbing, for further discussion).

TABLE 2-4. THE MOUNTAINEERS' TEN ESSENTIALS

To prevent emergencies and respond positively should one occur:

1. Navigation
2. Headlamp
3. Sun protection
4. First aid
5. Knife

To safely spend a night—or more—outside:

6. Fire
7. Shelter
8. Extra food
9. Extra water
10. Extra clothes

Map. Maps synthesize a vast amount of information about a region that cannot be replicated by written descriptions or memory. Each climber should carry a physical topographic map protected in a case or resealable plastic bag —it is not fragile, needs no electricity, and provides both backup and the "big

picture" about a region that cannot be replicated by written descriptions or a tiny screen. If your primary map is a fragile battery-driven electronic device, carry at least one redundant device and backup power, and always carry a printed topographic map as a backup.

Altimeter. Mountaineers have long understood the importance of knowing elevation for navigation. Referring to a topographic map and knowing your elevation solve half of the navigation equation, day or night, clear skies or foggy. With just one more scrap of data—a trail, a stream, a ridge, or a bearing to a known peak—climbers can often determine where they are. Today's altimeter is a sliver of silicon that can measure air pressure or use GPS satellite signals or a combination of the two. The modern mountaineer tends to use an altimeter more frequently than a compass.

Compass. Robust and easy to use, this essential tool allows wilderness travelers to orient the map and themselves to the landscape. A compass with a baseplate is essential for taking, measuring, and following field bearings and matching them up with the map. Many smartphones, GPS devices, and wristwatches also contain an electronic compass.

GPS device. GPS has revolutionized navigation and accurately gives climbers their location on a digital map. Modern phones, combined with a reliable GPS app, rival the best dedicated GPS units for accuracy and are easier to use (see Chapter 5, Navigation). Devices often have extensive libraries of maps, many available free; download the ones you need before your trip. Together with downloaded digital maps, phones (or tablets) can guide climbers in the wilderness far from any cell towers. The caveats? Phones are fragile and they need electricity. Climbers should take steps to armor these delicate devices, keep them dry in the rain, and extend their battery life. Bringing a fully charged external battery pack is an important precaution. Dedicated GPS devices are often more rugged and weatherproof than phones, making them a good choice for extreme environments.

PLBs and satellite communicators. Historically, the mountaineer has needed to be completely self-reliant, and climbers should still have that mindset when entering the wilderness today. But when an emergency unfolds despite good tools, preparation, and training, most climbers welcome help. PLBs and satellite communicators determine your position using GPS and then send a message using government or commercial satellite networks. These devices have saved many lives; all backcountry travelers should strongly consider carrying one. Satellite phones are reliable in wilderness, but regular

phones, which rely on proximity to cell towers, are not. Unless you are certain you will have a signal, assume that your phone will not function to make calls from the backcountry.

CHOOSING A GPS DEVICE

Modern mountaineers have several options available to them when it comes to GPS technology:

- **A phone combined with a good app** has become the most popular way for climbers to navigate by GPS. The extensive libraries of free digital worldwide maps made available by these apps, if downloaded before entering wilderness areas, allow freedom to travel hills near and far.
- **Dedicated GPS units** are more difficult to use and have fewer maps available, but they are more rugged and weatherproof than phones.
- **Digital wristwatches** can now provide GPS coordinates and altitude, to be used in conjunction with a physical map. Some now show tiny maps.

2. Headlamp

For climbers, headlamps are the flashlight of choice, freeing the hands for anything from cooking to climbing. Even if the climbing party plans to return before dark, each climber must carry a headlamp and consider carrying a backup. The efficient, bright LED bulb has completely replaced the inefficient incandescent bulb of a few years ago. An LED bulb lasts virtually forever but batteries do not, so carry spares. If you are using a rechargeable headlamp or batteries, start with a full charge. Any headlamp carried by an outdoor shop will be weatherproof, and a few models can survive submersion. All models allow the beam to be tilted down for close-up work, such as cooking, and pointed up for looking in the distance. Some headlamps feature a low-power red LED to preserve night vision and help climbers avoid disturbing tent mates during nocturnal excursions.

CHOOSING A HEADLAMP

- **Beam type, output, and distance.** Choose a headlamp that has both a wide beam and a spot beam. Each headlamp has a source output rated in lumens, a beam distance measured in meters, and a runtime

measured in hours. For general-purpose mountaineering, look for a lamp rated at least 50 lumens that casts a beam at least 160 feet (50 meters) and has a runtime of at least 24 hours. Keep in mind that the amount of daylight varies significantly depending on the time of year and latitude. If you anticipate significant nighttime operations (for example, search and rescue), choose a brighter beam with a top strap and larger battery pack positioned at the back of the head. Brighter illumination consumes more battery power.

- **Weight.** The typical headlamp weighs 3 to 4 ounces (85 to 115 grams), and all are about the same size. High-powered models are bulkier and heavier (up to 11 ounces, 300 grams). Ultralight models can weigh less than an ounce (28 grams). Choose according to need.
- **Brightness modes.** Most headlamps offer varying brightness. Use low for around camp to conserve battery life and not annoy your belay partners. A high beam is useful for moving through terrain at night.
- **Battery type.** Choose a headlamp powered by AA or AAA batteries, a battery type shared by other electronics you may be taking such as a SPOT Messenger or dedicated GPS device (for more on batteries see "Batteries" later in this chapter).
- **Additional features** include a blinking mode for use as a beacon, a red lamp to preserve nighttime vision, and regulated output to keep the beam brightness constant until the batteries are exhausted.

3. Sun Protection

Carry and wear sunglasses, sun-protective clothes, and broad-spectrum sunscreen rated at least SPF 30. Not doing so in the short run can lead to sunburn or snow blindness; long-term unpleasantness includes cataracts and skin cancer.

Sunglasses. In alpine country, high-quality sunglasses are critical. The eyes are particularly vulnerable to radiation, and the corneas of unprotected eyes can easily burn before any discomfort is felt, resulting in the excruciatingly painful condition known as snow blindness. Ultraviolet rays penetrate cloud layers, so do not let cloudy conditions fool you into leaving your eyes unprotected. It is advisable to wear sunglasses whenever you are outside and it is bright. This becomes critical on snow, ice, and water and at high altitudes.

Sunglasses should filter at least 99 percent of UV (ultraviolet) light, including both UVA and UVB. (Most opticians can test an old pair if you are unsure.) The tint in sunglasses allows only a fraction of the visible light through the lens to the eyes. Sunglasses, when rated, are usually scored by VLT (visible light transmission), or occasionally by percentage of light blocked. For glacier glasses, a lens should have a VLT rating of 5 to 10 percent. For conditions that don't involve snow or water, "sports sunglasses" with a VLT rating of 5 to 20 percent are sufficient. Many sunglasses have no VLT rating and should be treated as cornea-scorching fashion accessories. Look in a mirror when trying on sunglasses: if your eyes can easily be seen, the lenses are too light. Lens tints should be gray or brown for the truest color; yellow provides better contrast in overcast or foggy conditions.

Sunglass lenses should be made of polycarbonate or Trivex (a form of polyurethane). Glass, while more scratch-resistant, is heavy and can shatter. High-quality sunglasses can have a variety of helpful coatings including ones that repel water or minimize scratches or fogging. While polarized lenses can decrease glare, they annoyingly black out camera and phone LCD screens in certain orientations. Photochromic lenses automatically adjust to changing light intensity, but most lack a sufficient VLT rating for snow and adjust slowly in cold conditions. Sunglass frames should be a wraparound style or have side shields to reduce the light reaching your eyes, yet allow adequate ventilation to prevent fogging. Problems with fogging can be reduced by using an antifog lens cleaning product.

Groups should carry at least one pair of spare sunglasses in case a party member loses or forgets a pair. Eye protection can be improvised by cutting a bit of mylar from an emergency blanket or making small slits in a piece of cardboard or cloth.

Sun-protective clothes. Clothes offer more sun protection than sunscreen. Long underwear or wind garments are frequently worn on sunny glacier climbs. The discomfort of long underwear, even under blazing conditions, is often considered a minor nuisance compared with the hassle of smearing on sunscreen. Some garments are given a UPF (ultraviolet protection factor) rating, a system that is calibrated the same as the SPF rating. A UPF 50–rated garment allows 1/50 th of the UV radiation falling on its surface to pass through it. Most clothes do an admirable job blocking UV rays, but don't expect a thin white t-shirt to protect you on a long glacier climb. For the most

part, UPF ratings are not critical except to those with sensitive skin. And whenever possible, wear a hat—preferably one with a full brim.

Sunscreen. Sunscreen is vital to climbers' well-being in the mountains. Although individuals vary widely in natural pigmentation and the amount of screening their skin requires, the penalty for underestimating the protection needed is severe, including the possibility of skin cancer. Certain diseases, such as lupus, and some medications, such as antibiotics and antihistamines, can cause extra sensitivity to the sun's rays.

While climbing, use a broad-spectrum sunscreen that blocks both ultraviolet A (UVA) and ultraviolet B (UVB) rays. UVA rays are the primary preventable cause of skin cancer; UVB rays primarily cause sunburn. To protect skin from UVB rays, use a sunscreen with a sunburn protection factor (SPF) of at least 30. If you are near snow or water, use SPF 50 on thin-skinned areas such as the nose and ears.

The EPA highly recommends using sunscreens that carry the regulated term "broad spectrum." While there is no standard rating for UVA such as SPF, the term "broad spectrum" means "that the product provides UVA protection that is proportional to its UVB protection." Most sunscreen ingredients absorb UV light through a chemical reaction—although titanium dioxide and zinc oxide physically block UV and cause the fewest skin reactions. Of all the chemicals used in sunscreen, these four are most likely to cause adverse skin reactions: aminobenzoic acid (PABA), dioxybenzone, oxybenzone, and sulisobenzone.

CHOOSING A SUN PROTECTION STRATEGY

- First, wear appropriate sunglasses.
- Then, wear sun-protective clothes: hat, long sleeves, and pants.
- "Slop on" minimum SPF 30 broad-spectrum sunscreen to all exposed skin.
- Protect lips with sunscreen or an SPF-rated lip balm.
- Reapply sunscreen frequently.
- When using both sunscreen and insect repellent, first apply sunscreen and allow it to dry. After it has bonded to your skin, apply the repellent.

All sunscreens are limited by their ability to remain on the skin while you are sweating. US manufacturers can no longer claim that sunscreens are

"waterproof" or "sweatproof" or identify their products as "sunblock." It is feasible for a sunscreen to be water resistant for up to 80 minutes; but regardless of the claims on the label, reapply it frequently. Frequent reapplication is often impractical on a climb, so put on a heavy coating in the morning, wear sun-protective clothes, and reapply when you can.

Generously apply sunscreen to all exposed skin, including the undersides of your chin and nose and the insides of nostrils and ears. Few climbers apply enough—follow the Australian adage "Slop it on!" Even if you are wearing a hat, apply sunscreen to all exposed parts of your face and neck to protect against reflection from snow or water. Apply sunscreen 20 minutes before exposure to the sun, because it usually takes time to start working. Sunscreen that migrates into the eyes from sweat stings relentlessly. Kids' "no-tear" sunscreen is pH balanced to help prevent this problem and so some climbers only use these products. Lips burn, too, and require protection to prevent peeling and blisters. Reapply lip protection frequently, especially after eating or drinking. When your sunscreen is past the expiration date or more than three years old, replace it. (See Chapter 24, First Aid, for information on sunburn and snow blindness.)

4. First Aid

Carry and know how to use a first-aid kit, but do not let the fact that you have one give you a false sense of security. The best course of action is to always take the steps necessary to avoid injury or sickness in the first place. Chapter 24, First Aid, covers much more about first aid for climbers. Training in wilderness first aid or wilderness first responder skills is worthwhile. Most first-aid training is aimed at situations in urban or industrial settings where trained personnel will respond quickly. In the mountains, trained response may be hours—even days—away.

The first-aid kit should be compact and sturdy, with the contents wrapped in waterproof packaging. Commercial first-aid kits are widely available, though most are inadequate. A basic first-aid kit (see Table 24-1 in Chapter 24, First Aid) should include bandages, skin closures, gauze pads and dressings, roller bandage or wrap, tape, antiseptic, blister prevention and treatment supplies, nitrile gloves, tweezers, a needle, nonprescription painkillers and anti-inflammatory, antidiarrheal, and antihistamine tablets, a topical antibiotic, and any important personal prescriptions, including an EpiPen if you are allergic to bee or hornet venom.

Consider the length and nature of each trip in deciding what to add to the basics of the first-aid kit. For a climbing expedition, consider bringing appropriate prescription medicines.

5. Knife

Knives are so useful in first aid, food preparation, repairs, and climbing that every party member needs to carry one, preferably with a leash to prevent loss. In addition, a small repair kit can be indispensable. On a short trip, many climbers carry a small multitool, as well as strong tape and a bit of cordage. The list lengthens for more remote trips, and climbers carry an imaginative variety of supplies depending on previously experienced—or imagined—calamities. Supplies include other tools (pliers, screwdriver, awl, scissors) that can be part of a knife or pocket tool or can be carried separately—perhaps even as part of a group kit. Other useful repair items are safety pins, needle and thread, wire, duct tape, nylon fabric repair tape, cable ties, plastic buckles, cordage, webbing, and replacement parts for equipment such as a water filter, tent poles, the stove, crampons, snowshoes, and skis.

6. Fire

Carry the means to start and sustain an emergency fire. Most climbers carry a disposable butane lighter or two instead of matches. Either must be absolutely reliable. Firestarters are indispensable for igniting wet wood quickly to make an emergency campfire. Common useful fire-starters include chemical heat tabs, cotton balls soaked in petroleum jelly, and commercially prepared wood soaked in wax or chemicals. Alternatively, on a high-altitude snow or glacier climb where firewood is nonexistent, it is advisable to carry a stove as an additional emergency heat and water source. (For more information on stoves, see Chapter 3, Camping, Food, and Water.)

7. Shelter

Carry some sort of emergency shelter (in addition to a rain shell) from rain and wind, such as a plastic tube tent or a jumbo plastic trash bag. Single-use bivy sacks made of heat-reflective polyethylene are an excellent option at less than 4 ounces. “Emergency space blankets,” while cheap and lightweight, are inadequate to the task of keeping out wind, rain, or snow while retaining body heat. A tent can serve as the essential extra shelter only if it stays with the

climbing party at all times. A tent left behind in base camp is not enough. Carry an insulated sleeping pad to reduce heat loss while sitting or lying on snow or wet terrain.

Even on day trips, some climbers carry a regular bivy sack as part of their survival gear. A bivy sack at about 1 pound (0.5 kilogram) protects insulating clothing layers from the weather, minimizes the effects of wind, and traps much of the heat escaping from your body inside its cocoon. (See "Shelter" in Chapter 3, Camping, Food, and Water, for details on tents, insulated pads, and bivy sacks.)

8. Extra Food

For shorter trips, a one-day supply of extra food is a reasonable emergency stockpile in case foul weather, faulty navigation, injury, or other reasons delay a climbing party. An expedition or long trek may require more, and on a cold trip remember that food equals warmth. The food should require no cooking, be easily digestible, and store well for long periods. A combination of jerky, nuts, candy, granola, and dried fruit works well. If a stove is carried, cocoa, dried soup, instant coffee, and tea can be added. Some climbers only half-jokingly point out that exotic flavors of energy bars and US Army meals ready to eat (MREs) serve well as emergency rations because no one is tempted to eat them except in an emergency. And a few packets of instant coffee can help a dedicated coffee drinker keep a clear head. (See more on food in Chapter 3, Camping, Food, and Water.)

9. Extra Water

Carry sufficient water and have the skills and tools required to obtain and purify additional water. Always carry at least one water bottle or hydration bag or bladder. Wide-mouth containers are easier to refill. While hydration bladders are designed to be stored in the pack and feature a plastic hose and valve that allow drinking without slowing your pace, they are prone to leaking and freezing, are notoriously hard to keep clean, and often lead climbers to carry more water than they need to.

TABLE 2-5. SAMPLE EQUIPMENT LIST

All your gear does not go in your pack. Some you wear, some you leave in the car (out of plain sight, of course), and some you leave at home, depending on

the adventure. Items with an asterisk (*) are optional, depending on personal preference and the nature of the trip. Items within brackets [ ] can be shared by a group. See various other chapters for details on some of the gear on this list. *Note:* Because Essentials 1–7 are typically small and change little from trip to trip, keep them grouped together and ready to go.

ITEMS LEFT IN OR NEAR THE TRAILHEAD VEHICLE

- Map, directions to trailhead, and weather forecast
- *Refreshing drinks
- *Spare key (hidden on the outside of the car or near the car)
- *Pack scale (for checking pack weight at the start of the trip)
- Extra water
- *Fresh clothes for the drive home

ITEMS WORN OR CARRIED (assuming a cool morning to start, dressed as in Figure 2-2a)

- Day pack (day trips), or
- Backpack (overnight)
- Boots and *gaiters
- Socks (synthetic or wool) and *liners
- Brimmed hat
- Base layer top
- Long-sleeved shirt
- *Base layer bottoms
- *Underwear
- *Shorts
- Lightweight nylon pants (*zip-off legs)
- Wristwatch altimeter
- Trekking poles
- Keys to trailhead vehicle

PACKED GEAR FOR ALL TRIPS

THE TEN ESSENTIALS

1. **Navigation:** map, altimeter, compass, [GPS device: phone with GPS app or dedicated GPS device], [PLB, satellite communicator, or satellite phone], [extra batteries], [battery pack]

2. **Headlamp:** plus extra batteries
3. **Sun protection:** sunglasses, sun-protective clothes, and sunscreen
4. **First aid:** including foot care and insect repellent (if required)
5. **Knife:** plus repair kit
6. **Fire:** matches, lighter and tinder, or stove as appropriate
7. **Shelter:** carried at all times (can be lightweight emergency bivy)
8. **Extra food:** beyond minimum expectation
9. **Extra water:** beyond minimum expectation, or the means to purify
10. **Extra clothes:** beyond minimum expectation, as detailed below

CLOTHING

Garments that may be worn during the active portion of a climb as well as "extra clothes" that could be needed to survive the long, inactive hours of an unplanned bivouac. Choices depend on probable worst-case weather, thus none are marked as optional:

Base layer:

- Top and bottoms to wear while active
- Extra dry set for camp and to wear while sleeping

Midlayers:

- Synthetic shirts and pants
- Synthetic fleece
- Wool knit shirts
- Double-weave softshell jacket
- Double-weave softshell pants
- Puffy jacket (synthetic, down, or "active insulation")

Shell layers and belay jacket:

- Wind shell jacket
- Wind shell pants
- Laminated softshell jacket
- Waterproof-breathable laminated softshell jacket
- Hardshell jacket
- Hardshell pants (rain pants)
- Belay jacket

Head, hands, and feet:

- Warm hat (synthetic or wool)
- Warm hat (under-helmet)

- Rain hat
- Balaclava
- Buff or neck tube (extra)
- Leather gloves for belaying and rappelling
- Gloves or mittens (extra)
- Glove or mitten liners
- Socks (extra)
- Waterproof-breathable socks
- Stream-crossing footwear
- Gaiters: short, long, or expedition

OTHER (NONCLIMBING) GEAR

- Lunch and/or snacks sufficient for the climb
- Water (minimum 2 liters)
- Toilet kit (toilet paper and blue bags), *trowel
- *Insect repellent
- *Local communication devices: whistle, walkie-talkie
- *Spare eyeglasses
- *Cup
- *Nylon cord
- *Camera
- Battery backups for electronic gear
- *Binoculars
- *Bandanna
- *Protective phone cover

BASIC CLIMBING GEAR FOR ALL CLIMBS

- Helmet
- Climbing harness
- Personal anchor with locking carabiner
- Carabiners (including a large HMS locking carabiner or pearabiner)
- Runners
- Belay-rappel device
- *Leather gloves for belaying and rappelling
- Prusik slings
- [Climbing rope]
- *Approach shoes

ADDITIONAL ITEMS FOR AN OVERNIGHT TRIP

- Sleeping bag and stuff sack
- Sleeping pad
- [Tent], [tarp], or *bivy sack
- *[Ground cloth]
- [Food]
- [Water container(s)]
- [Group first-aid kit]
- [Group repair kit]
- [Stove, fuel, and accessories]
- [Pot(s) (and cleaning pad)]
- Spoon
- *Fork
- *Bowl
- *Toiletries
- *Alarm clock or alarm watch
- *Clothes to wear in camp and while sleeping
- *Camp footwear
- *Pack cover

ADDITIONAL GEAR FOR ROCK CLIMBS

- [Rack: chocks, cams, etc.]
- [Nut tool]
- *Rock climbing shoes
- *Chalk
- *Athletic tape

ADDITIONAL GEAR FOR SNOW, GLACIER, OR WINTER CLIMBS

CLIMBING

- Ice axe
- Chest sling or harness
- Waist and foot prusik slings
- Rescue pulley
- [Pickets and ice screws]
- Crampons adjusted to boots

- *MICROspikes
- *Powder baskets for trekking poles

ADDITIONAL WARM CLOTHES

- Base layer: Consider heavier-weight top and bottom.
- Midlayers: Consider additional and heavier-weight layers for insulation.
- Shell layer: Consider sturdier or additional shell layers.
- Belay jacket: increasingly important as the temperature drops. Consider one for each climber (rather than shared).
- Head, hands, and feet: consider taking more items that can work as a system as well as backups.
- Boots: Consider more-robust mountaineering boots.

OTHER GEAR

- [Dedicated GPS device (extreme environments)]
- [Spare sunglasses]
- [Snow shovel]
- *Snowshoes or *skis
- *Avalanche transceiver
- *Avalanche probes
- *[Wands]
- *[Snow saw]
- *Hand and foot warmers
- *Thermos bottle

Before starting on the trail, fill water containers from a reliable source. In most environments, you need to have the ability to treat water—by filtering, using purification chemicals, or boiling—from rivers, streams, lakes, and other sources. In cold environments, you will need a stove, fuel, pot, and lighter to melt snow. Daily water consumption varies greatly. For most people, 1.5 to 3 quarts (approximately the same in liters) of water per day is enough; in hot weather or at high altitudes, 6 quarts may not be enough. Plan for enough water to accommodate additional requirements due to heat, cold, altitude, exertion, or emergency. See “Water” in Chapter 3, Camping, Food, and Water, for details on water sources and purification.

10. Extra Clothes

What extra clothes are necessary for an emergency beyond the basic climbing garments used during the active portion of a climb? The term "extra clothes" refers to additional layers that would be needed to survive the long, inactive hours of an unplanned bivouac. Ask this question: *What extra clothes are needed to survive the night in my emergency shelter in the worst conditions that could realistically be encountered on this trip?*

An extra layer of long underwear can add warmth without adding much weight. An extra hat or balaclava will provide more warmth for its weight than any other article of clothing. For your feet, bring an extra pair of heavy socks; for your hands, an extra pair of mittens. For winter and expedition climbing in severe conditions, bring more insulation for your torso as well as your legs. (See "Choosing a Cold-Weather Strategy" sidebar, earlier in this chapter.)

OTHER IMPORTANT ITEMS

Many items in addition to the Ten Essentials are, of course, useful for climbing. Every climber has an opinion and with experience all climbers develop their own preferences. Think ahead. Take time periodically to envision scenarios of possible accidents and unexpected circumstances, including being separated from your party, lost and alone. What would you do in those situations? What equipment would be necessary to be prepared? What risks are you willing to accept?

Ice Axe

Indispensable for preventing or arresting falls on steep snow and glaciers, an ice axe is very useful on snow-covered alpine trails and for traveling in steep heather, scree, or brush; for crossing streams; and for digging sanitation holes. (For details on ice axes and their uses, see Chapter 6, Wilderness Travel, and Chapter 16, Snow Travel and Climbing.)

Crampons and MICROspikes

While an ice axe is indispensable, especially for arresting a fall on steep snow or ice, crampons help prevent a fall from occurring. On icy alpine trails, MICROspikes—essentially "tire chains" for your boots—can prevent an unintended triple axel into a tree. (See "Crampons" in Chapter 16, Snow Travel and Climbing to learn more.)

Trekking Poles

Trekking poles help propel climbers uphill and brake on the way down. They offer stability to cross streams and travel on snow or scree. They redistribute effort across arms and legs, minimizing the peak loads on leg muscles to increase overall endurance.

Some climbers shorten adjustable trekking poles slightly when traveling uphill (fig. 2-10a) and lengthen them slightly when traveling downhill (fig. 2-10b). If you need to change their length quickly, for example, when traversing uneven terrain, slide your uphill hand as far as necessary down the shaft of the pole below the handle (fig. 2-10c). Using the wrist strap is a bit counterintuitive. First, put your hand up through the strap and then grab both the strap and pole grip so that the strap comfortably supports the wrist. To scramble a short, steep section, let the poles dangle by the wrist straps. For a longer stretch, collapse the poles and stow them in the pack. Some ultralight tents use trekking poles in lieu of tent poles to save weight (see Chapter 3, Camping, Food, and Water).

CHOOSING TREKKING POLES

Take these features into consideration when choosing trekking poles:

- **Grips.** Foam or cork grips are designed for bare hands. Rubber grips are for use with gloves but tend to cause blisters on bare hands.
- **Shafts.** Aluminum poles tend to bend before they break. Carbon fiber poles are lighter but more expensive and may fracture unexpectedly.
- **Shock absorbers.** They add weight and cost, but some people prefer them.
- **Baskets.** Most poles come with small snow baskets, helpful also on ground or rock where it's easy to catch a pole tip. Larger baskets are useful when the snow is soft.
- **Tips.** Carbide steel withstands abrasion.
- **Length.** Most poles are adjustable using a locking mechanism; they should be long enough to allow a 90-degree angle at the elbow when standing on level ground. Poles should telescope or fold for easy stowing inside the pack. Women's trekking poles are shorter and have smaller grips.
- **Locking mechanisms.** Older designs primarily used twist-locks, which were prone to slipping when weighted. External lever and push-

button locks are more secure and quicker to adjust in the field. Folding poles use an internal cord to keep sections together and tightly aligned.

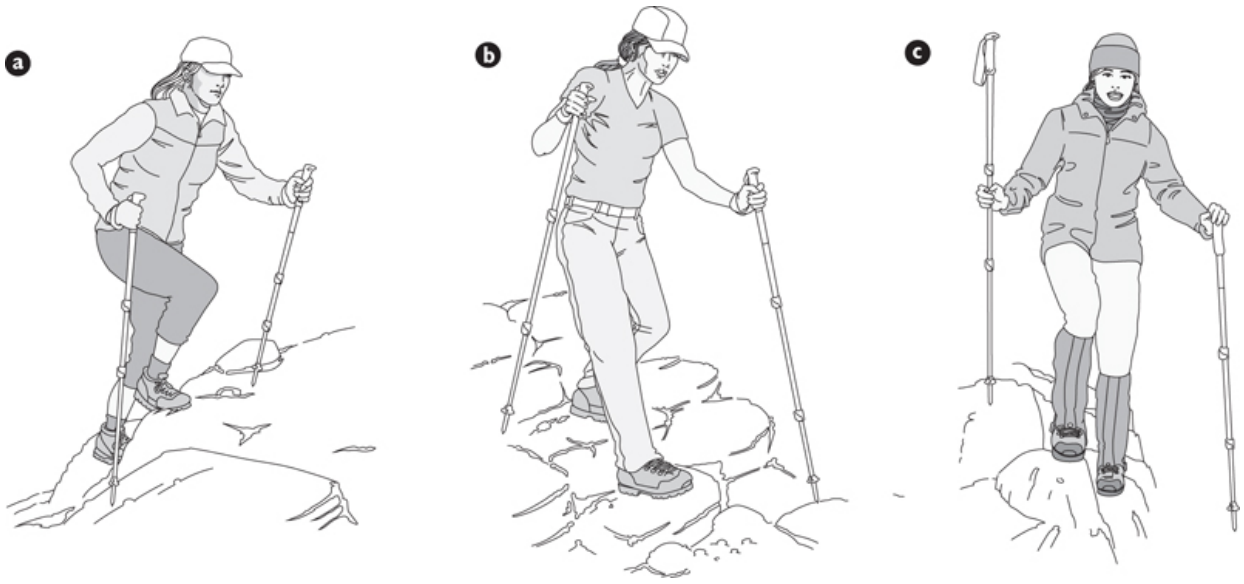

Fig. 2-10. Using trekking poles while traveling: a, shorten poles to go uphill; b, lengthen poles to go downhill; and c, slide hand down the uphill pole for quick changes as needed when scrambling in uneven terrain.

Toilet Kit

A toilet kit might consist of paper, sanitary wipes, a small digging trowel, "blue bags," and hand sanitizer. Location and regulations will dictate actions, but each climber needs to act responsibly to not allow human waste to foul the wild spaces we all love. Typically, alpine areas lack toilet facilities and so climbers must transfer all feces and toilet paper into blue bags, and store them at the bottom of their packs. Alpine areas have no soil to decompose feces or toilet paper, which if left behind foul the area for decades. Lower-elevation sites may have sufficient soil to aid the decomposition of feces, but few areas have sufficient capacity to decompose toilet paper. Wipes are primarily made from polyester and do not decompose. Climbers should always plan to remove toilet paper and wipes for disposal at the end of the trip. (See "Managing Human Waste in the Mountains" in Chapter 7, Leave No Trace, for proper disposal procedures.)

Insect Repellent

Some insects—mosquitoes, ticks, chiggers, biting flies, no-see-um gnats—feast on the human body. In the United States in the past 20 years we have seen a substantial increase in reported cases of mosquito-borne and tickborne diseases. For winter trips or for snow climbs any time of year, insect repellent may be unnecessary; for a lowelevation summer approach, however, thwarting these pests may be essential. When traveling in areas in the United States with disease-carrying mosquitoes (think Zika virus and West Nile virus) or disease-carrying ticks (think Lyme disease and Rocky Mountain spotted fever), take extra precautions to avoid being bitten and infected. Internationally, the situation is more complicated and the risk of malaria, Zika, and dengue loom large. In tropical areas, antimalaria medications and bednetting may be warranted.

CHOOSING A BUG DEFENSE STRATEGY

- First, wear pants, long sleeves, et cetera, as a physical barrier.
- Wear factory- or home-applied permethrin-treated clothes.
- Apply insect repellent to clothes in the field.
- Lastly, carefully apply the minimum needed insect repellent to skin.

TABLE 2-6. CHOOSING INSECT REPELLENTS

If insects are expected to be a potential health hazard and not just an annoyance, use multiple lines of defense: protective clothes, clothes treated with permethrin, and insect repellents applied in the field.

ACTIVE INGREDIENT (available concentrations)	APPLICATION	EFFECTIVENESS AGAINST		
		Mosquitoes	Ticks & Chiggers	Biting Flies & Blackflies
Field Application				
DEET (5%–100%)	Clothes and skin	2–12 hours	2–10 hours	Poor
Picaridin (5%–20%)	Clothes and skin	4–14 hours	6–14 hours	Good
IR3535 (7.5%–20%)	Clothes and skin	2–10 hours	2–8 hours	Yes
Oil of lemon eucalyptus (30%–40%)	Clothes and skin	6 hours	6 hours	Yes
Home or Factory Application				
Permethrin (0.5%–10%)	Clothes only	Yes	Yes	Yes
Avoid				
Citronella and other natural ingredients	Not applicable	No	No	No

Notes: "Yes" means the repellent's effectiveness in number of hours has not been quantified; "No" means it did not meet the benchmark of more than 2 hours' proven repellency. Permethrin applied at home is good through several launderings; factory applications claim effectiveness for the life of the garment. Catnip oil sold as "refined oil of nepeta cataria 7% lotion" is a new, natural ingredient, registered effective against mosquitoes but not ticks.

The first line of defense against voracious insects is covering up with clothes heavy enough to provide a physical barrier, including gloves and head nets in really buggy areas. In hot weather, long shirts and pants made of netting may prove worthwhile.

The next defensive measure is wearing factory- or home-applied permethrin-treated clothes as a chemical barrier and applying a spritz of (non-permethrin) repellent (for example, picaridin) as needed in the field to the outer layer of clothing—whether permethrin treated or not. A solid application to hat and scarf helps protect the face. Pay particular attention to socks as mosquitoes have an uncanny ability to target ankles. Finally, carefully apply an appropriate insect repellent to exposed skin being especially careful around the face. And know that sometimes the bugs win the battle; retreating to a tent with a full bug screen may be the only way to preserve sanity.

In the United States, insect repellents must be registered with the Environmental Protection Agency (EPA) and have solid evidence for all safety and effectiveness claims (Table 2-6). There are currently only five active ingredients with EPA registrations that claim to repel mosquitoes and ticks for more than two hours: DEET, picaridin, permethrin, IR3535, and oil of lemon eucalyptus. Botanical oils (citronella, soybean, lemongrass, cedar, et cetera) are no better than minimally effective. Insect repellents come in spray, liquid, cream, stick, and wipe forms and in various concentrations, with sprays the only easy option for clothes. Treated wristbands, vitamin supplements, garlic, and ultrasonic repellents are all equally ineffective.

Be extra bug-vigilant between dawn and dusk when bugs bite most. Mosquitoes have trouble tracking targets in windy conditions so camp and take breaks accordingly. When using sunscreen and repellent, first apply sunscreen and allow it to dry. After it has dried, apply the repellent. To minimize your attractiveness to insects (and bears!), avoid wearing fragrances. In tick country—especially on days when you have been thrashing through brush—check your clothes, body, and hair thoroughly at night.

DEET. Developed in 1944 for the US Army, DEET entered civilian use in 1957 and it is still the gold standard against mosquitoes, although permethrin and picaridin are solid competitors. One application of a repellent with a high concentration or a controlled-release formula of DEET will keep mosquitoes from biting for several hours, though they may still hover about annoyingly. Be aware that DEET is a powerful chemical that can dissolve plastics and

synthetic fabrics. While products can be purchased in varying concentrations up to 100 percent, a 30 percent concentration is safer and likely sufficient. For multihour protection use a 30 percent concentration in a time-release formula. DEET is not very effective at repelling biting flies. Permethrin-treated clothes and picaridin repellents are better against blackflies, deer flies, and gnats.

Permethrin. *For long-lasting use on clothes only,* never on skin, permethrin is the synthetic chemical analog to the naturally occurring chemical found in chrysanthemum flowers. It is the only insect repellent registered for factory treatment of clothes. The amount of permethrin allowed in clothes is very low and is poorly absorbed through the skin, so is not a safety concern. The more members of the party that use permethrin-treated clothes, the more effective it will be. Permethrin-treated clothes are odorless and compatible with being sprayed with the other four repellents listed here.

Picaridin (also known as Icaridin, KBR 3023, Bayrepel, and Saltidin). Available in Europe since 2001 and first registered with the US EPA in 2005, this odorless, nongreasy, non-plastic-melting repellent is preferred by many to DEET. Picaridin is recommended to repel disease-carrying mosquitoes by both the World Health Organization and the US Centers for Disease Control and Prevention. The EPA allows claims for up to 14 hours for the 20 percent concentration.

IR3535. According to the EPA, "IR3535 has been used as an insect repellent in Europe for 20 years with no substantial adverse effects."

Oil of lemon eucalyptus (also known as OLE and PMD). Commercially available oil of lemon eucalyptus is chemically synthesized to mimic a naturally occurring molecule similar to menthol. This ingredient is effective against mosquitoes, ticks, biting flies, and gnats.

LOCAL COMMUNICATION DEVICES

The climbing party may need tools for communicating locally. Whistles, avalanche transceivers, and walkie-talkies may facilitate communication among a climbing party that finds itself spread out along the route or to locate a lost or incapacitated member.

Whistle. A whistle's shrill, penetrating blast greatly exceeds the range of the human voice and can serve as a crude means of communication in situations in which shouts for help cannot be heard—such as being trapped in a crevasse or becoming separated from the party in fog, darkness, or thick forest. Whistles prove much more useful if a climbing party designates

specific signals before the trip for "Where are you?," "I'm here and OK," and "Help!" Three signals from any signaling device, repeated several times in sequence, is universal for "SOS."

Avalanche transceiver. Conditions may call for mountaineers to carry avalanche transceivers, used to locate victims of a snowslide. See Chapter 16, Snow Travel and Climbing, for detailed instructions on using avalanche transceivers.

Walkie-talkie or handheld two-way radio. The sounds of wind and water and physical obstacles between the two ends of a climbing rope can make communication difficult. Walkie-talkies can greatly ease communication between climbing partners or between a climbing party and base camp. Walkie-talkies include both family radio service (FRS) two-way radios and handheld amateur "ham" radios. FRS radios are commonly used by climbing parties for short-range communications (up to a few miles or kilometers). Modern handheld amateur "ham" radios are inexpensive, lightweight, and in some areas, can communicate worldwide through "repeaters." They are more complex than FRS radios. To be useful, all walkie-talkies in the party must be set to operate at the same frequency. Bring sufficient batteries. For summoning help in remote mountain areas, walkie-talkies are generally not reliable. Carry a PLB, satellite communicator, or satellite phone instead.

More tools. In the field, route markers can aid the return trip where the party lacks redundant GPS capability, or otherwise mark dangers such as crevasses. Remove route markers (such as glacier wands) after use to leave no trace.

BATTERIES

An expanding list of backcountry electronics—including GPS devices, satellite communicators, headlamps, walkie-talkies, and avalanche beacons—run on batteries so battery type and size are part of the equipment checklist. The standard batteries for most devices are 1.5 volt AA and AAA. AA cells contain roughly twice the capacity of the smaller AAA at a similar price. Batteries operate through chemical processes adversely affected by cold temperatures; Table 2-7 compares overall performance of batteries at low temperatures.

TIPS FOR USING ELECTRONIC DEVICES IN COLD WEATHER

- Use disposable lithium batteries where possible; bring extras.
- Use your pockets and sleeping bag to keep electronics as warm as possible.
- Cycle batteries and backups through warm pockets.

TABLE 2-7. BATTERY PERFORMANCE AT COLD TEMPERATURES

TEMPERATURE IN DEGREES	DISPOSABLE ALKALINE	LITHIUM	RECHARGEABLE NiMH	Li-ION
Overall	Poor	Excellent	Poor	Excellent
32°F (0°C)	70%	100%	75%	90%
-4°F (-20°C)	25%	80%	25%	80%
-40°F (-40°C)	0%	50%	0%	50%

Note: The minimum recommended operating temperature for each type of battery (in order from left to right) is -4° (-20°), -40° (-40°), 32° (0°), -40° (-40°).

Alkaline batteries. Alkaline batteries are the most commonly available general-purpose batteries. Their major problem is that voltage (hence, brightness) drops significantly as they discharge. Cold temperatures drastically accelerate this voltage drop, resulting in much shorter battery life.

Lithium batteries. Much longer lasting and lighter than alkaline, lithium batteries also cost more. Voltage remains almost constant over their charge, and efficiency at 0 degrees Fahrenheit (minus 18 degrees Celsius) is nearly the same as at room temperature. The more powerful the electronic device, the bigger the advantage lithium batteries have over alkalines. Cold temperatures compound this advantage. For cold-weather trips, lithium batteries are the clear choice for high-powered headlamps and other critical devices such as the SPOT Messengers.

Rechargeable batteries. One popular strategy is to use rechargeables for main batteries and disposable batteries as spares. Nickel–metal hydride (NiMH) rechargeables have replaced the once common nickel-cadmium (NiCd) in standard AA and AAA sizes, while lithium-ion (Li-ion) batteries are usually found in higher-voltage consumer electronics such as phones. Caution: NiMH batteries tend to self-discharge rapidly in storage at approximately 30 percent per month. Always start with a full charge.

Lithium-ion batteries. Li-ion batteries (not to be confused with disposable lithium batteries) are the power plants inside phones, cameras, and most battery packs (see below). Li-ion batteries are not yet available in standard 1.5 volt AA and AAA sizes. Li-ion batteries perform well in cold temperatures.

Portable battery packs. Based on Li-ion technology, battery packs are a handy way to store additional power to recharge Li-ion-powered devices such as phones and cameras. Their capacity is rated in milliamp hours (mAh), with about 3000 mAh currently needed to recharge a cell phone. Make sure they are fully charged at the start of each trip.

Solar panels. Affected by weather, length of day, and sun exposure, the use of portable solar panels requires planning and attention. The higher a panel's wattage, the faster it charges. While panels can charge devices directly, each passing cloud might interrupt the process. A more reliable alternative is to charge an intermediate portable battery pack.

Regardless of your choice, make sure you start each trip with batteries compatible with your headlamp and navigation tools, all with more than sufficient charge to handle any reasonable emergency.

PREPARING FOR THE FREEDOM OF THE HILLS

When you go into the wilderness, you should carry essential gear and leave the rest at home. Achieving that balance takes knowledge and good judgment. Understanding the basics of clothing and equipment will help you decide on those essentials needed to be safe, dry, and comfortable in the mountains. This is only the beginning of your discovery of the freedom of the hills. The next chapter on camping, food, and water will further expand your horizons.